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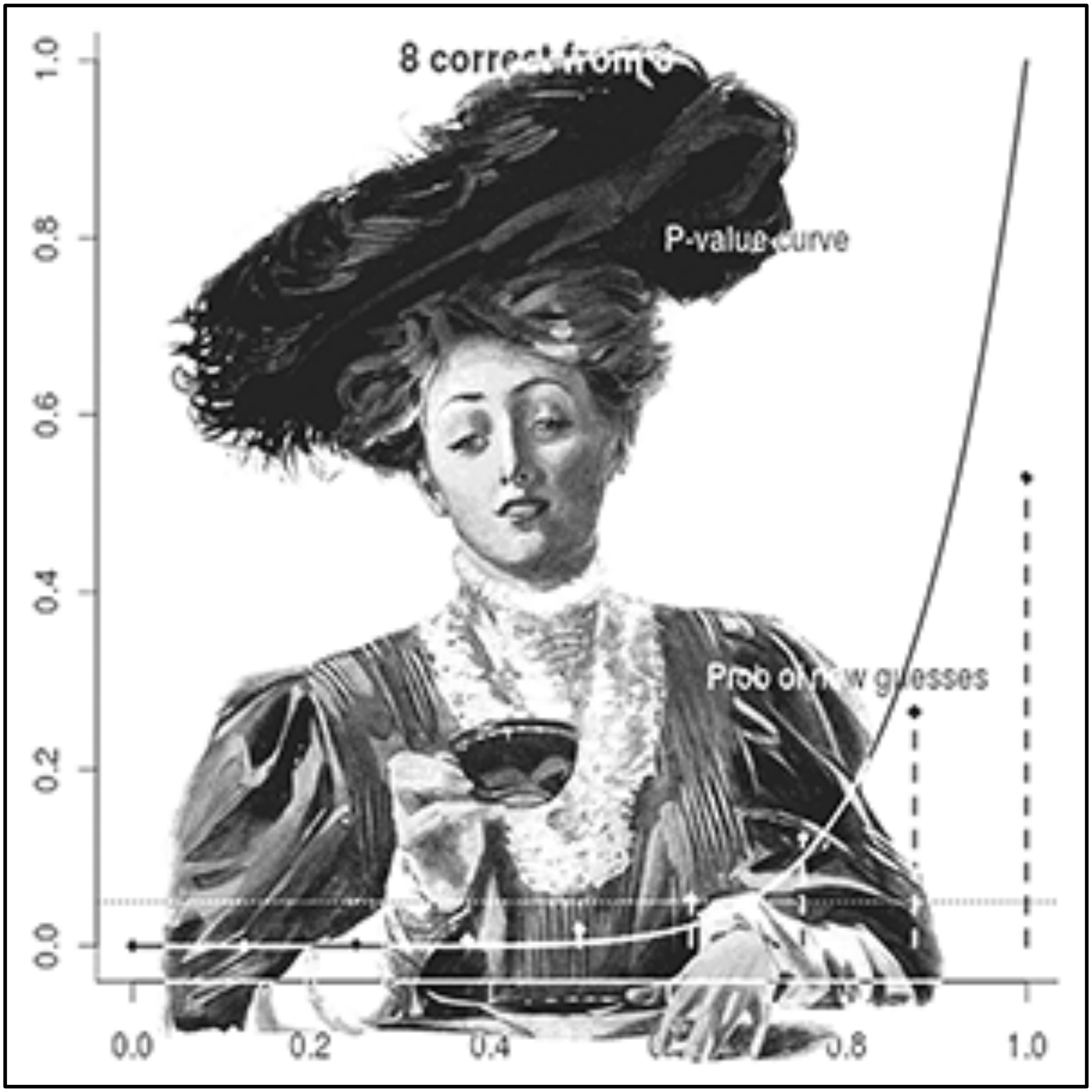
STATure



*STAT*istical applications for *u*ndergraduate *r*esearch *e*xploration

McMaster University

The field of statistics is the study of learning from data. Statistical learning causes you to utilize the best possible strategies to gather the information, utilize the right investigations, and adequately present the outcomes. Statistics is an urgent procedure behind how we make disclosures in science, settle on choices dependent on information, and make predictions. Statistics is an energizing field about the rush of discovery, learning, and challenging your assumptions.

LIFESCI 3LL3 - Living Systems Laboratory Practicum is a lab-based statistics course that provides students with the opportunity to explore various areas of study within the Life Sciences in a small-group learning environment. Students work with large data sets and SPSS software to gain knowledge in the field of scientific research. They learn to develop research questions, run appropriate statistical tests on their data, and compose the basic requirements for a scientific manuscript.

This **STATure** (**STAT**istical applications for **u**ndergraduate **r**esearch **e**xploration) publication is a compilation of the final report submissions created by the students in the Fall 2021 course. Each report is unique, and tells an interesting statistical story while facilitating the formation of new learning.

I hope you enjoy learning about statistics as you read these reports.

Dr. Janet Pritchard (Course Creator and Instructor)

Cover Art – An artistic impression of Dr. Muriel Bristol (1888-1950) who claimed to be able to tell whether the tea or the milk was added first to a cup. This lead Dr. Ronald Fisher (1890-1962) to devise the steps to test this hypothesis and eventually create the foundations for modern statistical science. (downloaded from https://thedailyomnivore.net/2015/06/08/lady-tasting-tea/)

Inside Art - A Bird in Flight. Hamid Naderi Yeganeh (1990-) is an Iranian mathematical artist and digital artist. He is known for using mathematical formulas to create drawings of real-life objects, intricate illustrations, animations, fractals and tessellations. This image was chosen for this initial STATure publication to represent taking flight of this exciting course.
Wikimedia Creative Commons. (https://archive.org/details/ABirdInFlight_201504)

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Between Group Differences in Proportions of Responses Indicate Relationship Between The Ability to Meet Financial Obligations During COVID-19 and Change in Cannabis Consumption, but not in Alcohol Consumption in Canadian Individuals Aged 15-34: A Cross-Sectional Study

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LIFESCI 3LL3: Living Systems Laboratory Practicum

Dr. Janet Pritchard

December 10, 2021

Introduction

The COVID-19 virus & pandemic has had a major impact on the global population. Interventions like quarantine, lockdowns, and social isolation have disrupted routines and normal day-day functions. These interventions have been shown to have significant negative psychological impacts (Wang et al., 2021). In a nationwide cross-sectional survey study to examine the health impacts of the pandemic, it was found that among Canadian adults, there was an increase in mental deterioration and stress, particularly among structurally vulnerable groups, like people of lower socioeconomic status (Jenkins et al., 2021).

There are different types of stress an individual may encounter. Relevant pandemic-related stressors include general stress from mental health, stress from contracting COVID-19 and of one's own health, relationships & social isolation, life disruptions, financial situation, and the health of family members and loved ones (Gadermann et al., 2021). A survey from the Canadian Centre on Substance Use and Addiction (CCSA) found financial related stress as the top ranked stressor during the pandemic (Canadian Centre on Substance Use and Addiction [CCSA], 2020b). This involves stress regarding employment status, ability or inability to access benefits, or other general credit/debt matters (Gadermann et al., 2021). However, of particular interest is the stress of being able to meet basic financial obligations (like paying for bills, rent, utilities, & food), which combined for 66% of financial stress of Canadian adults within the pandemic (Gadermann et al., 2021).

The elevation in stress levels has also elicited an increase in substance use, including cannabis and alcohol (Jenkins et al., 2021). When examining results depicting substance use amid the COVID-19 pandemic in Canadian adults, a study found that cannabis and alcohol had increased usage compared to other substances, with cannabis being used the most specifically among vulnerable people of lower-income (Jenkins et al., 2021). Additionally, an independent poll conducted by the CCSA found that younger Canadians (aged 18-34) were more likely to report an increase in their consumption of both cannabis and alcohol (CCSA, 2020a).

This is an expected outcome. Cannabis has been shown to combat stress, reducing its symptoms by nearly 94% in controlled sessions (Cuttler et al., 2018). Alcohol has also been shown to reduce stress in certain situations (Sayette, 1999). Various literature reviews have already demonstrated relationships between substance use and general stress within the pandemic. However, to our knowledge, there lacks a study specifically examining the relationship between the stress of meeting basic financial obligations and consumption habits of substances (like cannabis and alcohol). Particularly in Canadians aged 18-34, it remains unknown if there is a significant relationship between the two variables and how substance consumption habits differ between individuals whose ability to meet financial obligations were impacted by the pandemic or not. Financial stress of meeting obligations and essential needs is among the top stressors within the pandemic. Research is needed to better ascertain its impact to further inform interventions on potential mitigating solutions to reduce substance use.

In order to address this niche in literature, our group proposed the following research question: Is there a relationship between the ability to meet financial obligations and essential needs (specifically, meeting rent/mortgage payments, or paying for utilities and groceries) within the COVID-19 pandemic, and changes in weekly habits of substance use (notably cannabis and alcohol consumption) in Canadian individuals aged 15-34 (residing in a province; not including Yukon, Nunavut, & the Northwest Territories), compared to individuals of the same demographic whose financial obligations and needs are not impacted by the pandemic?

The primary outcome is the change in weekly habit of consuming cannabis. The secondary outcome is the change in weekly habit of consuming alcohol. Based on prior literature and background knowledge, our group hypothesizes that between group differences in proportions of responses for both primary and secondary outcomes will be significant, indicating relationships between the independent variable and outcomes.

Methods

The database that was chosen for the study was the “Canadian Perspective Survey Series 2, 2020 (CPSS): Monitoring the Effects of COVID-19” (Statistics Canada, 2020). The CPSS collected cross-sectional data (Polsky et al., 2020) from an online survey and information on the knowledge and behaviours of the people residing within the ten Canadian Provinces. This survey, in particular, collected information on the impacts of the pandemic on food security, mental health, and social & employment circumstances. The database randomly selected the participants from the Labour Force Survey (LFS). The LFS sampled from an area frame based on a stratified, multi-stage design that uses probability sampling. 31,896 randomly selected people from responding LFS households and a subset of participants from the Impacts of COVID-19 crowdsource collection were invited to join a panel. Of those, 31,626 agreed to join the panel, and only 7,242 had valid email addresses, who were invited to complete the CPSS survey, of which only 4,600 completed it. In addition, LFS uses a rotating panel sample design, which means that selected dwellings remain in the LFS sample for six consecutive months. For instance, each month, about one-sixth of the LFS sampled dwellings are in their first month of the survey and one-sixth in the second month. The survey’s data collection began on May 4th and ended on May 10th, 2020.

The database randomly selected individuals from the LFS sample and full-time members of the Canadian Armed Forces. Exclusion criteria of participants included people who did not complete the survey, had invalid or missing data, resided on reserves and other Aboriginal settlements, the institutionalized population, and households in remote areas. These individuals were excluded because the regions they dwelled in usually had very low population density and the database wanted to observe social circumstances. The institutionalized were not included because the population does not comprise members of households. The database collected data from people residing only in the provinces, not the territories. Participant focus for this study was directed on individuals who reported being employed and not absent at work, as well as respondents that are part of age groups who usually had higher rates of substance abuse, specifically 15 to 34 years old. Altogether, 448 participants out of 4,600 were analyzed.

The independent variable was the ability to meet basic financial obligations during the pandemic because it gave a general overview of the impact COVID-19 had on financial circumstances. The dependent variables include any changes in the individual's habit of consuming cannabis (primary outcome) or alcohol (secondary outcome). The study is explicitly researching the changes in cannabis and alcohol consumption because usage of cannabis and alcohol is generally higher than other substances (Jenkins et al., 2021). Their details are further described in the data codebook.

The additional data outcomes were the demographic variables used in Table 1 to describe the population better. This includes the respondent's age group, sex, and employment status, which was important to consider in the research. In order to pay off expenses, an individual needs to have an income that one gets from being employed. This variable was used to filter the data only to include employed participants. Telework status, which stated the work location of the participant, filtered out participants absent from work. Perceived mental health was also included to indicate the respondent's mental health status based on their judgement. Since mental health is commonly associated with substance abuse and impacts the individual's financial situation (Czeisler et al., 2020). Higher scores indicated positive perceived mental health status. Their details are further described in the data codebook.

The SPSS Software, Version 28, was used to conduct the analysis. In Table 1, primary study outcomes and the additional outcomes were included to further describe our population and demographic. All of the variables in question had discrete values, not continuous, so normality tests were impossible to conduct. Instead, dichotomous variables 'Financial_Impact', 'Alcohol_Change' and 'Cannabis_Change' were created. Each of the variables had two categories, for which a 2x2 chi-square table was created to compare the proportions of participants who fall into those categories. For the alcohol and cannabis variables, the categories were either 'increase' or 'no increase'. From the chi-square analysis, two double bar graphs were produced, one for each dependent variable, to show the difference of how many participants had an impact on either consumption of cannabis or alcohol from their financial circumstances.

Data Codebook

SPSS Name	Variable Label	Question	Coding Instructions	Variable Description	How will the variable be used?
LM_40	COVID-19 impacts the ability to meet financial obligations or essential needs	Which of the following describes the impact of COVID-19 on your ability to meet financial obligations or essential needs, such as rent or mortgage payments, utilities and groceries?	1=Major Impact 2=Moderate Impact 3=Minor Impact 4=No impact 5=Too soon to tell	Discrete Ordinal Independent Variable Primary Outcome	Mainly used to test the relationship with changes in weekly habits for consuming alcohol and/or cannabis.

BH_40 C	Change in weekly habits - Consuming cannabis	Have your weekly habits changed for any of the following activities? - consuming cannabis	1=Increased 2=Decreased 3=Not Applicable	Discrete Ordinal Dependent Variable Primary Outcome	Mainly used to test the relationship with the ability to meet financial obligations or essential needs in COVID-19.
BH_40 A	Change in weekly habits - Consuming alcohol	Have you weekly habits changed for any of the following activities? - consuming alcohol	1=Increased 2=Decreased 3=Not Applicable	Discrete Ordinal Dependent Variable Primary Outcome	Mainly used to test the relationship with the ability to meet financial obligations or essential needs in COVID-19.
AGEG RP	Age group of respondent	-	1=15 to 25 years old 2=25 to 34 years old 3=35 to 44 years old 4=45 to 54 years old 5=55 to 64 years old 6=65 to 74 years old 7=75 years and older	Discrete Interval Secondary Outcome	Used to filter out data to focus on age groups that are said to have higher rates of substance abuse and to better answer the research question.
SEX	Sex of respondent	-	1=Male 2=Female	Discrete Nominal Tertiary Outcome	Used to describe the demographic of the population in Table 1.
PEMP STC	Employment status	-	1=Employed and at work at least part of the reference week 2=Employed but absent work for reasons not related to COVID-19 3=Employed but absent from work due to COVID-19 4=Not employed	Discrete Nominal Secondary Outcome	Used to filter out unemployed participants. Along with observing the association with the ability to meet financial obligations and essential needs in COVID-19, in Table 1.

PTELE WSC	Telework Status	-	1=Work location has changed from outside the home to at home 2=Work location remains at home 3=Work location remains outside the home 4=Absent from work	Discrete Nominal Secondary Outcome	Used to filter out participants who were absent from work.
MH_05	Perceived mental health	In general, how would you describe your mental health?	1=Excellent 2=Very good 3=Good 4=Fair 5=Poor	Discrete Ordinal Tertiary Outcome	Used to further describe the population in Table 1 and observe its impact on meeting financial obligations and essential needs in COVID-19.

There are no continuous variables present within the dataset being used for this study.

Results

Table I. Financial obligations and cannabis/alcohol consumption. Reported the count of individuals who did or did not experience financial impact due to Covid-19 corresponding to participant characteristics.The participants included employed Canadian individuals (male and female) aged 15-34 with different mental health statuses residing in a province (not including Nunuavut, Northwest Territory and Yukon).

		Impact of meeting financial obligations		
Count		Not Impacted	Impacted	N
Sex of respondent	Male	106	83	189
	Female	166	93	259
	N =	272	176	448
Age group of respondents	15 to 24 years old	38	41	79
	25 to 34 years old	234	135	369
	N =	272	176	448
Change in cannabis consumption (increase or not increased)	No Increase	245	142	387
	Increase	27	34	61
	N =	272	176	448
Change in Alcohol consumption (increase or not increased)	No increase	205	119	324
	Increase	67	57	124
	N =	272	176	448
Employment status	Employed and at work at least part of the reference week	272	176	448
	N =	272	176	448
Perceived mental health	Excellent	32	15	47
	Very good	71	48	119
	Good	100	61	161
	Fair	54	39	93
	Poor	15	13	28
	N=	272	176	448

Data are presented as the number (%) of participants unless otherwise noted. "N" represents the number of individuals.

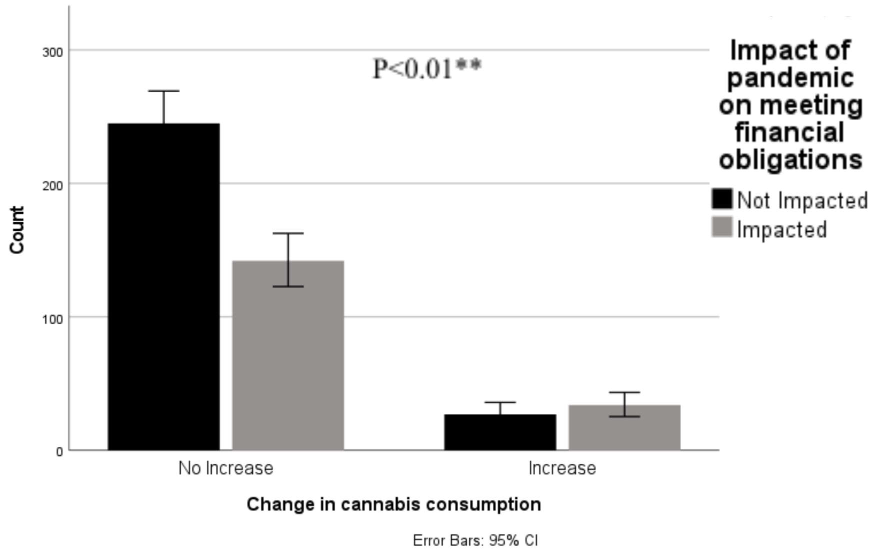

Figure 1. Clustered bar count of impact on cannabis consumption by financial impact. The 7.6 % (34/488) participants experienced financial impact and increase in weekly cannabis consumption. 31.7% (142/488) participants experienced financial impact and no increase in weekly cannabis consumption. For participants that are financially impacted, the amount that experienced increased in weekly cannabis consumption is less that than the participants that experienced no increase in weekly cannabis consumption. The p-value is 0.007. The graph shows a 95% confidence interval.

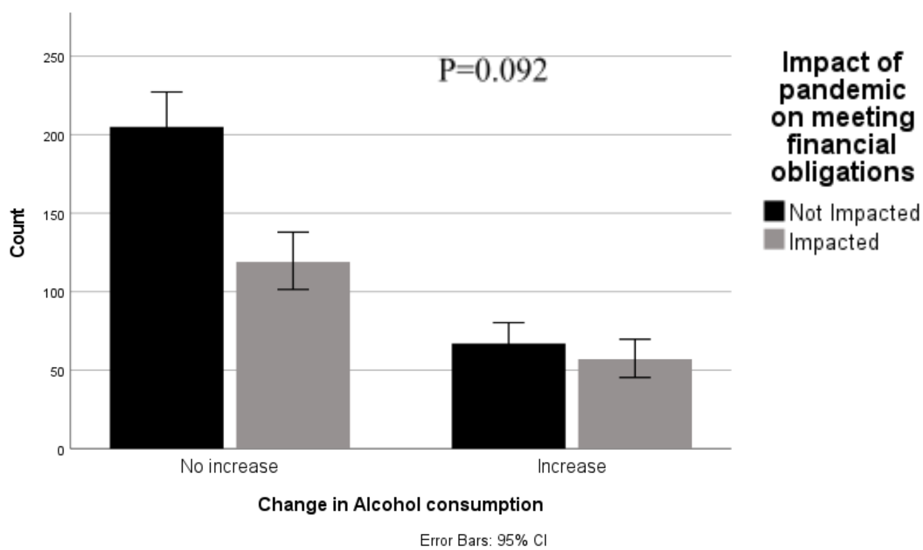

Figure 2. Clustered bar count of impact on alcohol consumption by financial impact. From the participants that experienced financial impact due to Covid-19 pandemic, the bar increase in

weekly alcohol consumption is less than the bar that shows no increase in alcohol consumption change. The 12.7 % (57/488) participants experienced financial impact and increase in weekly cannabis consumption. 26.6% (119/488) participants experienced financial impact and no increase in weekly cannabis consumption. The P-value is 0.092. The graph shows a 95% confidence interval.

Table II. Chi-Square correlation between Financial impact and Weekly Cannabis Consumption. The footnote of the table applies to the expected count for each cell. Because the statistic of the test is based on a 2x2 cross tabulation table, the degree of freedom is 1. The P-value for this test statistic is 0.007.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.013[a]	1	.005		
Continuity Correction[b]	7.235	1	.007		
Likelihood Ratio	7.820	1	.005		
Fisher's Exact Test				.007	.004
Linear-by-Linear Association	7.995	1	.005		
N of Valid Cases	448				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 23.96.

b. Computed only for a 2x2 table

Table III. Chi-square correlation between Financial impact and Weekly Alcohol Consumption. The footnote of the table applies to the expected count for each cell. Because the statistic of the test is based on a 2x2 cross tabulation table, the degree of freedom is 1.The P-value for this test statistic is 0.092.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.210[a]	1	.073		
Continuity Correction[b]	2.834	1	.092		
Likelihood Ratio	3.179	1	.075		
Fisher's Exact Test				.084	.047
Linear-by-Linear Association	3.202	1	.074		
N of Valid Cases	448				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 48.71.

b. Computed only for a 2x2 table

Discussion

The main findings of the study show that for the primary outcome (change in weekly habit of consuming cannabis), the between group differences in proportions of responses (those who mentioned meeting their financial obligations is impacted by the pandemic vs. those who reported not impacted) is significant, indicating a relationship between COVID-19 impact on meeting basic financial obligations and the primary outcome (variables are not independent of each other). The findings also show that for the secondary outcome (change in weekly habit of consuming alcohol), the between group differences in proportions of responses is not significant, indicating no relationship between COVID-19 impact on meeting basic financial obligations and the secondary outcome (variables are independent of each other). The results failed to support the hypothesis. A lack of significance for the between group differences in proportions of responses for the secondary outcome is an unexpected result. A possible reason for this may be due to accessibility of these substances. It may be the case that alcohol is less accessible to individuals (particularly youth who are under financial stress), thereby resulting in no increase of their change in alcohol consumption, and resulting in less of a difference in response in comparison to individuals whose financial obligations are not impacted by COVID-19.

The interpretation of the Chi-Square tests determines if there is a relationship between two variables, however, it does not tell us the size of the relationship. The results indicate a relationship between change in weekly cannabis use and financial obligations impacted by COVID-19 but the tests indicated that there was no relationship between change in weekly alcohol consumption and meeting financial obligations impacted by COVID-19. These results are different in comparison to other research. A study found that alcohol and cannabis consumption among young adults significantly increased due to COVID-19 disruptions, mainly financial strain (Papp & Kouros , 2021). However, this study used a smaller sample size of 295 participants, 18-21 year old's all originating from the same university (Papp & Kouros , 2021).

This is an age group that has been proven to be associated with an increased substance use behaviour and the results may not be applied to a national population as our study did (Skidmore et al., 2016). Our study looks at a more nationally representative sample which can better ascertain the impact of financial stress on substance use. Additionally, another study found that 13.3% of participants, especially young adults aged 18-24 years old, increased their substance use to cope with the stressors due to COVD-19 (Czeisler et al., 2020). It was also found that 40.9% of participants reported to have at least one adverse mental health condition relating to anxiety, depression, and trauma/stress disorders which caused the increase in substance use (Czeisler et al., 2020). Our results differed from this published study because of the targeted demographic. Czeisler conducted his study in the United States whereas ours was in Canada. With that, the United States has a greater substance use which may be the reason why COVID-19 had a greater impact on the participants in his study than ours did (Vigo et al., 2019). Our study reflects on an audience who may be a better representation of the global population for determining the impact of the inability to meet financial obligations due to COVID-19 on substance use since the United States is one of the worst countries for substance abuse.

A strength of our study is that the database used is nationally-representative (responses from all provinces). Additionally, it focuses specifically on individuals aged 15-34, an age group with increased cannabis and alcohol use compared to other age groups (CCSA, 2020a). However, the study has limitations to be discussed as well. First, based on the cross-sectional design of the study and the chi-square analysis used, although a relationship can be determined, causality between variables could not be established. Other statistical analysis methods like a Mann-Whitney U test could not be completed given the categorical and non-continuous nature of the data used in this study. Second, data responses obtained through the Odesi database are self-reported from participants which can be subject to participant bias and affect the overall validity of results obtained. Next, there are potential confounding variables (not accounted for) which may have impacted outcome results regarding the change in substance use consumption. Some examples may include accessibility to cannabis or alcohol, whether participants had prior experiences or addiction towards the substances, prior stress inducing traumatic experiences (impacting mental health), and other specific demographic variables like exact net income or area of residence (urban or rural setting). Another limitation is the inclusion criteria. Individuals from aboriginal and first nations reserves were not included in the study as data was not available. Previous studies have shown increased alcohol and cannabis usage in aboriginal youth within reserves (Lemstra et al., 2013). Thus, a lack of data collection from these participants/population may have impacted the obtained results of the study as well as limited the generalizability of the findings.

For next directions and steps, future research should broaden the inclusion criteria of participants to individuals not included in this study including individuals living within the territories as well as aboriginal participants from first nations reserves. This would increase generalizability and accuracy of results obtained. Additionally, further data collection of continuous variables should be explored (i.e. exact quantitative amount of substance consumption) in order to improve accuracy of results, as well conduct other statistical analyses like ANCOVA to better account for possible covariates influencing outcomes. Finally, future studies can expand on additional data collection such as researching individuals of other age groups to better understand how the stress of meeting financial obligations (brought forth by the pandemic) influences substance use. The findings of this study have serious clinical implications. The increased consumption of cannabis and alcohol has been associated with various negative symptoms, including weakening the immune system, making users potentially more vulnerable to viral diseases like COVID-19 (Borgonhi et al., 2021; World Health Organization, 2020). This poses serious problems towards public health. This study acts as a foundation in that it establishes a relationship between the stress of meeting financial obligations and substance use consumption (and how it differs between individuals who are impacted or not). Findings from this study can contribute to developing or improving the design of future interventions combating substance abuse. Politicians or health officials can use the results of this study to develop public health measures/policies which specifically aid individuals aged 15-34, including providing more income support or credits to mitigate the stress of meeting basic financial obligations.

References

Borgonhi, E. M., Volpatto, V. L., Ornell, F., Rabelo-da-Ponte, F. D., & Kessler, F. H. P. (2021). Multiple clinical risks for cannabis users during the COVID-19 pandemic. *Addiction Science & Clinical Practice, 16*(1), 5. https://doi.org/10.1186/s13722-021-00214-0

Canadian Centre on Substance Use and Addiction (2020). *COVID-19 and Increased Alcohol Consumption: NANOS Poll Summary Report.* https://www.ccsa.ca/sites/default/files/2020-04/CCSA-NANOS-Alcohol-Consumption-During-COVID-19-Report-2020-en.pdf

Canadian Centre on Substance Use and Addiction (2020). *Mental health and substance use during covid-19*. https://www.ccsa.ca/mental-health-and-substance-use-during-covid-19

Cuttler, C., Spradlin, A., & McLaughlin, R. J. (2018). A naturalistic examination of the perceived effects of cannabis on negative affect. *Journal of Affective Disorders, 235*, 198–205. https://doi.org/10.1016/j.jad.2018.04.054

Czeisler, M. É., Lane, R. I., Petrosky, E., Wiley, J. F., Christensen, A., Njai, R., Weaver, M. D., Robbins, R., Facer-Childs, E. R., Barger, L. K., Czeisler, C. A., Howard, M. E., & Rajaratnam, S. M. W. (2020, August 14). *Mental health, substance use, and suicidal ideation during the COVID-19 pandemic - United States, June 24-30, 2020*. MMWR. Morbidity and mortality weekly report. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7440121/.

Dumas, T. M., Ellis, W., & Litt, D. M. (2020). What does adolescent substance use look like during the COVID-19 pandemic? Examining changes in frequency, social contexts, and pandemic-related predictors. *Journal of Adolescent Health*, *67*(3), 354-361.

Gadermann, A. C., Thomson, K. C., Richardson, C. G., Gagné, M., McAuliffe, C., Hirani, S., & Jenkins, E. (2021). Examining the impacts of the COVID-19 pandemic on family mental health in Canada: Findings from a national cross-sectional study. *BMJ Open, 11*(1), e042871. https://doi.org/10.1136/bmjopen-2020-042871

Jenkins, E. K., McAuliffe, C., Hirani, S., Richardson, C., Thomson, K. C., McGuinness, L., Morris, J., Kousoulis, A., & Gadermann, A. (2021). A portrait of the early and differential mental health impacts of the COVID-19 pandemic in Canada: Findings from the first wave of a nationally representative cross-sectional survey. *Preventive Medicine, 145*, 106333. https://doi.org/10.1016/j.ypmed.2020.106333

Lemstra, M., Rogers, M., Moraros, J., & Caldbick, S. (2013). Prevalence and risk indicators of alcohol abuse and marijuana use among on-reserve First Nations youth. *Paediatrics & Child Health, 18*(1), 10–14. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3680265/

Papp, L. M., & Kouros, C. D. (2021). Effect of COVID-19 disruptions on young adults' affect and substance use in daily life. *Psychology of Addictive Behaviors, 35*(4), 391–401. https://doi.org/10.1037/adb0000748

Polsky, J. Y., & Gilmour, H. (2020). Food insecurity and mental health during the COVID-19 pandemic. *Health reports*, *31*(12), 3-11.

Sayette M. A. (1999). Does drinking reduce stress?. *Alcohol research & health : the journal of the National Institute on Alcohol Abuse and Alcoholism, 23*(4), 250–255.

Skidmore, C. R., Kaufman, E. A., & Crowell, S. E. (2016, October 1). *Substance Use Among College Students*. Child & Adolescent Psychiatric Clinic . https://www.childpsych.theclinics.com/article/S1056-4993(16)30064-5/fulltext.

Statistics Canada (2020). *Canadian Perspective Survey Series 2, 2020: Monitoring the Effects of COVID-19* (CPSS-5311-E-2020) [Data set].

Vigo, D., Psych, L., Jones, L., & Thornicorft, G. (2019, November 20). *Burden of mental, neurological, substance use disorders and self-harm in North America: A comparative epidemiology of Canada, Mexico, and the United States* . SAGE Journals. https://journals.sagepub.com/doi/full/10.1177/0706743719890169.

World Health Organization (2020). *Alcohol and COVID-19: What you need to know.* https://www.euro.who.int/en/health-topics/disease-prevention/alcohol-use/publications/2020/fact-sheet-alcohol-and-covid-19-what-you-need-to-know-2020

Switching From Cigarettes to E-cigarettes Provides Limited Evidence of Successful Smoking Cessation in Canadian Adult Smokers: An Observational Study

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December 8, 2021

Introduction

Tobacco usage is the leading global cause for preventable disease and mortality, presenting a substantial public health challenge around the world (Barringtion-Trimis et al., 2020). The most common form of tobacco usage is cigarette smoking which can increase the risk of cardiovascular diseases such as coronary heart disease and lung cancer, and can develop into fatal diagnosis (West, 2017). Smoking accounts for more than 8 million deaths worldwide, with an estimated rise to 10 million by 2030 (World Health Organization, 2021). In Canada and the United States, smoking is most prevalent among adults aged 45-54, and approximately 87% of adult daily smokers have started smoking before the age of 18 (Reid et al, 2019).

Despite the widespread awareness of the damaging health effects of smoking, millions of people continue to smoke because of the difficulty to quit (Chaiton et al., 2012). Researchers have observed that in Canada nearly 50% of smokers have made an attempt to quit smoking in the past year, and only less than 5% were still abstinent from smoking (Reid et al., 2016). Smokers experience pleasure and reduced stress and anxiety when nicotine is inhaled from tobacco smoke, a highly addictive compound that creates severe withdrawal symptoms from abstinence of smoking (Reid et al., 2016). Smoking is also challenging to quit because of the highly conditioned behavior that it presents under specific environments which become associated with the rewarding aspects of smoking and nicotine usage (Baumeister, 2017).

Cessation assistance such as pharmacotherapy and cessation counseling can substantially improve the success of quitting attempts in smokers (Cinciripini et al., 2013). Two thirds of smokers who attempted quitting smoking in the past two years used cessation assistance, including medications and nicotine replacement therapy (Reid et al., 2019). The most effective medications for cessation assistance include varenicline and bupropion which help to imitate the pleasurable effects nicotine has on the body without the risk of harmful toxicities (Cinciripini et al., 2013). Nicotine replacement therapy is aimed at reducing the symptoms of nicotine withdrawal by slowly delivering nicotine through inhalers, chewing gum, or oral sprays (Reid et al., 2016). One of the most popular methods of cessation assistance is electronic cigarette usage (Jackson et al., 2019).

For over a decade, electronic cigarettes (e-cigarettes) also known as vapes, have risen in popularity in countries around the world (Van Teijlingen et al., 2019). E-cigarettes are battery-operated devices that heat a solution containing nicotine, flavorings, and other chemical compounds into an aerosol that is inhaled (Vickerman et al., 2021). These devices allow the consumption of nicotine without the consumption of other cancerous chemicals like tar in traditional tobacco containing cigarettes (Van Teijlingen et al., 2019).

Public health officials have become divided in the inconsistent and contrasting research surrounding the safety and effectiveness of e-cigarettes (Pinsinger and Dossing, 2014). On one hand, there are concerns raised about the increased prevalence of e-cigarettes amongst youth, and health hazards that are yet unknown in adult users. A product initially marketed as a smoking cessation aid for adults is now 2-3 times more common among adolescents and young adults (Jamal et al., 2017). Studies have shown that e-cigarette usage can prompt youth into developing nicotine addictions and increases their chances of becoming lifetime cigarette users (Selya et al., 2017). There are also concerns over the damaging health effects of e-cigarette usage in adult smokers who may establish a long-term vaping addiction (Vickerman et al., 2021).

On the other hand, some research has shown that e-cigarettes can provide potential improvements in harm reduction and smoking cessation over conventional cigarettes (Gomajee et al, 2019). Research has shown that the use of sweet flavored e-cigarettes is positively related to transitioning smokers away from cigarettes (Li et al., 2021). Berry and researchers (2019) found that frequent e-cigarette use over 12 months is associated with a reduction in cigarettes smoked which can lower the risk of smoking related illnesses. Martínez and colleagues (2020) observed that the dual usage of e-cigarettes and smoking leads to a reduction in the number of cigarettes smoked, however they also observed an increase in total nicotine dependence which can present adverse health consequences. There is mixed evidence surrounding successful vaping induced smoking cessation as some randomized trials found that e-cigarettes can help cigarette smokers quit (Bullen et al., 2013), whereas other studies found no association between e-cigarette usage and smoking cessation (Rennie et al., 2016).

There has been limited definite research indicating whether or not switching from cigarettes to e-cigarette usage can indeed increase the likelihood of quitting smoking amongst current adult smokers (Biener and Hargraves, 2017). As a result, it is not yet known if transitioning to e-cigarettes presents a successful smoking cessation strategy for smokers (Hajek et al., 2019). Our study investigates if there is a difference in smoking status measured as current or former smoker in Canadian smokers aged 25 - 54 who tried to quit smoking cigarettes by switching to e-cigarettes compared to Canadian smokers aged 25 - 54 who have not tried to quit smoking cigarettes by switching to e-cigarettes. This aim is with hopes of obtaining a better understanding about the success rate of vaping-induced smoking cessation.

Methods

Study Design and Database

The Canadian Tobacco and Nicotine Survey (CTNS) 2019 measures the prevalence of cigarette smoking, e-cigarette, and cannabis use among Canadians aged 15 years and older. CTNS is conducted by Statistics Canada on behalf of Health Canada. The objective is to gather information on the prevalence of cigarette smoking, e-cigarette and cannabis use in the country. While Statistics Canada has been conducting surveys on uses of alcohol, tobacco and other drugs for many years, the CTNS was conducted to collect data primarily focused on tobacco and nicotine consumption (Statistics Canada, 2020). It reports observational, cross-sectional data from a stratified population of participants residing in Canada’s 10 provinces, who completed the CTNS in 2020 (Statistics Canada, 2020). The questionnaire for the CTNS underwent cognitive testing in the form of in-depth interviews in both of Canada's official languages, conducted by Statistics Canada's Questionnaire Design Resource Center (Statistics Canada, 2020). Data was collected directly from survey respondents either through an electronic questionnaire or through computer assisted telephone interviewing from December 8, 2020 to January 16, 2021 (Statistics Canada, 2020).

Study Participants

Participants in the database from the CTNS were non-institutionalized individuals aged 15 and older who reside in one of Canada's ten provinces, (Prince Edward Island, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, Newfoundland and Nova Scotia) and were not members of collectives or living on the reserves. The inclusion criteria for this study consisted of a total of 139 males and females aged 25-54 living in Canada's 10 provinces who either tried to quit smoking cigarettes by switching to e-cigarettes or did not try to quit smoking cigarettes by switching to e-cigarettes in the past 12 months and their smoking status as current or former smoker. The exclusion criteria were individuals who did not state their gender, individuals who never smoked cigarettes, and individuals who skipped, did not know, refused to answer, or did not state their response to whether they have tried to quit smoking by switching to vaping in the past 12 months. These were removed from the data set and treated as missing cases. Participants who missed pre-existing scheduled calls or did not complete final survey questions were also removed from the data set.

Study Outcomes

The primary outcome investigated in this study was smoking status as current or former smoker of participants who tried to quit smoking cigarettes by switching to e-cigarettes. To assess e-cigarette usage as a method of smoking cessation over the past 12 months, participants were asked "During the past 12 months, did you try to quit smoking cigarettes by switching to a vaping device or an e-cigarette?" in which they responded either "yes" or "no". Participants were asked to indicate their current smoking status after 12 months and could choose from the categories "current smoker", "former smoker" and "never smoked". In our study, successful smoking cessation was indicated by participants whose smoking status was 'former smoker' and responded "yes" to switching from cigarette to e-cigarette usage in the past 12 months. We chose to investigate participants aged 25-54 because it is the average age group of smokers in Canada, excluding territories, and cigarette consumption is highest amongst these individuals (Statistics Canada, 2020). A cross sectional observational approach was used to compare different variables simultaneously amongst a diverse population while obtaining quicker results with higher external validity compared to a longitudinal or experimental design (Carlson and Morrison, 2009). Our approach can be easily replicated in different populations, places, and time points to generalize to universal populations (Carlson and Morrison, 2009). Researchers have shown that in self-reported surveys the important measures to evaluate the effectiveness of smoking cessation included prolonged abstinence of 6-12 months (Cheung et al., 2017). Our study reflects the literature as smoking status is indicated as current or former smoker after 12 months. Our outcome was chosen to get a better understanding of the success rate of e-cigarette induced smoking cessation and to address the knowledge gap of this topic in public health.

Additional Data Collection

Some additional characteristics that can be observed in the database are gender, province of residence, and frequency of cigarette usage in the past 12 months measured by 'daily usage', 'once a month', and 'not at all'. The province of residence is of importance for understanding the geographical spread of participants and where e-cigarettes usage may be most common. The frequency of cigarette usage is used to assess participants' dependence on tobacco and nicotine, which has shown to play a role in smoking cessation (Alagabbi and BinDhim, 2020). This information can aid in understanding participant history and their smoking habits.

Statistical Analysis

We completed a statistical analysis using data collected through ODESI and was manipulated through SPSS version 23. There was no continuous data and tests of normality could not be conducted. All variables presented were categorical (i.e., trying to quit smoking by switching to e-cigarettes, smoking status). A 2x2 chi-square test was performed to assess the differences in distribution between the group that tried to quit smoking by switching to e-cigarettes and the group that did not switch to e-cigarettes. A p-value of less than 0.05 was considered statistically significant. The Yate's continuity correlation value was used to determine significance since no cells had an expected count of a value less than five. A binary logistic regression was also used to evaluate the relationship between smoking status and participants who tried to quit smoking by switching to e-cigarettes. The predictor variable 'tried to quit smoking by switching to e-cigarettes' and the outcome of interest 'smoking status' were included. There were no violated assumptions in the logistic regression since there were at least

10 participants for the 1 predictor variable used, and there were no reported outliers. From this analysis we used the significance value and the Exp(B) odds ratio.

Results

Data was gathered from a total of 139 Canadian participants aged 25-54 years. Of the participants, 39 (28.05%) responded "yes" and 100 (71.94%) responded "no" to whether they have tried to quit smoking cigarettes by switching to e-cigarettes. Of the participants who responded "yes", 25 (64.1%) were males and 14 (35.9%) were females. Descriptive characteristics of the study population are included in Table 1.

Table 1. Descriptive Characteristics of the Participants from the Canadian Tobacco and Nicotine Survey 2020 (N=139).

Characteristics	**Tried to Quit Smoking Cigarettes by Switching to E-cigarettes - Yes (n=39)** No. (%)	**Tried to Quit Smoking Cigarettes by Switching to E-cigarettes - No (n=100)** No. (%)
Age (Years)		
25-34	13 (33.3)	26 (26.0)
35-44	13 (33.3)	39 (39.0)
45-54	13 (33.3)	35 (35.0)
Gender		
Male	25 (64.1)	46 (46.0)
Female	14 (35.9)	54 (54.0)
Smoking Status		
Current Smoker	33 (84.6)	84 (84.0)
Former Smoker	6 (15.4)	16 (16.0)
Province of Residence		

Prince Edward Island	1 (2.56)	5 (5.00)
New Brunswick	2 (5.13)	0 (0.00)
Quebec	12 (30.8)	22 (22.0)
Ontario	15 (38.5)	37 (37.0)
Manitoba	1 (2.56)	6 (6.00)
Saskatchewan	2 (5.13)	6 (6.00)
Alberta	2 (5.13)	6 (6.00)
British Columbia	4 (10.3)	10 (10.0)
Newfoundland	0 (0.00)	4 (4.00)
Nova Scotia	0 (0.00)	4 (4.00)
Frequency Smoked Cigarettes		
Daily	29 (74.4)	53 (53.0)
Once a Month at Least	4 (10.3)	31 (31.0)
Not at All	6 (15.4)	16 (16.0)

Data are presented as number (%) of participants (frequency of responses). Missing cases were removed from the dataset.

Figure 1: Chi Square Analysis

Figure 1 shows participant responses to whether they have tried to quit smoking cigarettes by switching to e-cigarettes and their current smoking status as a current or former smoker. After performing a 2x2 chi-square test, a p-value of 1.000 was observed which demonstrated no significant differences between the groups as the value was greater than 0.05. Of the 39 participants who responded "yes" to whether they have tried to quit smoking cigarettes by switching to e-cigarettes, only 15.4% participants (less than a quarter of the population) were former smokers, and of the 100 participants who responded "no", 16.0% were former smokers.

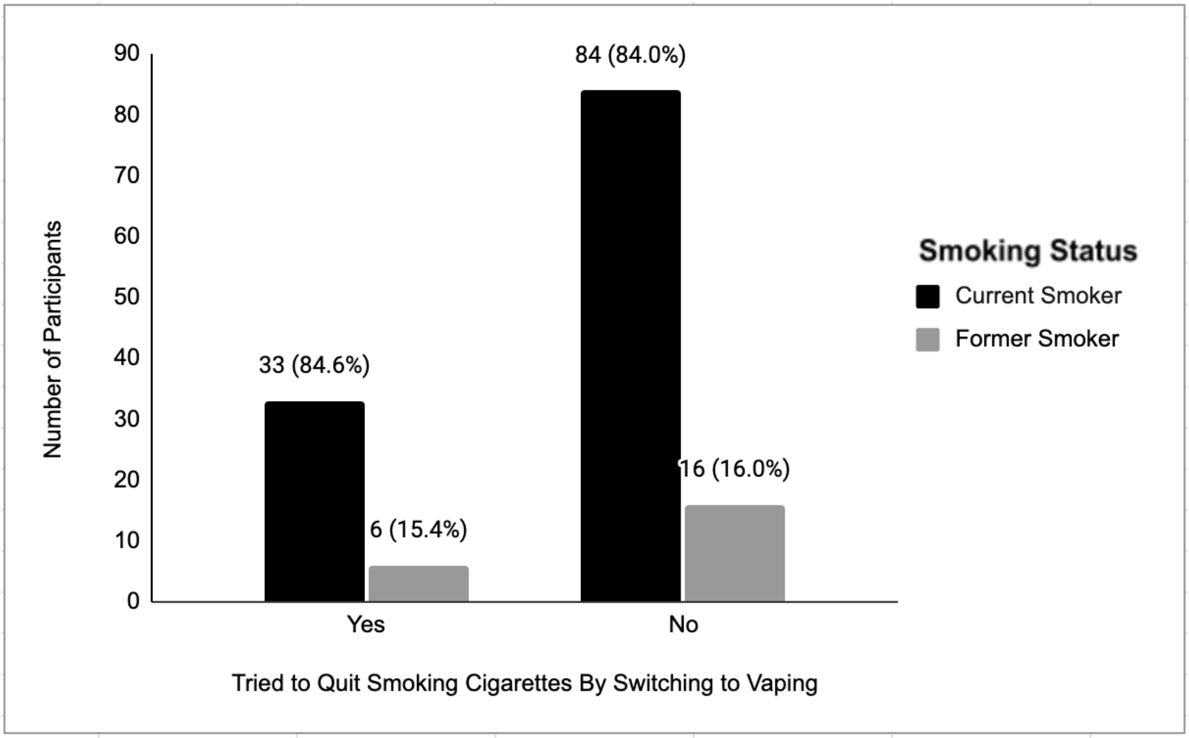

Figure 1. Number of Participants Who Have and Have Not Tried to Quit Smoking Cigarettes by Switching to Vaping and Their Current Smoking Status (N=139). Data displays the total number of participants who have and have not tried to quit smoking cigarettes by switching to vaping (n=139) and their respective cigarette smoking status as current or former smoker. Of the 139 participants, a total of 39 have tried to quit smoking cigarettes by switching to vaping and 100 have not tried to quit smoking cigarettes by switching to vaping. Of note, 33 participants who have tried to quit smoking cigarettes by switching to vaping are current smokers and 6 are former smokers. Chi-squared analysis was used to determine significance (p=1.000) obtained from continuity correlation.

Table 2: Binary Logistic Regression

Finally, in Table 2 we conducted a binary logistic regression analysis to determine if participants who tried to quit smoking cigarettes by switching to vaping contributed to their smoking status. The predictor variable did not present a statistically significant contribution to the model. We observed a positive relationship (Exp(B) = 1.048) between variables, suggesting people who have tried to quit smoking cigarettes by switching to vaping are 1.048 times more likely to be a former smoker. However, these results were not significant (Chi-squared test = 0.008, p = 0.928) and no significant differences were found between groups as the significance value was greater than 0.05.

Predictor Variable	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP(B) Lower	Upper
Tried to quit smoking cigarettes by switching to e-cigarettes	0.047	0.521	0.008	1	0.929	1.048	0.377	2.908
Constant	-1.705	.444	14.754	1	<0.001	0.182		

Table 2. Binary Logistic Regression Analysis of Participants Who Tried to Quit Smoking Cigarettes by Switching to Vaping and Their Current Smoking Status. The model displays data regarding the contribution of predictor variables on the outcome of interest. The predictor variable includes participants who tried to quit smoking cigarettes by switching to vaping and the outcome of interest is smoking status of these participants. B is the regression coefficient which shows the relationship between the outcome of interest and the predictor variable. S.E. is standard error which shows how far from the regression line the observed values are. The Wald test shows the contribution of the predictor variable in interpreting the logistic regression model. The significance value demonstrates whether the predictor value is significant. Exp (B) is the exponentiation of the B coefficient, which is an odds ratio for the outcome of interest. From the analysis, Exp (B) is 1.048 and significance is p=0.929.

Discussion

This study aimed to investigate if there is a difference in the smoking status of Canadian adult smokers who tried to quit smoking cigarettes by switching to vaping compared to those who did not try to quit smoking cigarettes by switching to vaping. The findings from this study showed no statistically significant difference in the smoking status as current or former smoker between participants who have tried to quit smoking cigarettes by switching to vaping and those who have not. We found no evidence that quitting smoking cigarettes by switching to vaping made a difference in individual's smoking status.

There are likely a few reasons for why switching from smoking cigarettes to vaping may not have contributed to successful smoking cessation. One possible reason might be that e-cigarettes should be used frequently for a sustained period of time to notice a change in an individual's smoking status (Zhuang et al., 2016). Researchers have shown that daily usage of e-cigarettes for one month is strongly associated with smoking cessation amongst daily smokers (Biener et al., 2014). Giovenco and Delnovo (2018) found that daily usage of e-cigarettes for one year is a strong correlate of smoking cessation compared to infrequent e-cigarette users who experienced low prevalence of smoking cessation. Participants from our study may not have frequently used e-cigarettes during the past 12 months which can explain our findings that e-cigarettes may not have contributed to a change in smoking status.

Alongside the frequency of e-cigarette usage, the variety of e-cigarette flavour can contribute to smoking cessation (Yang et al., 2020). Friedman and Xu (2020) observed that adults who vaped flavored e-cigarettes were more likely to quit smoking than those who vaped unflavored e-cigarettes. Despite efforts of restricting vape flavours in response to the surge of e-cigarette usage amongst youth, bans of menthol flavoured vape could prompt smokers to initiate back into cigarette smoking (Yang et al., 2020). Our findings could be explained due to the possibility that participants used flavored or unflavored e-cigarettes which may have influenced their smoking status.

Nicotine dependency may also contribute to the smoking status of an individual who switches to vaping. Selya et al., (2017) found that e-cigarette users with high nicotine dependence smoked cigarettes less frequently, whereas nondependent and novice e-cigarette users smoked cigarettes slightly more frequently. Martinez et al., (2020) found that highly dependent e-cigarette users were more likely to see a reduction in cigarette smoking. Our findings could be explained due to higher or lower nicotine dependence amongst e-cigarette users which may have been a contributing factor in participant smoking status.

Similar to our findings, many studies focusing on e-cigarettes as cessation aids have not reported definitive results. Pierce and researchers (2021) found that switching to e-cigarettes is not associated with an improved change in an individual's smoking status. Similar to our study, their primary measures included cigarette smoking status as established smoker, recent former smokers, and current smokers (Pierce et al., 2021). They found no association between e-cigarette use and prevention of relapse to cigarette smoking measured by smoking status (Pierce et al., 2021). Despite having controlled for the length of time for e-cigarette usage, there still may be other confounding variables that could have impacted their findings, in addition to participation bias from the observational study (Pierce et al., 2021). Wu and researchers (2018) also found that e-cigarette use did not predict smoking abstinence in Chinese adult smokers after a 6 months follow up. Similar to our study, participants responded "yes/no" to e-cigarette use and whether they had tried to abstain from conventional cigarettes (Wu et al., 2018). They also performed a logistic regression to observe multiple variables including sociodemographic characteristics and smoking profile (Wu et al., 2018). Although they demonstrated that e-cigarettes have little effect on cessation from cigarettes, their findings may have been impacted by the limited usage and lack of nicotine in e-cigarettes used by participants (Wu et al., 2018).

In contrast to our findings, Notley and researchers (2018) found positive results between e-cigarette usage and smoking cessation. They demonstrated that vapes played a role in reducing the effects of tobacco smoking on health by assisting attempts of smoking cessation in UK adults (Notely et al., 2018). Unlike our study design, Notely and researchers measured the frequency of usage of e-cigarettes and other individual factors such as perceived health benefits, pleasure from flavours, and practical aspects of e-cigarettes (Notely et al., 2018). The differences in this study could be a result of accounted confounding variables that may have strengthened their data and findings (Notely et al., 2018). However, the researchers under-represented populations from lower socio-economic groups and ethnic minorities which is important to observe as these populations experience higher prevalence of smoking (Notely et al., 2018).

Our study has some limitations that should be considered. Firstly, participants responded to survey questions about their self-reported tobacco use habits, so there may have been participant bias. Secondly, the sample surveyed may not have adequately represented smokers that have switched to vaping. The inclusion criteria of the study included only non-institutionalized people aged 15 and older living in Canada's ten provinces, who are not members of collectives or living on reserves. This makes it so that Indigenous communities and group home environments may not have been considered and consequently findings cannot be generalized to the entire Canadian population. Additionally, the sample size of 39 individuals in the selected age group who have switched to vaping to quit smoking may not have been large enough to produce significant results. The small sample size and non-significant results cannot be generalizable to represent the population that uses vaping as a cessation tool to smoking. Finally, we did not measure secondary outcomes in this study such as frequency of e-cigarette usage or nicotine dependence that may have played a role in vaping induced smoking cessation. Due to the fact that we had no continuous variables and only categorical data, no normality tests were conducted and limited categorical analysis were performed. The lack of statistical analysis performed can explain the lack of significance observed between groups.

Our study contributes to the research topic that e-cigarette usage may not be a successful cessation method for current smokers. However, this requires further investigation and consideration of other factors that may be contributing to smoking cessation via e-cigarette usage. Studies can explore how confounding variables such as frequency of e-cigarette usage and nicotine dependence can contribute to a change in smoking status, which have both shown to be key outcomes in smoking cessation. Looking forward researchers can perform randomized control trials rather than observational studies that include specific intervention strategies to obtain higher internal accuracy of results and establish a definitive causal relationship between e-cigarettes and smoking cessation. Our findings suggest researchers to further investigate other cessation aids that may be more successful in helping smokers quit. Researchers can also explore the use of e-cigarettes amongst Indigenous communities since these groups have shown to experience greater barriers to smoking cessation (Dawson et al, 2012). Public health officials can find ways to emphasize that e-cigarettes may not be an ideal method for cessation and encourage the youth population to limit their intake of tobacco and nicotine from e-cigarettes. It is imperative that scientists continue to investigate the success rate of e-cigarettes as a smoking cessation method to ensure a safe and effective solution for smokers who are trying to obtain a healthier lifestyle.

References

Algabbani A, BinDhim N. Smoking prevalence, nicotine dependence, and intention to quit among cigarettes smokers. *European Journal of Public Health*. 2020;30(Supplement_5). doi:10.1093/eurpub/ckaa166.1177

Barrington-Trimis JL, Braymiller JL, Unger JB, et al. Trends in the age of cigarette smoking initiation among young adults in the US from 2002 to 2018. *JAMA Network Open*. 2020;3(10). doi:10.1001/jamanetworkopen.2020.19022

Baumeister RF. Addiction, Cigarette Smoking, and voluntary control of action: Do cigarette smokers lose their free will? *Addictive Behaviors Reports*. 2017;5:67-84. doi:10.1016/j.abrep.2017.01.003

Berry KM, Reynolds LM, Collins JM, et al. E-cigarette initiation and associated changes in smoking cessation and reduction: The population assessment of Tobacco and Health Study, 2013–2015. *Tobacco Control*. 2018. doi:10.1136/tobaccocontrol-2017-054108

Biener, L., & Hargraves, J. L. (2014). A longitudinal study of electronic cigarette use among a population-based sample of adult smokers: Association with smoking cessation and motivation to quit. *Nicotine & Tobacco Research*, *17*(2), 127–133. https://doi.org/10.1093/ntr/ntu200

Bullen C, Howe C, Laugesen M, et al. Electronic cigarettes for smoking cessation: A randomised controlled trial. *The Lancet*. 2013;382(9905):1629-1637. doi:10.1016/s0140-6736(13)61842-5

Carlson MDA, Morrison RS. Study design, precision, and validity in observational studies. *Journal of Palliative Medicine*. 2009;12(1):77-82. doi:10.1089/jpm.2008.9690

Chaiton M, Diemert L, Cohen JE, et al. Estimating the number of quit attempts it takes to quit smoking successfully in a longitudinal cohort of smokers. *BMJ Open*. 2016;6(6). doi:10.1136/bmjopen-2016-011045

Cheung KL, de Ruijter D, Hiligsmann M, et al. Exploring consensus on how to measure smoking cessation. A Delphi Study. *BMC Public Health*. 2017;17(1). doi:10.1186/s12889-017-4902-7

Cinciripini PM, Robinson JD, Karam-Hage M, et al. Effects of varenicline and bupropion sustained-release use plus intensive smoking cessation counseling on prolonged abstinence from smoking and on depression, negative affect, and other symptoms of nicotine withdrawal. *JAMA Psychiatry*. 2013;70(5):522. doi:10.1001/jamapsychiatry.2013.678

Dawson AP, Cargo M, Stewart H, Chong A, Daniel M. Aboriginal health workers experience multilevel barriers to quitting smoking: A qualitative study. *International Journal for Equity in Health*. 2012;11(1). doi:10.1186/1475-9276-11-27

Friedman AS, Xu SQ. Associations of flavored e-cigarette uptake with subsequent smoking initiation and cessation. *JAMA Network Open*. 2020;3(6). doi:10.1001/jamanetworkopen.2020.3826

Giovenco DP, Delnevo CD. Prevalence of population smoking cessation by electronic cigarette use status in a national sample of recent smokers. *Addictive Behaviors*. 2018;76:129-134. doi:10.1016/j.addbeh.2017.08.002

Gomajee R, El-Khoury F, Goldberg M, et al. Association between electronic cigarette use and smoking reduction in France. *JAMA Internal Medicine*. 2019;179(9):1193. doi:10.1001/jamainternmed.2019.1483

Government of Canada, Statistics Canada. (2021, September 8). Smokers, by age group. Retrieved December 9, 2021, from https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310009610.

Hajek P, Phillips-Waller A, Przulj D, et al. A randomized trial of e-cigarettes versus nicotine-replacement therapy. *New England Journal of Medicine*. 2019;380(7):629-637. doi:10.1056/nejmoa1808779

Jackson SE, Kotz D, West R, Brown J. Moderators of real‐world effectiveness of smoking cessation aids: A population study. *Addiction*. 2019;114(9):1627-1638. doi:10.1111/add.14656

Jamal, A., Gentzke, A., Hu, S. S., Cullen, K. A., Apelberg, B. J., Homa, D. M., & King, B. A. (2017). Tobacco use among middle and high school students—United States, 2011–2016. MMWR. Morbidity and mortality weekly report, 66(23), 597. doi: 10.15585/mmwr.mm6623a1

Li, L., Borland, R., Cummings, K. M., Fong, G. T., Gravely, S., Smith, D. M., ... & McNeill, A. (2021). How does the use of flavored nicotine vaping products relate to progression towards quitting smoking? Findings from the 2016 and 2018 ITC 4CV Surveys. Nicotine & Tobacco Research. https://doi.org/10.1093/ntr/ntab033

Martínez, Ú., Martínez-Loredo, V., Simmons, V. N., Meltzer, L. R., Drobes, D. J., Brandon, K. O., ... & Brandon, T. H. (2020). How does smoking and nicotine dependence change after onset of vaping? A retrospective analysis of dual users. Nicotine and Tobacco Research, 22(5), 764-770. https://doi.org/10.1093/ntr/ntz043

Notley, C., Ward, E., Dawkins, L. *et al.* (2018).The unique contribution of e-cigarettes for tobacco harm reduction in supporting smoking relapse prevention. *Harm Reduct J* 15, 31. https://doi.org/10.1186/s12954-018-0237-7

Pierce JP, Chen R, Kealey S, et al. Incidence of cigarette smoking relapse among individuals who switched to e-cigarettes or other tobacco products. *JAMA Network Open*. 2021;4(10). doi:10.1001/jamanetworkopen.2021.28810

Pisinger C, Døssing M. A systematic review of health effects of Electronic Cigarettes. *Preventive Medicine*. 2014;69:248-260. doi:10.1016/j.ypmed.2014.10.009

Reid JL, Hammond D, Tariq U, Burkhalter R, Rynard VL, Douglas O. *Tobacco Use in Canada: Patterns and Trends, 2019 Edition.* Waterloo, ON: Propel Centre for Population Health Impact, University of Waterloo.

Reid RD, Pritchard G, Walker K, Aitken D, Mullen K-A, Pipe AL. Managing smoking cessation. *Canadian Medical Association Journal*. 2016;188(17-18). doi:10.1503/cmaj.151510

Rennie LJ, Bazillier-Bruneau C, Rouëssé J. Harm reduction or harm introduction? prevalence and correlates of e-cigarette use among French adolescents. *Journal of Adolescent Health*. 2016;58(4):440-445. doi:10.1016/j.jadohealth.2015.12.013

Selya AS, Dierker L, Rose JS, Hedeker D, Mermelstein RJ. The role of nicotine dependence in e-cigarettes' potential for smoking reduction. *Nicotine & Tobacco Research*. 2017;20(10):1272-1277. doi:10.1093/ntr/ntx160

Statistics Canada. (2020). Canadian Tobacco and Nicotine Survey (CTNS). Statistics Canada. https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5305#a2

Tobacco. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/tobacco. Accessed October 7, 2021.

Van Teijlingen, E., Mahato, P., Simkhada, P., van Teijlingen, C., Asim, M., & Sathian, B. (2019). Vaping and e-cigarettes: A public health warning or a health promotion tool?. Nepal journal of epidemiology, 9(4), 792. doi: 10.3126/nje.v9i4.26960

Vickerman, K. A., Carpenter, K. M., Raskob, M. K., Nash, C. M., Vargas-Belcher, R. A., & Beebe, L. A. (2021). Vaping and e-cigarettes within the evolving tobacco quitline landscape. American Journal of Preventive Medicine, 60(3), S142-S153. https://doi.org/10.1016/j.amepre.2020.07.013

West R. Tobacco smoking: Health impact, prevalence, correlates and interventions. *Psychology & Health*. 2017;32(8):1018-1036. doi:10.1080/08870446.2017.1325890

Wu S, Wang M, Li W, Kwong A, Lai V, Lam T. Does electronic cigarette use predict abstinence from conventional cigarettes among smokers in Hong Kong? *International Journal of Environmental Research and Public Health*. 2018;15(3):400. doi:10.3390/ijerph15030400

Yang, Y., Lindblom, E. N., Salloum, R. G., & Ward, K. D. (2020). The impact of a comprehensive tobacco product flavor ban in San Francisco among young adults. *Addictive Behaviors Reports*, *11*, 100273. https://doi.org/10.1016/j.abrep.2020.100273

Zhuang Y-L, Cummins SE, Y Sun J, Zhu S-H. Long-term e-cigarette use and smoking cessation: A longitudinal study with US population. *Tobacco Control*. 2016;25(Suppl 1):i90-i95. doi:10.1136/tobaccocontrol-2016-053096

Exploring a Correlation between Quality of Sleep and Smoking Behaviour amongst Canadian Adolescent Youth in Grades 9-12 through a Cross-sectional Design

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Introduction

It is a socially and medically accepted fact that the abuse of any drug would have a negative impact on one's general health (Han et al., 2010). A study focused on cigarettes, published by Mucha et al. (2006) found that very few systems in the body were unaffected by the impacts of smoking, and intensity such as the number of cigarettes smoked was a risk factor for disease. Moreover, when looking at both male and female children who had or had not smoked, children who took up smoking had higher rates of asthma and of having had wheezing than children who had never smoked (Gold et al., 1996). This is one example of the negative health outcomes that result from smoking cigarettes. Across North America, drug and substance use among adolescent youth is rising (Griffin & Botvin, 2010). More specifically, there is increased data that supports frequent use of alcohol, tobacco, and other drugs specifically among adolescent youth (Griffin & Botvin, 2010). In addition, there is a direct correlation between early drug use and consistent drug abuse in adulthood (Griffin & Botvin, 2010). With this behaviour remaining consistent throughout an individual's life, we may also observe the rise of physical and mental health problems leading to a challenging lifestyle (Griffin & Botvin, 2010). Understanding this relationship, it is critical to not only consider preventative strategies but examine potential agents as to why substance use occurs among adolescent youth so early (Griffin & Botvin, 2010). One of the potential factors to consider is sleep quality. In a study examining the sleep quality of university students, it was demonstrated that individuals who had poor sleep quality were more likely to engage in drug use (Fadhel, 2020). This was also associated with poor academic performance and decreased mental health among university students (Fadhel, 2020). It is extremely important to explore this relationship as awareness and reinforcement for a quality night's sleep may reduce overall intake of drugs and alcohol in adolescents.

Over the years, cigarette smoking prevalence for adolescents is on the decline (U.S. National Library of Medicine, 2012). In figure 5.3 of their data, cigarette smoking decreased beyond 1991 for students in grade 8, 10 and 12. Despite this, according to the Government of Canada (2019), the prevalence of cigarette smoking among adolescent youth aged 15 to 19 proved to be 5%. As the negative health impact of cigarettes becomes more widely known, we should see a decline in adolescent smoking prevalence. Marketing for cigarettes is way down in percent of millions of dollars spent, from 74.5% in 1975 to just 1.9% in 2008 (National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 1970). This decrease in money spent in marketing should help decrease the prevalence of cigarette smoking in adolescents, however, there appears to be other factors that initiate adolescents into cigarette usage. Existing studies have observed this topic in adults, showing a positive correlation between increased smoking levels and poorer quality of sleep, but studies today are limited regarding an adolescent aged population (Purani et. al, 2019).

Currently, there is an abundance of information around the specific demographic of adults, but there remains a knowledge gap when considering how quality of sleep is related to cigarette use among adolescent youth. Particularly, there is a lack of research concerning adolescent smoking prevalence in Canada, and the correlation this has with their sleep satisfaction. It is important to have a study isolated to this age group to see if the positive correlation that exists in fully matured adults also exists in adolescent developing youth (Purani et al., 2019).

Our study will use the Canadian Student Tobacco, Alcohol and Drugs Survey database, collected in 2018-2019, to see if there is a correlation between smoking behaviour in Canadian adolescent youth in grades 9 to 12 and their self-reported satisfaction of sleep.

Methods

Study Design and Database

The study design was a cross-sectional and observational study that used the database, Canadian Student Tobacco, Alcohol and Drugs Survey 2018-19 abbreviated to CSTADS (Propel Centre for Population Health Impact, University of Waterloo, 2021). CSTADS is a data collection survey with a total sample size of 62850 students from grades 7-12, running from October 2018 to June 2019 throughout most of the Canadian provinces. The primary aim of the study was to assess if high school cigarette smokers had a different level of self-reported sleep satisfaction compared to non-smoking high school students. The primary outcome showed that there was an extremely weak correlation between smoker status and sleep satisfaction, though there was a significant difference between the proportions between groups.

Study Participants

In the original database, the survey respondents included young Canadian residents attending private, public and Catholic schools enrolled in one of grades 7 to 12. Those excluded from the questionnaire were those enrolled in schools in Yukon, Northwest Territories, and Nunavut. In addition, those who went to special schools were also excluded (e.g. schools for visually impaired, virtual schools, etc.). Participants in our study fit our inclusion criteria if they were enrolled in grades 9-12. Our exclusion criteria is participants in grades 7 or 8, as well as participants who answered “not stated” to relevant questions in the survey. Individuals who are former smokers were also excluded from our analysis. Grade 7 and 8 students are excluded to control for differences in student's social environment and to control for the time student's woke up to go to school. General assumptions that high school students tend to wake up at the same time as each other to get ready for school were made. Any individuals with missing data for our variables of interest, recorded as "99" within all ordinal variables collected, were also manually deleted and excluded from the study. This is to maintain the same sample population for all the tests run. The dataset originally contained 62,850 students; based on the inclusion and exclusion criteria, the sample size of the study encompassed 32,342 students.

Study Outcomes

The primary outcome of the study was to assess the correlation between sleep satisfaction and smoking status, observing whether or not there is a significant relationship. This is based upon existing research studies, indicating that smoking negatively affects the body's sleep-wake cycle (Purani et. al, 2019). The secondary outcomes of the study assessed the correlations between grade and smoking status, as well as correlation between grade and sleep satisfaction. These are important outcomes to assess as a study suggests that secondary school students are faced with increasing amounts of stress throughout their academic careers (Hetrick & Parker, 2019). Together, social influence and stress play a significant role in substance use among secondary school students (Hetrick & Parker, 2019).

Additional Data Collection

Aside from the data gathered concerning our main independent variable (Smoking Status) and dependent variables (Sleep Satisfaction), additional data was obtained. Specifically, descriptive statistics were calculated for both Grade Level and Province.

Statistical Analysis

The data collected from the participants was expressed as ordinal variables in the original dataset; no tests of normality were able to be performed, as there were no continuous variables used.

For the purpose of our analysis, selected ordinal variables were re-coded to be dichotomous categorical variables. Sleep satisfaction was originally recorded under the question, “In the last 2 weeks, how often have you felt satisfied with your sleep?”. Participants were given the following answer options: 1) every day / night, 2) several times, 3) twice, 4) once, 5) never. This variable was re-coded, so that all who answered “every day / night” or “several times" were generalized as “satisfied” with their sleep, while all other students, indicating sleep satisfaction twice or less in the past two weeks, were generalized as “not satisfied” with their sleep. For, “what is your smoking status?”, participants were asked to choose from the following answer options; 1) smoker, 2) non-smoker, 3) previous smoker. This variable was re-coded to only include answers for "smokers" and "non-smokers" which was better suited to fit the research question of our study.

A logistic regression analysis was not performed. Although it was initially intended, no predictor variables satisfied the minimum 0.3 Spearman Rho correlation with the dependent variable of sleep satisfaction. Instead, as the variables contained only categorical data, the Spearman Rho analysis was used to study the correlation, while the Chi Square test was used to see any significant findings between group differences. The cross-tabulation was mapped using a bar chart addressing the main research question. The secondary outcome, observing grade and smoking status, as well as grade and sleep satisfaction, was also analyzed with the aid of bar charts, using the Spearman Rho and Chi Square analysis to check for significance.

Results

Table 1.

Descriptive Characteristics of Study Participants (n=32342)

Descriptive Variable	
Female	16238 (50.2)
Male	16104 (49.8)
Grade 9 Students	9750 (30.1)
Grade 10 Students	9600 (29.7)
Grade 11 Students	8123 (25.1)
Grade 12 Students	4869 (15.1)
Province	
Newfoundland and Labrador	2833 (8.8)
Prince Edward Island	2375 (7.3)
Nova Scotia	3135 (9.7)
New Brunswick	2007 (6.2)
Québec	8789 (27.2)
Ontario	2370 (7.3)
Manitoba	1641 (5.1)
Saskatchewan	1800 (5.6)
Alberta	3729 (11.5)
British Columbia	3663 (11.3)
Smoking Status	
Current smoker	1422 (4.4)
Never smoker	30920 (95.6)
Are you often satisfied with your sleep?	
Not Satisfied	14003 (43.3)
Satisfied	18339 (56.7)

*This table includes relevant demographics of our study population and has information on specific variables that are of interest for our study. All of the data is expressed as frequencies with the relevant percentage in the brackets. Specific details to consider are the even ratio of females to males (50.2% vs. 49.8%). Additionally, it was found that 43.4% of our sample was not satisfied with their sleep and 4.4% of our population are current smokers (n= 32342).

Chi-Square and Spearman Rho Analysis

Amongst Canadian adolescents grades 9-12, the difference in percentage of people satisfied with their sleep, compared to those unsatisfied with their sleep, is visible. When placed in a bar chart comparing students who reported currently smoking and those who have never smoked, current smokers were more likely to be unsatisfied with their sleep and for non-smokers, more of them reported being satisfied with their sleep than not. However, further statistical analysis showed that this difference is only significant at the 0.01 level, demonstrating that the correlation between sleep satisfaction and smoking status is very weak. A Chi-Squared analysis showed a 2-sided asymptotic significance of <0.001, with a Pearson Chi-Square value of 117.843 at 1 degree of freedom. These results indicate a significant difference between groups in the data, however, the Chi-Square Test is limited and cannot display between which groups differ, in specific. Sleep satisfaction and smoking status displayed a Spearman Rho value of 0.060, with $p<0.001$. This results in a correlation that is significant at the 0.01 level, indicating an existent positive correlation between sleep satisfaction and smoking status, however this correlation is very weak, as a strong correlation value would be close or exactly 1.

Upon further observation of the demographic, it can be noted that the percentage of smokers increases with increasing grade level, as seen in Figure 2. A Chi-Square analysis showed a 2-sided asymptotic significance of <0.001, with a value Pearson Chi-Square value of 305.402 at 3 degrees of freedom. A Spearman Rho correlation of -0.096, with $p<0.001$ was observed, confirming this correlation as present, but very weak.

In observing sleep satisfaction at each grade level, another weak relationship was observed (Figure 3). A Chi-Square analysis yielded a 2-sided asymptotic significance of <0.01, with a Pearson Chi-Squared value of 144.473 at 2 degrees of freedom, showing a between-group difference. A Spearman Rho correlation showed a value of -0.064 with $p<0.001$, showing that this difference exists, but the correlation between grade and sleep satisfaction is very weak.

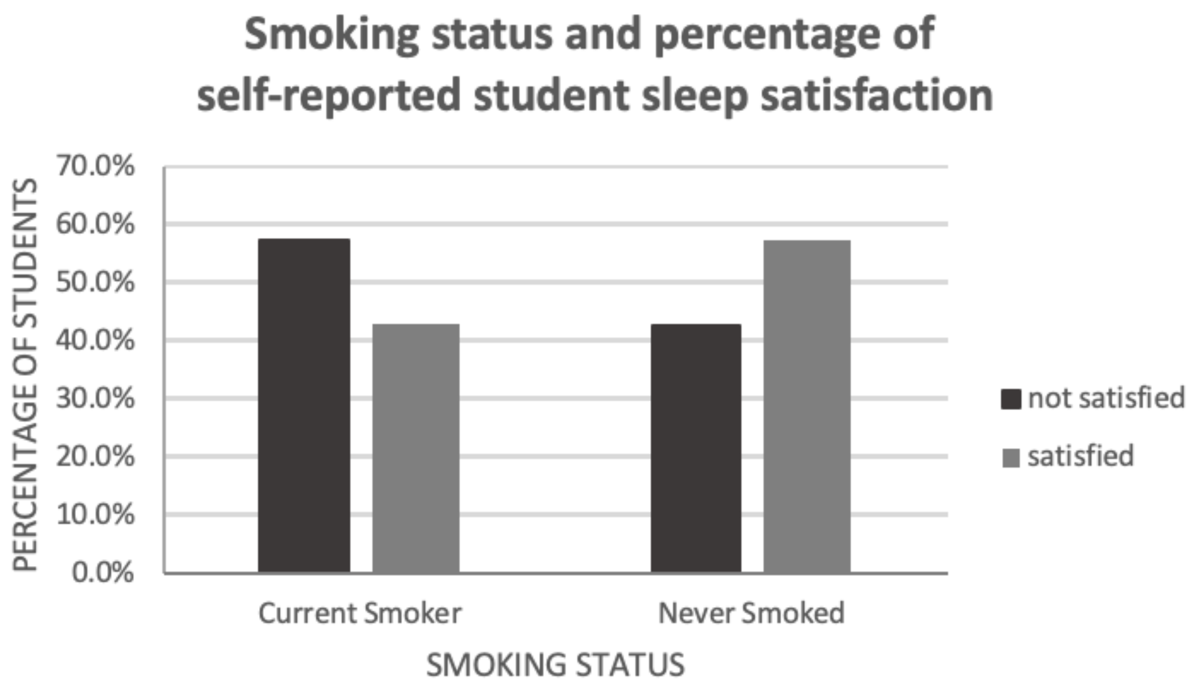

Figure 1: Smoking status and percentage of self-reported student sleep satisfaction. Students were asked to report how many times they have felt satisfied with their sleep in the past two weeks. For current smokers (1422), 57.2% (814) were observed to have been generally unsatisfied, while 42.8% (608) were generally satisfied. For those who have never smoked (30920), 42.7% (13189) were observed to have been generally unsatisfied, while 57.3% (17731) reported being generally satisfied with their sleep in the past two weeks. (n = 32342)

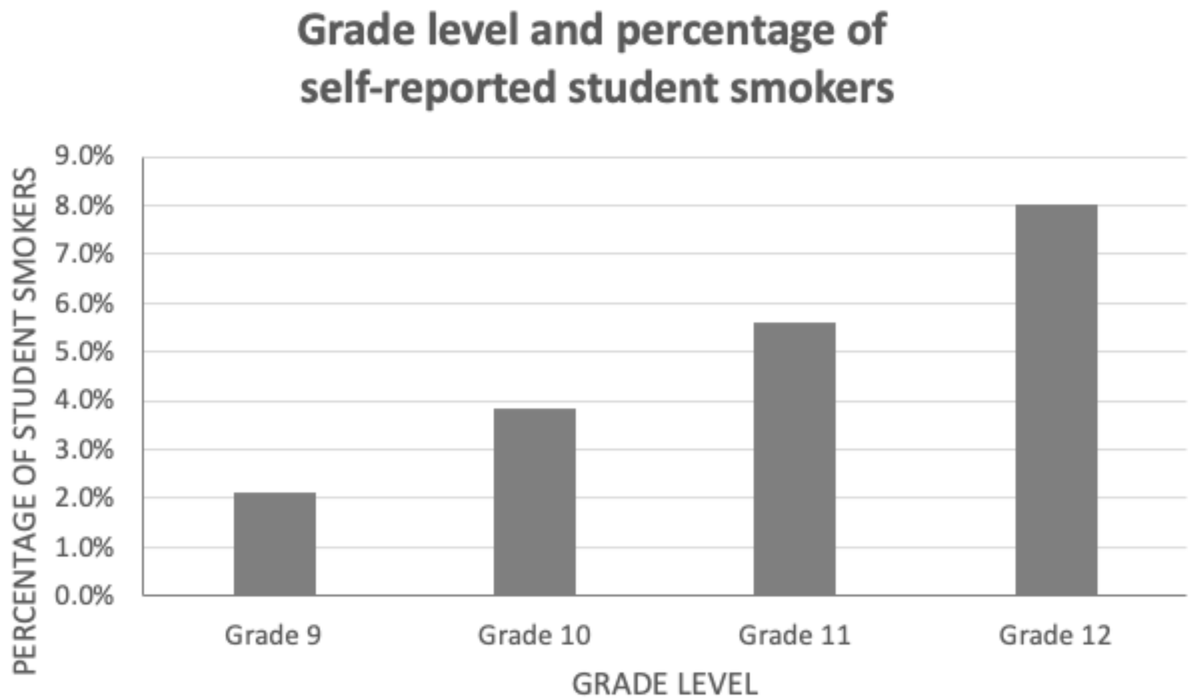

Figure 2: Grade level and percentage of self-reported student smokers. Grade level and percentage of smokers was indicated above. 2.13% (208) of grade 9 students were smokers, 3.85% (370) of grade 10 students, 5.58% (453) of grade 11 students, and 8.03% (391) of grade 12 students self-reported their smoking status as "current smoker" (n = 1422).

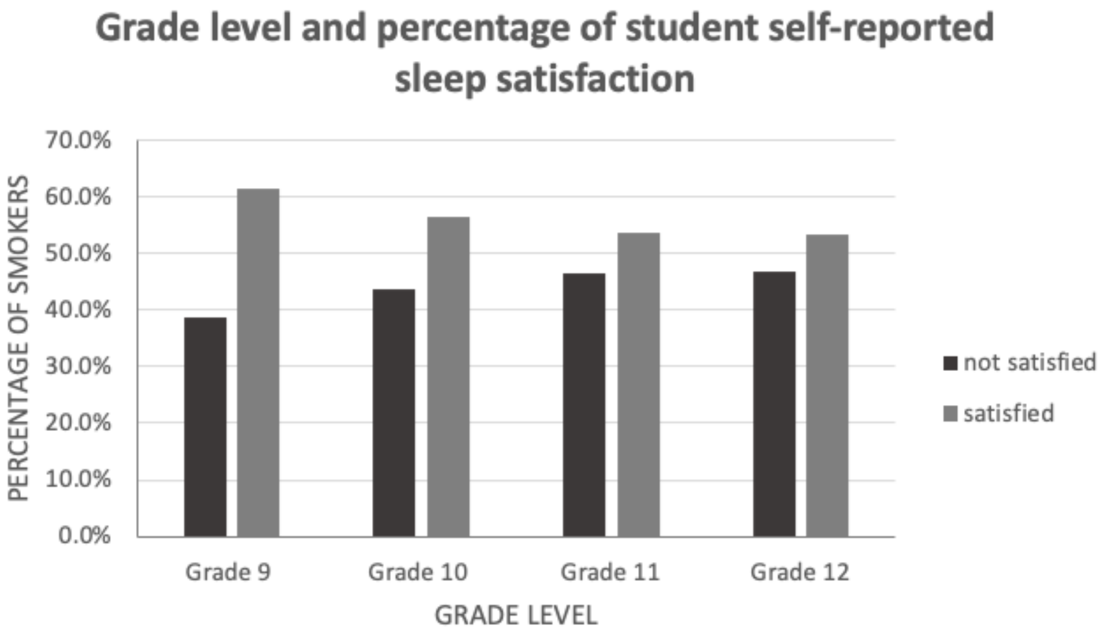

Figure 3: Grade level and percentage of student self-reported sleep satisfaction. In the past two weeks, generally unsatisfactory sleep was observed in 38.59% (3763) of grade 9 students, 43.67% (4192) of grade 10 students, 46.46% (3773) of grade 11 students, and 46.70% (2274) of grade 12 students. In the past two weeks, generally satisfactory sleep was reported by 61.41% (5987) of grade 9 students, 56.33% (5408) of grade 10 students, 53.54% (4349) of grade 11 students, and 53.30% (2595) of grade 12 students (n = 32342).

Discussion

Data Interpretation

Our study aimed to assess whether a correlation existed between the self-reported sleep satisfaction of Canadian provincial high school students and their smoking status for cigarettes. After manipulation of the CSTADS database, a series of statistical analyses were conducted. The Chi Square analysis and Spearman rho test were used to see if a correlation existed between sleep satisfaction and smoking behaviour with respect to our primary outcome of the study. Additionally, these statistical tests were conducted to assess our secondary outcomes for a correlation between grade level and sleep satisfaction along with grade level and smoking status. For the primary outcome of the study, the Chi-Square value of 117.843 with degrees of freedom 1 was obtained. This demonstrates that there is a significant difference between sleep satisfaction and smoking status at the significance level of 0.01 however, this difference is ultimately weak. A Spearman Rho correlation coefficient of 0.060 was calculated, with $p<0.001$ which demonstrates a weak positive correlation between the two variables. With regards to our secondary outcomes, a Chi-Square value of 305.402 at 3 degrees of freedom was obtained for smoking status and grade level. This suggests that there is a significant difference between the two groups. However, the Spearman Rho correlation coefficient of -0.096, with $p<0.001$ which demonstrates a weak negative correlation. When analyzing sleep satisfaction and grade level, a Chi-Square value of 144.473 at 2 degrees of freedom was determined which expresses a significant difference between the two groups. The Spearman Rho correlation coefficient of -0.064 with $p<0.001$ which demonstrates a weak negative correlation.

These findings suggest that a weak correlation exists between sleep satisfaction and smoking status. However, when considering individuals who reported they were not satisfied with their sleep, it was found that 57.4% are current smokers. Additionally, there is an increasing upward trend for the percentage of smokers as Grade Level increases. Grade 12 students have the highest percentages and more grade 12 students report that they were least satisfied with their sleep, a total of 46.7%. With regards to our database, grade 12 students represented the smallest group of students, making up only 15.1% of the population. With these specific trends existing in our dataset for grade 12 students, having an unequal distribution across the dataset could potentially explain why weak correlations were observed.

Comparison of Results

A previously conducted study on cigarette smoking rates among adults varied according to usual hours of sleep, and was lowest among those who slept 7 to 8 hours (18%) and higher among adults who slept less than 6 hours (31%) or 9 hours or more (26%). Those who slept below 7 hours engaged in smoking behaviour more frequently than those who slept 7 to 8 hours, and additionally, those who slept greater than 9 hours were also at a higher risk of smoking behaviour (Schoenborn et al., 2015). This evidence supports the hypothesis that cigarette smoking may lead to a decrease in individuals receiving the recommended hours of sleep. These results are not entirely consistent with our findings as we found that smoking status weakly influenced sleep satisfaction. There are several limitations that may impact this study and may provide evidence as to why our results do not support the same conclusions. One being, the associations between sleep and other behaviours are extremely complex. Causality is very hard to determine based on a cross-sectional design. In addition, a study that looks at more wide spread variables like socioeconomic status may influence sleep and cause flexibility in the results obtained. In addition, there is an abundance of research currently being conducted on nicotine patches and sleep quality but there appears to be limited research concerning smoking status and sleep quality. This randomized control trial investigates various patterns related to sleep such as rapid-eye movement densities which is very different from the self reported quality of sleep that CSTADS reports (Staner et al., 2006).

Limitations and Confounding Variables

From conducting this observation study there are several limiting factors and confounding variables which must be addressed. The first limitation is associated with the dataset we used to conduct our analysis. Although the dataset contains an abundance of relevant information it would have been more beneficial to have control on what questions were asked to obtain the data. This ultimately has an influence on our overall interpretation as this study attempts to plot correlations from data collected by uninvolved individuals. Additionally, it was necessary to make certain assumptions to transform the ordinal variables into dichotomous categorical variables prior to running the Chi-Square tests. For example, sleep satisfaction was initially measured over a 2 week period. However, we had to assume the reported level of sleep satisfaction to be a generalized value over an undefined period of time. Their reported sleep satisfaction for the 2-week period is not an accurate representation of their overall sleep patterns. Finally, the study was conducted through self-reporting by students. It is possible that some may have inaccurately reported, either due to forgetfulness or the presence of shame or stigma.

In regards to confounding variables, it is important to consider that an individual's socioeconomic status can influence their responses to the survey. Previously conducted research showed that individuals from a lower socioeconomic background are more likely to engage in substance use, specifically smoking and alcohol (Patrick et al., 2012) . Another confounding variable to consider is the current attitudes towards smoking. A study has demonstrated that the prevalence of cigarette use has begun to decrease since 2011, which could be attributed to a variety of factors such as education (Whitesell et al., 2013). However, the use of tobacco products is still high with 5.5% of 10^{th} grade students and 10.3% of 12^{th} grade students reportedly using these products (Whitesell et al., 2013). Understanding the presence of these limitations and confounding variables helps in assessing the overall effectiveness and validity of our study.

Future Directions and Implications

Future directions as a result of this study would be to conduct further research to examine the relationship between the investigated variables with a more controlled study population. Controlling the population and data collection could be done by customizing the questionnaire and ensuring a more even distribution across grade levels. This is important as a more similar population to study from will lead to less confounding variables to control for. Running additional statistical analyses would also be beneficial in exploring relationships between additional relevant variables. If our population's data is normal, a logistic regression analysis would be a great tool to understand the relationship between our dependent variable, sleep satisfaction and predictor variables. Such predictor variables that we identified are if they are a victim of bullying, risk perception of cigarettes, province of residence, if smoking was allowed in their household and if there are other medications prescribed to the individual. This study provides the necessary foundation to further explore the relationship between sleep satisfaction and cigarette use. We hope the questions raised by the results of this study can start more conversations regarding the impact of smoking behavior on sleep satisfaction and to prevent disordered sleep by reinforcing the negative impacts associated with cigarette smoking.

References

Centers for Disease Control and Prevention. (2017, March 2). *CDC - how much sleep do I need? - sleep and sleep disorders*. Retrieved December 9, 2021, from https://www.cdc.gov/sleep/about_sleep/how_much_sleep.html.

Fadhel, F. H. (2020, November 23). Exploring the relationship of sleep quality with drug use and substance abuse among university students: A cross-cultural study. *Middle East Current Psychiatry.* Retrieved October 8, 2021, from https://mecp.springeropen.com/articles/10.1186/s43045-020-00072-7#citeas.

Gold, D. R., Wang, X., Wypij, D., Speizer, F. E.,Ware, J.H., & Dockery, D. W. (1996). Effects of Cigarette Smoking on Lung Function in Adolescent Boys and Girls. *N Engl J Med, 335*, 931-937. 10.1056/NEJM199609263351304

Griffin, K. W., & Botvin, G. J. (2010, July). *Evidence-based interventions for preventing substance use disorders in adolescents*. Child and adolescent psychiatric clinics of North America. Retrieved December, 1 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2916744/

Government of Canada. (2020, July 7). *Canadian Tobacco and Nicotine Survey (CTNS): summary of results for 2019.* https://www.canada.ca/en/health-canada/services/canadian-tobacco-nicotine-survey/2019-summary.html

Han, B., Gfroerer, J. C., & Colliver, J. D. (2010). Associations between duration of illicit drug use and health conditions: results from the 2005–2007 national surveys on drug use and health. *Annals of epidemiology*, *20*(4), 289-297. Retrieved from https://doi.org/10.1016/j.annepidem.2010.01.003

Hetrick, S. E., & Parker, A. G. (2019). *The impact of stress on students in Secondary School and Higher Education*. Taylor & Francis. Retrieved December 10, 2021, from https://www.tandfonline.com/doi/full/10.1080/02673843.2019.1596823.

Mucha, L., Stephenson, J., Morandi, N., & Dirani, R. (2006). Meta-analysis of disease risk associated with smoking, by gender and intensity of smoking. *Gender medicine*, *3*(4), 279–291. Retrieved from https://doi.org/10.1016/s1550-8579(06)80216-0

National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. (1970, January 1). *The tobacco industry's influences on the use of tobacco among youth*. Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General. Retrieved December 9, 2021, from https://www.ncbi.nlm.nih.gov/books/NBK99238/.

Patrick, M. E., Wightman, P., Schoeni, R. F., & Schulenberg, J. E. (2012, September). *Socioeconomic status and substance use among young adults: A comparison across constructs and Drugs*. Journal of studies on alcohol and drugs. Retrieved December 9, 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3410945/.

Propel Centre for Population Health Impact, University of Waterloo (2021). *Canadian Student Tobacco, Alcohol and Drugs Survey, 2018-2019.* (2020-01-22). [Data set]. Ontario Data Documentation, Extraction Service and Infrastructure (ODESI) , Scholars Portal. http://odesi2.scholarsportal.info/webview/

Purani, H., Friedrichsen, S., & Allen, A. M. (2019). Sleep quality in cigarette smokers: Associations with smoking-related outcomes and exercise. *Addictive behaviors*, *90*, 71-76. Retrieved from https://doi.org/10.1016/j.addbeh.2018.10.023

Schoenborn, C. A., M.P.H., & Adams, P. F. (2015, November 6). *Sleep Duration as a Correlate of Smoking, Alcohol Use, Leisure-Time Physical Inactivity, and Obesity Among Adults: United States, 2004-2006*. Centers for Disease Control and Prevention. Retrieved December 9, 2021, from https://www.cdc.gov/nchs/data/hestat/sleep04-06/sleep04-06.htm.

Staner, L., Luthringer, R., Dupont, C., Aubin, H. J., & Lagrue, G. (2006). Sleep effects of a 24-h versus a 16-h nicotine patch: a polysomnographic study during smoking cessation. *Sleep medicine*, *7*(2), 147–154. https://doi.org/10.1016/j.sleep.2005.09.008

U.S. National Library of Medicine. (2012). *Figure 5.3, cigarette prices and prevalence of youth smoking by grade in school, United States, 1991–2011 - preventing tobacco use among youth and Young Adults - NCBI Bookshelf*. Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General. Retrieved December 9, 2021, from https://www.ncbi.nlm.nih.gov/books/NBK99238/figure/ch5.f3/.

Whitesell, M., Bachand, A., Peel, J., & Brown, M. (2013, March 20). *Familial, social, and individual factors contributing to risk for adolescent substance use*. Journal of Addiction. Retrieved December 9, 2021, from https://www.hindawi.com/journals/jad/2013/579310/.

A comparison of total cholesterol, HDL, and LDL levels and their associations with heart attacks between Canadian men and women over the age of 65: a cross-sectional and observational study

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INTRODUCTION

Cardiovascular disease (CVD) is a major cause of death worldwide, describing conditions that affect the heart or blood vessels which typically manifest as heart attacks and strokes (Park et al., 2017). Heart disease is a type of CVD and is an umbrella term that describes any conditions that affect the heart's structure and function (Giardina, 2000). In this study, we will be focusing on heart attacks. Myocardial infarction, otherwise known as heart attack, is the abrupt ischemic death of myocardial tissue caused by blockages from platelets, fatty deposits, and plaque in the inner walls of coronary vessels (Frangogiannis, 2015). The leading cause of death among women is heart disease (Park et al., 2017). Nearly half a million women globally succumb to heart disease every year, with a quarter of a million dying from coronary artery disease (Giardina, 2000). However, there are still several risk factors and symptoms that remain unknown. For instance, women over the age of 65 are considered an at-risk group for developing heart attacks (Tullmann & Dracup, 2005). Additionally, women develop heart disease approximately ten years later than men, and they are likely to have worse heart complications after a heart attack (Giardina, 2000). The lack of awareness and knowledge about heart disease and heart attacks among women perpetuate additional symptoms in women that are less commonly present in men, such as nausea, vomiting, fatigue, dyspnea, and pain in the back, neck, or jaw (Tullmann & Dracup, 2005).

Cholesterol is an organic compound that can be synthesized by the liver and ingested from animal products (Eapen et al., 2009). This sterol plays a vital role in cellular processes, such as being a precursor for hormone synthesis and bile acids, and maintaining the fluidity and integrity of the cell membrane (Eapen et al., 2009; Shinitzky, 1978). The liver creates a healthy amount of cholesterol, but an increase in low-density lipoprotein (LDL) and decrease in high-density lipoprotein (HDL) is associated with the risk of heart disease (Lemieux et al., 2001). LDL and

HDL carry cholesterol around the body (Hernáez et al., 2019). Following the entry of the LDL particle into the artery, the molecule becomes oxidized and leads to plaque formation in the blood vessel (Wegner et al., 2012). Over time, the blood vessel will narrow, causing an increased chance of having a heart attack (Hao & Friedman, 2014). The HDL particle is known for having potent antioxidative properties, as studies show that it is a major inactivator of oxidized LDL, thereby preventing plaque formation in the arteries and lowering the chances of a heart attack (Kontush et al., 2003). Total plasma cholesterol (TCHOL) is a measure of total cholesterol in the blood, which includes the concentrations of both HDL and LDL combined (Lee & Siddiqui, 2021). In older women, studies have found that LDL levels tend to increase, HDL levels tend to decrease, and total plasma cholesterol (TCHOL) levels begin to elevate (Saha et al., 2013). This lipid profile is hypothesized to be a risk factor for developing CVDs such as heart attacks (Saha et al., 2013). In younger women, the risk of heart attack is 2.5 to 4.5 times lower than men of the same age, but as women age, there is a sharp increase in heart attack rates (Eapen et al., 2009).

There is currently a lack of research regarding the prevalence of heart disease in older women. Despite CVD being the major cause of death in older post-menopausal women (Park et al., 2017), it was recently determined that for the National Science and Engineering Council of Canada (NSERC) funded cardiovascular research programs, female participants were excluded in 63% of publications, with 49% of literature having only male participants (Wilson, Adams, & Pyke, 2020). Moreover, the Heart and Stroke Foundation of Canada found that over 65% of clinical research for heart disease focuses solely on male participants (Heart & Stroke Foundation, 2018). There is also research that suggests there is a tendency of physicians to diagnose men with heart disease conditions with greater certainty in comparison to women, and that they consider the potential implications of age on diagnosis for men more than women (Adams et al., 2007). Thus, it is vital to consider various factors that may contribute to the potential susceptibility of women to heart diseases. This knowledge gap has driven us to address if Canadian women over the age of 65 with high cholesterol levels (i.e., greater than 5.2 mmol/L) are at a greater risk for having heart-related complications, measured by the experience of a heart attack, in comparison to men of the same age range who also have high cholesterol levels.

METHODS

***Study Design and Database* |** This research study used a cross-sectional and observational design, with data collected from the Canadian Heart Health Database (CHHDB) at Memorial University (Canadian Heart Health Database, 1997). This database contained integrated information from the Provincial Heart Health Surveys conducted between the years of 1986 to 1992 as part of the Canadian Heart Health Initiative (Canadian Heart Health Database, 1997). The data collection aimed to estimate the prevalence of CVD risk factors, awareness among the population, and the consequences. The information was collected from ten provincial surveys, containing family history information from four provincial surveys: Ontario, Quebec, Alberta, and Saskatchewan (Canadian Heart Health Database, 1997). The data was collected in two stages by trained nurses. At the first stage, the nurses visited the participants' homes to gather demographic information, their knowledge of CVD risk factors, and other opinions and attitudes on the study topic. Two blood pressure tests were also done on the participants. During the second stage, participants came to a clinic to report anthropometric measurements, and two additional blood pressure measurements were taken (Canadian Heart Health Database, 1997). This database was chosen as the collection was conducted several decades ago, allowing for the investigation of trends that were prominent at that specific period.

***Study Participants* |** The database included information on individuals aged 18 to 74 years old, excluding those who were full-time residents of military camps, institutions, or Indian reserves. The dataset contained a total of 23,129 cases and 266 continuous and discrete variables (Canadian Heart Health Database, 1997). For this study, only participants in the age range of 65 to 74 years old were included to focus the study's observations on this specific age group. The final study population consisted of 3,168 participants, and only 11 variables were analyzed. The remaining 19,961 cases and irrelevant variables in the dataset were deleted when the following criteria were met: did not state their gender; not in the 65-74 YEARS age group; the height (in centimetres [cm]), weight (in kilograms [kg]), and BMI were "VARIABLE UNKNOWN", "RECODED MISSING", or "NOT STATED/REF"; the total plasma cholesterol (TCHOL; in millimoles per litre [mmol/L]), the high-density lipoproteins (HDL; in millimoles per litre [mmol/L]), and the low-density lipoproteins measurements (LDL; in millimoles per litre [mmol/L]) were "VARIABLE UNKNOWN" or "NO MEASUREMENT"; and the answers to the question "[EVERHA] HAVE YOU EVER HAD A HEART ATTACK?" were "NOT SURE" or "NOT STATED/REF".

***Study Outcomes* |** The primary outcome of interest for this study was total plasma cholesterol levels (in mmol/L), represented by the "TCHOL" variable. The secondary outcomes are high-density lipoprotein levels (in mmol/L), and low-density lipoprotein levels (in mmol/L), represented by the "HDL" and "LDL" variables respectively. An additional outcome is the occurrence of a previous heart attack, measured by the question "HAVE YOU EVER HAD A HEART ATTACK?" and represented by the "EVERHA" discrete variable. Participants were asked the question "HAVE YOU EVER HAD A HEART ATTACK?" in a home interview sample in the first stage of data collection by nurses, where they answered "YES", "NO", "NOT SURE", or did not state their answers (represented by "NOT STATED/REF") (Canadian Heart Health Database, 1997). The total plasma cholesterol, HDL, and LDL levels in the participants were assessed by having individuals fast for at least 8 hours before visiting a clinic in-person (Canadian Heart Health Database, 1997). Then, a blood sample was taken where a fasting lipid panel test was used (Canadian Heart Health Database, 1997). Although the sensitivity for this test is 95%, as mentioned by Fatima et al. (2016), literature regarding its specificity is scarce. Because of this knowledge gap, the reliability and validity of this test were compromised, thereby also negatively affecting this test's reproducibility. However, this test was used because it provides the clinical importance of reporting on the primary and secondary outcomes of the patients. There was the possibility of intrasubject variation as scheduled appointment times for the blood test varied from person to person. However, all participants fasted for a relatively similar duration (Canadian Heart Health Database, 1997). The question "HAVE YOU EVER HAD A HEART ATTACK?" was asked in the form of an interview, which was a valid and reproducible form of outcome measurement (Reuben, Siu, & Kimpau, 1992). However, there was the potential for response bias that must be considered (Furnham, 1986). Regardless of this, self-reported data provides clinical importance to the study, as researchers gain a perspective on the lifestyle factors of the patients. These could then be considered when analyzing the data. Intraobserver or interobserver variations were not seen in the blood tests or the questionnaire, as definitive concentrations were produced by the lipid test and no additional observers were involved in either of the data collections. TCHOL, LDL and HDL were assigned as the main outcome measures, as studies have shown that an increase in LDL with a concurrent decrease in HDL have associations to heart attack risks (Lemieux et al., 2001). Literature also suggests that elevated TCHOL levels were associated with a greater chance of heart attack occurrence (Eapen et al., 2009), which was the justification for the chosen outcomes.

***Additional Data Collection* |** The additional outcome measures of this study included height (in cm), weight (in kg), and BMI, with the variable names 'HGTC', 'WGTC', and 'BMI' respectively. These variables were included in the Shapiro-Wilk test to determine if the data was normally distributed. Literature suggests that an individual's height, weight, and BMI exceeding a healthy level may contribute to an increased risk of heart attack, e.g., obesity is a risk factor for CVD (Akil & Ahmed, 2011). Furthermore, individuals who are obese tend to have a higher BMI, which is a calculation dependent on the height and weight of the individual (Akil & Ahmed, 2011). Due to this association, these variables were used as additional outcome measures to determine if the data was normally distributed. As a result, further statistical analyses could proceed with an emphasis on the primary and secondary measures.

***Statistical Analysis* |** To test for normality of data, the Shapiro-Wilk test was conducted. Additionally, a Mann-Whitney *U* test was conducted to test between-group differences with the continuous variables, as the research question aimed to investigate differences in health outcomes based on gender. Furthermore, a chi-squared test was conducted to determine between-group differences in proportions of responses to categorical type questions. In **Table 1**, the variables were recorded for each gender separately and were selected based on their possible association with the outcome being investigated in the research question. The values were median ± the interquartile range (IQR) unless otherwise stated, as the data was not normally distributed. The results were presented in the form of a table and a stacked bar graph. All tests were performed with the SPSS Statistics software, using a *p*-value of 0.05 for significance.

RESULTS

***Participant recruitment* |** The dataset contained a total of 23,129 cases and 266 continuous and discrete variables (Canadian Heart Health Database, 1997). In this study, only data 3,168 participants and 11 variables were analyzed. The remaining 19,961 cases in the dataset were filtered out and deleted when the following criteria were met: did not state their gender; not in the 65-74 YEARS age group; the height (in cm), weight (in kg), and BMI were "VARIABLE UNKNOWN", "RECODED MISSING", or "NOT STATED/REF"; the total plasma cholesterol (TCHOL; in mmol/L), the high-density lipoproteins (HDL; in mmol/L), and the low-density lipoproteins measurements (LDL; in mmol/L) were "VARIABLE UNKNOWN" or "NO MEASUREMENT"; and the answers to the question "[EVERHA] HAVE YOU EVER HAD A HEART ATTACK?" were "NOT SURE" or "NOT STATED/REF".

***Descriptive statistics and distribution of the study population* |** The data from **Table 1** demonstrates a comparison of the age (in years), height (in cm), weight (in kg), BMI, TCHOL (in mmol/L), HDL (in mmol/L), and LDL (mmol/L) measurements of the 3,168 participants, in which 1,656 individuals identified as "MALE" and 1,512 individuals identified as "FEMALE". The values are presented as medians ± IQR. The male participants had higher medians for age, height, and weight. The male and female participants had the same medians for BMI, but a different IQR. The female participants had higher medians for TCHOL, HDL, and LDL. The test for normality yielded a Shapiro-Wilk significance value of less than 0.001 for these continuous variables.

Table 1 Descriptive Characteristics of the 1986 to 1992 Canadian Heart Health Database Participants [N = 3168].

Variable	**Male (N = 1656)**	**Female (N = 1512)**	***p*-Value**
Age (years)	69.00 ± 4.00	69.00 ± 5.00	<0.001
Height (cm)	172.00 ± 9.00	159.00 ± 8.00	<0.001
Weight (kg)	79.00 ± 17.00	66.00 ± 17.00	<0.001
BMI	26.40 ± 4.90	26.40 ± 6.20	<0.001
TCHOL (mmol/L)	5.46 ± 1.25	5.84 ± 1.33	<0.001
HDL (mmol/L)	1.14 ± 0.36	1.32 ± 0.44	<0.001
LDL (mmol/L)	3.48 ± 1.13	3.65 ± 1.28	<0.001

Values are median ± IQR, unless otherwise stated. Height = Height in centimetres (cm) measured at a clinic; Weight = Weight in kilograms (kg) measured at a clinic; BMI = Body Mass Index; TCHOL = Total Plasma Cholesterol in millimoles per litre (mmol/L); HDL = High Density Lipoprotein in millimoles per litre (mmol/L); LDL = Low Density Lipoprotein in millimoles per litre (mmol/L).

***Mann-Whitney U Test showed a difference in TCHOL levels between males and females* |** A Shapiro-Wilk significance value of less than 0.001 was obtained after testing for normality, thus the Mann-Whitney *U* Test was used to compare differences for the median TCHOL variable (in mmol/L) between the male and female participants. The null hypothesis stated that the distribution of TCHOL is the same across categories of sex (i.e., male or female). The Mann-Whitney *U* test value was 1,578,751.000, with a significance of 0.000.

***The Chi-Square analysis demonstrated no significant difference between males and females in terms of heart attack occurrences based on TCHOL levels* |** A Chi-Squared test was conducted to determine the proportion of male and female participants who have less than or greater than 5.2 mmol/L levels of TCHOL (in mmol/L). The TCHOL variable was transformed to create a cut-off point of 5.2 mmol/L as it has been established that TCHOL levels below approximately 200 milligrams per decilitre ([mg/dL]; or 5.2 mmol/L) are desirable in healthy individuals (*High Cholesterol: Overview*, 2017). **Figure 1** demonstrates a comparison of male (**A**) and female (**B**) participants' answers to the variable and question "[EVERHA] HAVE YOU EVER HAD A HEART ATTACK?" from a Chi-Squared test. In this analysis, 105 out of 261 (40.23%) of the male participants and 26 out of 109 (23.85%) of the female participants had TCHOL levels that are less than 5.2 mmol/L and answered 'Yes' to the question. 553 out of 1395 (39.64%) of the male participants and 320 out of 1403 (22.80%) of the female participants had TCHOL levels that are less than 5.2 mmol/L and answered 'No' to the question. 156 out of 261 (59.77%) of the male participants and 83 out of 109 (76.15%) of the female participants had TCHOL levels that are greater than 5.2 mmol/L and answered 'Yes' to the question. 842 out of 1395 (60.36%) of the male participants and 1083 out of 1403 (77.19%) of the female participants had TCHOL levels that are greater less than 5.2 mmol/L and answered 'No' to the question. The continuity correction value obtained was 2.478, with two-sided asymptotic significance value of 0.115.

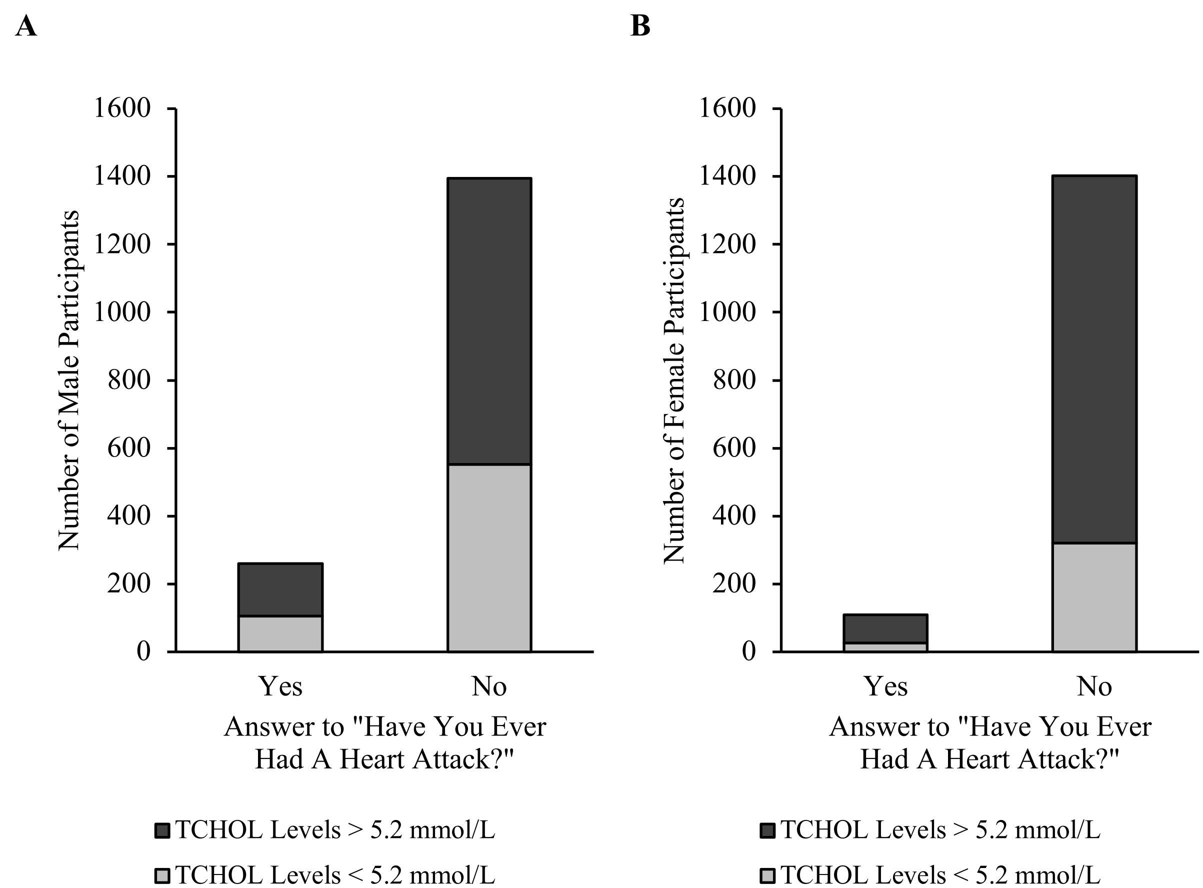

Figure 1. A comparison of male and female participants' answers based on a chi-square analysis. Stacked bar graphs demonstrating the number of male participants [N = 1656] and female participants [N = 1512] who answered 'Yes' or 'No' to the question "Have you ever had a heart attack?". The dark grey bars represent participants who had total plasma cholesterol levels less than 5.2 mmol/L. The light grey bars represent participants who had total plasma cholesterol levels greater than 5.2 mmol/L. A total of 3168 participants were included in this analysis.

DISCUSSION

Summary of Research Study and Main Findings | This research study aimed to determine if Canadian women over the age of 65 with high cholesterol levels (i.e., greater than 5.2 mmol/L), are at a greater risk for having heart-related complications, measured by the experience of a heart attack, in comparison to men of the same age range who also have high cholesterol levels. The data was not normally distributed, but the median TCHOL, HDL, and LDL values between males and females were significantly different, i.e., females are more likely to have higher median TCHOL, HDL and LDL concentrations than males. In addition, participants who had higher TCHOL levels (greater than 5.2 mmol/L) experienced more heart attacks than those who had lower TCHOL levels (less than 5.2 mmol/L), but more males suffered a heart attack compared to females. Upon closer inspection, there was no significant difference between the experience of heart attacks in males versus females when they both have high TCHOL levels (greater than 5.2 mmol/L).

Shapiro-Wilk and Mann-Whitney U Test Analysis | A Shapiro-Wilk test was conducted to determine if the data was normally distributed for the male and female participants included in the study. The *p*-values were less than 0.001 for each outcome measure (i.e., age, height, weight, BMI, TCHOL levels, HDL levels, and LDL levels), which indicates that the data is not normally distributed. Therefore, to find the between-group differences of the TCHOL, HDL, and LDL levels, the Mann-Whitney U test was conducted, and it was determined that the *p*-value was less than 0.05. As shown in **Table 1**, this indicates that the median TCHOL, HDL, and LDL values between males and females were significantly different. Specifically, the median values for these outcomes are higher in females than males. As the results showed that older women are more likely to have higher median TCHOL, HDL and LDL concentrations than men, this leads us to believe that older women are at a higher risk of having a heart attack than men. A study conducted by Russo et al. (2015) found that older women had higher TCHOL, HDL, and LDL levels compared to the men in the study and women struggled to hit a healthy LDL cholesterol target compared to men. They concluded that these factors expose older women to a higher risk of coronary heart disease (CHD) (Russo et al., 2015). These findings by the researchers corroborate the findings in our study and support the notion that high concentrations of our primary outcomes are associated with increased heart attack risks in older women compared to men. The reason for this may be explained by decreased estrogen levels that occur in older women (Hodin et al., 2001). Estrogen is a chemical determinant to lipoprotein concentrations in women that naturally decreases with age; specifically, after menopause (Kilim & Chandala, 2013). It should be noted that lower estrogen concentration results in decreased HDL levels (Kilim & Chandala, 2013). Additionally, after menopause, women experience elevated TCHOL and LDL levels, and since HDL has decreased, there is less involvement of its cardioprotective factors (Kilim & Chandala, 2013). This would expose older women to an increased risk of having CVD (Kilim & Chandala, 2013).

Chi-Square Analysis | The chi-square analysis was performed to determine the potential association between TCHOL, gender, and if the individual has ever experienced a heart attack. This analysis reveals that for both males and females, participants who had a higher TCHOL level (greater than 5.2 mmol/L) experienced more heart attacks than those who had a lower TCHOL level (less than 5.2 mmol/L). However, there were also more males who suffered a heart attack compared to females. After the examination of the significance values, it is evident that there is no significant difference between the experience of heart attacks in males versus females when they both have high TCHOL levels. The continuity correction value obtained was 2.478, leading to a two-sided asymptotic significance value of 0.115, which is greater than the significance value of 0.05. Therefore, there is insufficient evidence to support the hypothesis of this association having a gender-based difference, meaning it was inconclusive for our study. According to a longitudinal study conducted by Corti et al., (1997), an elevation in TCHOL levels is an associated risk factor for death from CHD in older adults. Similarly, the Framingham study examined a group of men and women prospectively for 14 years, finding that there was a higher incidence of CHD as age and TCHOL levels increase (Kannel et al., 1971). Finally, a prospective cohort study conducted in 1998 found that TCHOL was a significantly associated risk factor for CHD, with a higher risk as an individual ages and a 34% increase in risk correlated with high TCHOL levels for women (Wilson et al., 1998). It is suggested that this correlation is due to faulty lipid transport caused by hyperlipidemia, resulting in an increased risk of atherogenesis and subsequent reduced blood flow to the heart (Kannel et al., 1971). Given this mechanism of action and the findings which suggest associations between increased TCHOL and CHD in older women, it was hypothesized that in our study there would be an increase in heart attacks with higher levels of cholesterol, also demonstrating a gender-specific difference. However, the results obtained were not statistically significant, which may be attributed to the various limitations of the study which will be elaborated further.

Study Limitations and Future Implications | The research study conducted provides novel insights into the topic of cardiovascular health for older individuals. While the chi-square statistical analysis does not provide sufficient evidence to support the initial hypothesis, this study provides the potential for further research. For instance, a randomized controlled trial can be conducted to determine the likelihood of older women with high cholesterol developing heart diseases. Unlike our study design, a randomized controlled trial would limit the number of confounding variables potentially affecting the results, as multiple factors may have impacted the measured outcomes in an observational study where groups and interventions are not randomized. For instance, lifestyle factors such as stress and smoking habits may impact the occurrence of a heart attack (Millet, Peters, & Woodward, 2018), which was not accounted for. In addition, a follow-up study can be conducted to determine the potential association between recurrent heart attacks and cholesterol levels between genders, as this database grouped all occurrences of heart attacks in one category. However, it did not differentiate between the likelihood of subsequent heart attacks occurring after the first incidence. Another limitation of the observational study we conducted is related to the database. The data may be outdated since the survey was conducted in the 1980s. This field of research would benefit from modern data collection that considers recent environmental changes, medical advancements, and more. Additionally, this database contained missing data for various questions, which had to be accounted for in statistical analyses. This has the potential to alter the results presented, as certain participants had to be excluded for not providing answers to the questions and variables we analyzed. Another limitation to this study is that the fasting lipid test has limited information on the specificity as it is an older test used to determine lipid profile, thereby compromising the validity and reliability of the results. This can be improved by using a non-fasting lipid test in future studies (Fatima et al. 2016). Finally, it is important to consider that the questionnaire answered by participants is subject to response bias to increase social desirability (Furnham, 1986), meaning the results may not be as accurate. Despite these limitations, this research study offers a multitude of benefits to medical research. These implications can be applied in cardiovascular health research and education, especially towards women who may have a current lack of knowledge and awareness regarding their risks of the development of the disease. Furthermore, research like this can be useful in determining preventative and protective measures for CVD, as dietary intake of cholesterol is a modifiable risk factor that can be promoted through health campaigns. Finally, this study can be utilized for therapeutic purposes if the mechanisms of disease are examined further, as it provides insights on the biological mechanisms that are involved in the pathophysiology of cholesterol and CVD, thus providing potential pathways for targeted treatment approaches.

References

Adams, A., Buckingham, C. D., Lindenmeyer, A., McKinlay, J. B., Link, C., Marceau, L., & Arber, S. (2008). The influence of patient and doctor gender on diagnosing coronary heart disease. Sociology of health & illness, 30(1), 1-18. https://doi.org/10.1111/j.1467-9566.2007.01025.x

Akil, L., & Ahmad, H. A. (2011). Relationships between obesity and cardiovascular diseases in four southern states and Colorado. *Journal of Health Care for the Poor and Underserved*, *22*(4A), 61–72. https://doi.org/10.1353/hpu.2011.0166

Canadian Heart Health Database Centre, Memorial University (1997). Canadian Heart Health Database, 1986-1992 (chhd-E-1986-1992). [Data set]. Canadian Heart Health Database. http://odesi2.scholarsportal.info.libaccess.lib.mcmaster.ca/webview/index.jsp?v=2&submode=abstract&study=http%3A%2F%2F142.150.190.128%3A80%2Fobj%2FfStudy%2Fchhd-E-1986-1992&mode=documentation&top=yes

Corti, M. C., Guralnik, J. M., Salive, M. E., Harris, T., Ferrucci, L., Glynn, R. J., & Havlik, R. J. (1997). Clarifying the direct relation between total cholesterol levels and death from coronary heart disease in older persons. *Annals of Internal Medicine*, *126*(10), 753-760. https://doi.org/10.7326/0003-4819-126-10-199705150-00001

Eapen, D., Kalra, G., Rifai, L., Eapen, C., Merchant, N., & Khan, B. (2009). Raising HDL cholesterol in women. *International Journal of Women's Health*, 181. https://doi.org/10.2147/IJWH.S5110

Fang, J., Luncheon, C., Ayala, C., Odom, E., & Loustalot, F. (2019). Awareness of heart attack symptoms and response among adults—United states, 2008, 2014, and 2017. *MMWR.*

Morbidity and Mortality Weekly Report, *68*(5), 101–106. https://doi.org/10.15585/mmwr.mm6805a2

Fatima, S., Ijaz, A., Sharif, T.B., Khan, D.A., & Siddique, A. (2016). Accuracy of non-fasting lipid profile for the assessment of lipoprotein coronary risk. *JCPSP, 26(12). 954-957.* https://www.researchgate.net/publication/311948450_Accuracy_of_Non-Fasting_Lipid_Profile_for_the_Assessment_of_Lipoprotein_Coronary_Risk

Frangogiannis, N. G. (2015). Pathophysiology of myocardial infarction. In *Comprehensive Physiology* (pp. 1841–1875). American Cancer Society. https://doi.org/10.1002/cphy.c150006

Furnham, A. (1986). Response bias, social desirability and dissimulation. *Personality and individual differences*, *7*(3), 385-400. https://doi.org/10.1016/0191-8869(86)90014-0

Giardina, E. G. (2000). Heart disease in women. *International Journal of Fertility and Women's Medicine*, *45*(6), 350–357.

Hao, W., & Friedman, A. (2014). The LDL-HDL Profile Determines the Risk of Atherosclerosis: A Mathematical Model. *PLoS ONE*, *9*(3), e90497. https://doi.org/10.1371/journal.pone.0090497

Heart and Stroke Foundation of Canada. 2018. Ms.Understood: Heart & Stroke 2018 Heart Report. Available from https://www.heartandstroke.ca/-/media/pdf-files/canada/2018-heart-month/hs_2018-heart-report_en.ashx.

Hernáez, Á., Soria-Florido, M. T., Schröder, H., Ros, E., Pintó, X., Estruch, R., Salas-Salvadó, J., Corella, D., Arós, F., Serra-Majem, L., Martínez-González, M. Á., Fiol, M., Lapetra, J., Elosua, R., Lamuela-Raventós, R. M., & Fitó, M. (2019). Role of HDL function and

LDL atherogenicity on cardiovascular risk: A comprehensive examination. *PLOS ONE*, *14*(6), e0218533. https://doi.org/10.1371/journal.pone.0218533

Hodin, H. N., Mack, W. J., Lobo, R. A., Shoupe, D., Sevanian, A., Mahrer, P. R., ... & Azen, S. P. (2001). Estrogen in the prevention of atherosclerosis: a randomized, double-blind, placebo-controlled trial. *Annals of internal medicine*, *135*(11), 939-953. https://doi.org/10.7326/0003-4819-135-11-200112040-00005

Information, N. C. for B., Pike, U. S. N. L. of M. 8600 R., MD, B., & Usa, 20894. (2017). *High cholesterol: Overview*. Institute for Quality and Efficiency in Health Care (IQWiG). https://www.ncbi.nlm.nih.gov/books/NBK279318/

Kannel, W. B., Castelli, W. P., Gordon, T., & McNamara, P. M. (1971). Serum cholesterol, lipoproteins, and the risk of coronary heart disease: the Framingham Study. *Annals of internal medicine*, *74*(1), 1-12. https://doi.org/10.7326/0003-4819-74-1-1

Kilim, S. R., & Chandala, S.R. (2013). A comparative study of lipid profile and oestradiol in pre- and post-menopausal women. *Journal of Clinical & Diagnostic Research, 7(8),* 1596-1598. https://doi.org/10.7860/JCDR/2013/6162.3234

Kontush, A., Chantepie, S., & Chapman, M. J. (2003). Small, Dense HDL Particles Exert Potent Protection of Atherogenic LDL Against Oxidative Stress. *Arteriosclerosis, Thrombosis, and Vascular Biology*, *23*(10), 1881–1888. https://doi.org/10.1161/01.ATV.0000091338.93223.E8

Lee, Y., & Siddiqui, W. J. (2021, July 26). *Cholesterol levels.* In StatPearls. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK542294/

Lemieux, I., Lamarche, B., Couillard, C., Pascot, A., Cantin, B., Bergeron, J., Dagenais, G. R., & Després, J.-P. (2001). Total Cholesterol/HDL Cholesterol Ratio vs LDL

Cholesterol/HDL Cholesterol Ratio as Indices of Ischemic Heart Disease Risk in Men: The Quebec Cardiovascular Study. *Archives of Internal Medicine*, *161*(22), 2685. https://doi.org/10.1001/archinte.161.22.2685

Millett, E. R., Peters, S. A., & Woodward, M. (2018). Sex differences in risk factors for myocardial infarction: cohort study of UK Biobank participants. bmj, 363. https://doi.org/10.1136/bmj.k4247

Park, N. J., Chang, Y., Bender, C., Conley, Y., Chlebowski, R. T., Van Londen, G. J., ... & Kuller, L. H. (2017). Cardiovascular disease and mortality after breast cancer in postmenopausal women: results from the Women's Health Initiative. PloS one, 12(9), e0184174. https://doi.org/10.1371/journal.pone.0184174

Reuben, D. B., Siu, A. L., & Kimpau, S. (1992). The predictive validity of self-report and performance-based measures of function and health. Journal of gerontology, 47(4), M106-M110. https://doi.org/10.1093/geronj/47.4.M106

Russo, G., Pintaudi, B., Giorda, C., Lucisano, G., Nicolucci, A., Cristofaro, M. R., Suraci, C., Mulas, M. F., Napoli, A., Rossi, M. C., & Manicardi, V. (2015). Age- and gender-related differences in ldl-cholesterol management in outpatients with type 2 diabetes mellitus. *International Journal of Endocrinology*, *2015*, 1–8. https://doi.org/10.1155/2015/957105

Saha, K. R., Rahman, M. M., Paul, A. R., Das, S., Haque, S., Jafrin, W., & Mia, A. R. (2013). Changes in lipid profile of postmenopausal women. *Mymensingh Medical Journal: MMJ*, *22*(4), 706–711. PMID: 24292300

Shinitzky, M. (1978). An efficient method for modulation of cholesterol level in cell membranes. *FEBS Letters*, *85*(2), 317–320. https://doi.org/10.1016/0014-5793(78)80482-7

Tullmann, D. F., & Dracup, K. (2005). Knowledge of heart attack symptoms in older men and women at risk for acute myocardial infarction: *Journal of Cardiopulmonary Rehabilitation*, *25*(1), 33–39. https://doi.org/10.1097/00008483-200501000-00008

Wegner, M., Piorunska-Stolzmann, M., Araszkiewicz, A., Zozulinska-Ziolkiewicz, D., Naskret, D., Uruska, A., & Wierusz-Wysocka, B. (2012). Does oxidized LDL contribute to atherosclerotic plaque formation and microvascular complications in patients with type 1 diabetes? *Clinical Biochemistry*, *45*(18), 1620–1623. https://doi.org/10.1016/j.clinbiochem.2012.08.019

Wilson, P. W., D'Agostino, R. B., Levy, D., Belanger, A. M., Silbershatz, H., & Kannel, W. B. (1998). Prediction of coronary heart disease using risk factor categories. *Circulation*, *97*(18), 1837-1847. https://doi.org/10.1161/01.CIR.97.18.1837

Wilson, R., Adams, M. L., & Pyke, K. E. (2020). Inclusion of female participants in cardiovascular research: a case study of Ontario NSERC-funded programs. *Applied Physiology, Nutrition, and Metabolism*, *45*(8), 911-914. https://doi.org/10.1139/apnm-2019-0693

Inability to be understood by others when communicating explains extended years spent in school for 10-14-year-old students with any degree of auditory disability or hearing loss in Canada (1984)

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Introduction

Young children acquire knowledge through everyday play and exploration in a safe and stimulating environment (Child Development Basics, 2021). Effective education within a school environment is vital because it illuminates the developing mind which is crucial for future aspirations (Al-Shuaibi, 2014). It is important to note that these school environments may be effective for many students, but they may not provide the same social and intellectual stimulation for disabled students. In terms of diagnostics, school environments are typically where students and parents first receive professional insight on childhood disabilities. There is no guarantee as to when students will get diagnosed or if they will, as some disabilities may go unnoticed, however, the time at which they do could potentially affect the child's success in school (Aron & Loprest, 2012). An early diagnosis benefits children with disabilities as it allows for immediate intervention and accommodations to be made. When classroom environments do not support a child's disability such as hearing loss, it creates a gap in education between children with disabilities and those without. Children with hearing impairments are not any less capable of succeeding in school compared to their hearing-abled peers, but some teachers may have a poor understanding of hearing loss and are therefore unable to adjust teaching styles creating disadvantages for children with auditory disabilities (Victory, 2020).

For non-disabled visual and auditory students, 80% of learning is conducted through vision (Baum & Owen, 1988). A research study found that children with learning disabilities tend to perform poorly on tasks that utilize verbal stimuli, regardless of the task at hand

(McGrady & Olson, 1970). Children with learning disabilities, especially auditory, have distinct methods of learning and acquisition (Ontario Ministry of Education, 2014). Another study compares cognitive and motivational patterns across disabled and non-disabled children and found that the increasing differences are because early intervention and methods were not administered to those with neuro-divergent learning styles, and this consequently translated into social and behavioural habits as well (Baum & Owen, 1988). This is why a traditional classroom is not always an ideal environment for all children as teachers may not be able to accommodate these differences and needs, leading to an overall 35% of students with hearing impairments being held back a year in school (Audiology Hearing Services of Charlotte, 2020).

The different language and experiential histories that deaf and hearing-impaired children have had are often disregarded and interpreted as deficiencies, despite it being the opposite. Research centred around deaf students ages 13 to 17, and their ability to comprehend text indicates that deaf students are far more proficient readers than teachers give them credit for (Marschark & Wauters, 2008). Children with disabilities can comprehend texts that teachers might consider to be too tough, recognize tactics that assist with their own comprehension and are well aware of when teachers undermine their capability to absorb literature. As early investigators failed to account for the fact that deaf children have different languages and experiential histories in contrast to hearing-abled children, this creates subtle and unsubtle differences in cognitive and linguistic functioning of hearing-impaired children. Additionally, specialized staff are not required to receive early childhood education in order to work with children with disabilities, yet another systemic issue that further contributes to the limitations in the education system and the overall lack of financial assistance provided by governments (Child Care Canada, 2013). The issue is of inclusion, and it stems from the lack of knowledge and research preventing individuals and professionals from understanding that inclusion in the classroom is an educational issue and not a private one that families must be responsible for (Child Care Canada, 2013). While subsequent research exists for how well students can perform on cognitive tasks, and what resources are required, the knowledge gap exists in visualizing how systemic failings affect the progress of students with any degree of hearing disability. As this is not seen as an issue in the education system, families must turn to outside resources, despite studies showing the burden of inclusion programs should not be placed on children or their families (Child Care Canada, 2013). Our study aims to assess students who claim they have difficulty communicating, and subsequently how many years they spend behind in school- a direct measure of the resources, aids, and accommodations they receive for their learning style.

Methods

Study Design and Database

Our analytical study aimed to analyze data from the observational Canadian Health and Disability Survey (CHDS) conducted from 1983 to 1984. This CHDS assessed an approximate 97% of the Canadian population; 59,195 children (14 years of age and under) of which 3,382 had a long-term health condition, used a prosthesis or had a health-related activity limitation. This demographic excludes residents of institutions (inmates), Indigenous and/or First Nations reserves, the Yukon and Northwest Territories, and armed forces personnel. The CHDS measured a variety of factors such as; individual and community health, economic and financial burdens, education and schooling, long-term physical disability conditions, degree of disabilities, use of aids, as well as general demographic information such as sex, residence, age, etc. Respondents provided their answers through face-to-face interviews in a questionnaire format. Most respondents were parents and/or guardians of the child participant.

Study Participants

From the total population of 59,195 children, 288 students were selected for our final analysis. Our selection criteria included all students from ages 10-14, with any degree of auditory disability or (non-medically diagnosed), and having a valid answer for the question "Does [name of student in question] have trouble being understood by others?". This criterion allows for extensive focus on the social understanding of hearing impairments and learning, as our research demonstrates that professional diagnoses and intervention is often lacking in assessing growing children, due to many social restraints, such as adult lack of knowledge, social stigmas, culture, etc (Child Care Canada, 2013)

Study Outcomes

The primary outcomes of our study are to see how long students between the ages of 10-14- the critical age of psycho-social development (source)- and with auditory disabilities are held back in school, the cases of students range from 1-11 years spent in school. Participants who previously answered "yes" to the question 'Does [the individual in question] have any auditory or hearing impairments? (no need to be professionally diagnosed)', were then asked "Does [the individual in question] have trouble being understood by others?". The options were 'yes (child can be understood by others)', and 'no (child has trouble being understood by others)'.

Additional Data Collection

For the question "Does [the individual in question] have trouble being understood by others?", 2 contingent groups were created. 'Yes group'-signifying students who had no trouble being understood by others, and 'No group' signifying students who had trouble being understood. Additional data collection involved the observation of variables: sex, age, years held back in school, and province of residence across both 'yes' and 'no' group. Additional analysis was performed for another variable, the survey asked "Can (individual in question) not perform one of the following traits? (Sign Language, Fingerspelling, and/or Lipreading)". The options for this variable were 'Yes: cannot perform any of the above' and 'No-can at least perform one of the listed traits'. We inferred that those with auditory impairments of varying degrees may not *all* be able to communicate in ASL, lip read, and finger-spell, thus this variable was not filtered through our data.

Statistical Analysis

Our study observes solely categorical variables within the CHDS, and therefore, due to the nature of the data, limited tests could be performed. The software Statistical Packages for the

Social Sciences (SPSS) v.23 was utilized to filter, sort, and analyze the data. We conducted a Spearman Rho analysis between the variables ‘years held back in school’ and whether the student is understood by others or not (yes and no groups). Additionally a logistic regression analysis was performed to measure the effects of 4 categorical predictor (independent) variables on the dichotomous dependent variable ‘years held back in school’. Predictor variables include: Sex (male), Province of residence (10 Canadian provinces), Non-Verbal communication skills (Yes-is unable to perform well in at least one of three tasks [sign language fluency, lipreading, or fingerspelling]), and being understood by others (No- child has trouble being understood by others). The categories mentioned in brackets for each predictor variable are the predictor outcomes for the weight that the category influences on predicting the outcome of the dependent variable (i.e. how much does each variable category have an effect on the dependent variable ‘years held back in school’). The dependent variable was transformed into a dichotomous variable, with categories 1-2 years, and 3+years. As our research suggests 1-2 years of schooling should be sufficient enough to allow students to improve their academic performance (Marschark & Wauters, 2008), and receive appropriate aid. For this analysis ‘3+ years’ is probability=1 , and ‘not 3+ years’ (i.e. 1-2 years) is probability=0. The p-value for significance threshold for our study is 0.05, this is most appropriate for our population size, and variables (Biostatistics: The Bare Essentials, 2014).

Results

Table 1. Descriptive Demographic Characteristics of the selected participants from the Canadian Health and Disability Survey of 1983-1984 (Child File). N=288. Data are presented as the frequency and percent (%) of surveyed individuals who have been classified as either being understood by others, or not being understood by others. All included cases are between 10-14 years of age. [1]Data presented in brackets with a single asterisk indicating within-group percentages, and total population (N) for the 'no' group is 237 (N_{No}= 237) and for the 'yes' group is 51 (N_{Yes}= 51).

Characteristics	**Yes group (child can be understood by others)** Frequency. (%)	**No group (child has trouble being understood by others)** Frequency. (%)
Age (Years)		
10-14	237 (82.29%)	51 (17.70%)
Sex		
Male	165 (57.29%)	43 (14.93%)
Female	72 (25.0%)	8 (2.77%)
Years held back in school (N_{No}= 237 , N_{Yes}= 51)		
1	169 (58.68%) ([1]71.3%)	7 (2.43%) ([1]13.7%)
2	48 (16.66%) ([1]20.3%)	15 (5.20%) ([1]29.4%)
3+	20 (6.94%) ([1]8.44%)	29 (10.06%) ([1]56.9%)
Province of Residence		
Newfoundland	23 (7.98%)	3 (1.04%)
Prince Edward Island	7 (2.43%)	1 (0.34%)
Nova Scotia	15 (5.20%)	4 (1.38%)

New Brunswick	27 (9.37%)	5 (1.73%)
Quebec	43 (14.93%)	6 (2.08%)
Ontario	63 (21.87%)	12 (4.16%)
Manitoba	19 (6.59%)	4 (1.38%)
Saskatchewan	16 (5.55%)	5 (1.73%)
Alberta	9 (3.12%)	4 (1.38%)
British Columbia	15 (5.20%)	7 (2.43%)

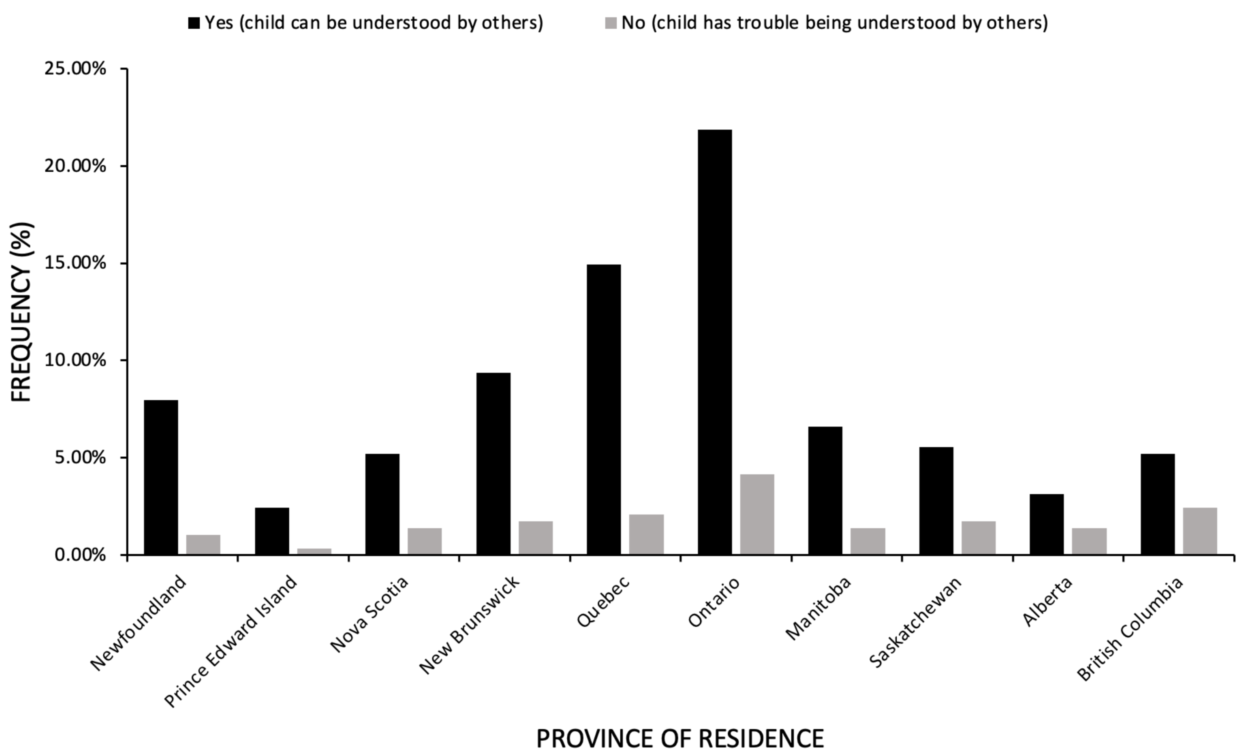

Figure 1. Percentage of Yes and No Groups across 10 Canadian provinces (N=288). Figure illustrates the percentages of ‘yes’ and ‘no’ groups across all 10 provinces. All percent values measure total population.

Table 2. Binary Logistic Regression Analysis of years held back in school (2 categories), against Sex, Province of Residence, Non-Verbal Communication Skills, and Being Understood by Others. Logistic regression model set to calculate the influence of 4 predictor variables on the dichotomous dependent variable ‘amount of years held back in school’, with categories of ‘3+ years’, and ‘1-2 years’, with 3+ years being the desired outcome (probability=1). All predictor variables are categorical, and the model predicts the influence based on the category listed for each (e.g. Sex (male) predicts the influence of being a male on the likelihood of being held behind in school for 3+ years).[2]Data regarding all 10 provinces is summarized in results.

							95% C.I. for EXP(B)	
	B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp (B)**	**Lower**	**Upper**
Sex (male)	0.527	0.149	0.210	1	0.647	1.694	0.178	16.115
Province of Residence	[2]	[2]	[2]	1	[2]	[2]	[2]	[2]
Non-Verbal Communication Skills (No-has none of the above skills)	1.31	0.663	2.87	1	0.924	1.140	0.079	16.541
Understood by others (No group)	0.319	0.869	4.36	1	*0.0323	1.376	0.084	22.636
Constant	-0.535	1.749	0.094	1	0.760	0.585		

Data was gathered from 288 students across Canada between 10 to 14 years of age, who incurred any degree of auditory disability and/or hearing loss and answered the question about being understood by others or not (categorized as yes and no groups). Within Table 1, the majority 71.3% of ‘yes group’ cases were held back for 1 year in school, whereas the majority 56.9% of ‘no group’ cases were held back for 3+ years in school, and 29.4% were held back for 2 years in school.

Figure 2 bar graph analysis shows that students within the ‘yes group’ comprise 237 cases, with the highest majority located in Ontario (n=63) at 21.87%, and Quebec (n=43) at 14.98%. Students who have difficulty being understood, (‘no group’) comprise a total of 51 cases, with the highest majority located in Ontario (n=12) at 4.16%, and British Columbia (n=7) at 2.43%.

Spearman Rho Order Correlation was utilized to assess the relationship between years held back in school with having non-verbal communication skills (p=0.30), no significant relationship.

Table 2 Logistic Regression Analysis; Understood by others (‘no group’) was the singular significant outcome (sig. = 0.0323). With an exponential beta value (Exp (b)) of 1.1469, the odds of spending 3+ years in school are 1.4169 times greater if students are not understood by others. The ‘no group’ is the cardinal predictor of spending extra time in school (Wald value= 4.36, largest of Wald values). [2] From 10 provinces of residence, residence in Nova Scotia significantly affects the chances of spending 3+ years in school (Sig=0.0972). All other variables present no statistical significance.

Discussion

Our analyses showed that out of the population of students who had difficulty being understood by others, more than half spent 3+ years behind in school. Similarly, difficulty being understood by others (‘no group’) is the most significant predictor in whether students will spend 3+ years behind in school.

Our statistical analysis noticed fewer significant results than expected, as most variables did demonstrate prevalence and trends to support our hypothesis. Our study did not produce any negative results, solely non-significant outcomes, with the exception of not being understood by others and 3+ years spent in school.

Our preliminary research and hypothesis stipulated that to be able to grow and learn effectively, students, especially at a young age, must actively be participating in their environment (Al-Shuaibi, 2014). Our hypothesis explains that children who are not understood by others will find fewer chances to actively engage in their environment due to the lack of inclusion and acceptance of communication forms that are non-verbal. Children with auditory disabilities often use non-verbal forms of communication (sign language, lipreading, and fingerspelling) when engaging with their environment which may be categorized by teachers and administrators as ‘deviant’, thus hindering the student from moving forward. Research suggests that teachers who have a poor understanding of hearing loss create disadvantages for children with auditory disabilities and impairments as they are unable to adjust their teaching styles to satisfy all students within their classroom (Victory, 2020).

Our secondary analysis specifies that under certain economic, financial, personal, cultural and social conditions, students who are not understood by others will spend extended years (more than 1-2) in school, because they may not receive the adequate resources to excel, due to these very conditions. Compared to our research, we noticed that other published findings share similarity in assessment of students within mainstream schooling systems. Choi et al, assess students attending a mainstream, state school (equivalent to an elementary school in North America), and do not limit their treatment groups to students with a diagnosed intellectual or auditory impairment, rather base their answers on feedback from parents and teachers. This study also controls for any aids provided to children through special programs, schooling, or personal causes. This control ensures the results are unbiased to any resources students with auditory disabilities may receive, and best tries to measure the impacts of mainstream schooling systems on students. Similarly, other studies also assess social factors that are critical in child development. Mourad et al and Choi et al, concluded that children with auditory impairments spent less time interacting with peers. In contrast, other published research often only assess singular factors, such as social behaviour, educational development and test performance, and often for a singular cohort. Many studies assess students within mainstream schools or special schools (publically funded, and/or privately funded with baseline resources) and not across a variety of schools, which does not factor in socio-economic issues. Additionally, our research uncovered slightly higher diagnoses of ‘no’ (student is not understood by others) cases in Ontario and British Columbia, and while statistically insignificant, this may prove that diagnosis is more common in large cities, and more affluent areas, where there are more resources (Conference Board of Canada, 2015). The limitations here are the lack of consideration of less-affluent areas and even between-location differences. For example, British Columbia’s healthcare system and integration of medicine into school are very different from Ontario. One example of this phenomenon is that the majority of city schools across British Columbia have in-school nurses, whereas this is not as common in Ontario (The Conference Board of Canada, 2015). Similarly, teacher qualifications, and the ability of teachers and administrators, as well as parents and guardians, to recognize symptoms of deviance, hearing loss, or other disabilities or impairments varies across different locations.

While statistics exist about disability and learning, our data adds an intersectional perspective to the field. Rather than basing hearing loss off of a medical model, we used a social model, eliminating barriers in diagnosis, use of aids or pieces of equipment, and including all students who have varying degrees of hearing loss, and we also measure years held back in school, a non-biased, irrefutable trait that cannot be denied.

As for limitations, outliers above 6 years of being held back from school were noticed. This may explain that there are other factors contributing to the success of a student's education. Selection bias is another limitation of our study. Proxies were parents who may not always give the most correct answer which can be attributed to the shame, guilt and reality of what their children are or may be, this is heavily associated with cultural, traditional, and self-serving factors. Similarly, with respect to the time period, stigma in diagnosis is yet another limitation. The years 1983-1984 diagnoses as an example, what defined disability and the capability of teachers to recognize diverse children with hearing and/or other problems were less known. Non-verbal signs of communication are often mistaken by verbal teachers as disrespect or signs of academic delay, for example: not paying attention, not making eye contact when learning or being spoken to, and other forms of communication such as stimming, course breathing and facial expressions. Students may show they are listening and engaging but teachers may interpret this as disrespect, academic dissonance and non-progression (Baum & Owen, 1988). Moreover, we did not assess financial factors, as government aid varies from province to province. Taking OHIP as an example, this government-provided health plan may cover a selection of services provided to students or children with disabilities. However, OHIP is only for residents of Ontario so students and families of different provinces might experience different financial struggles.

After reviewing other research, it must be considered that learning and disability surveys cannot be grouped into general questionnaires and that these studies must be longitudinal to assess multiple factors in an adolescent student's life. Longitudinal studies help to identify drivers of inequality, linkages between academic performance and environmental and social factors and assess how mainstream services and society, in general, affect minorities and their life courses. In the past, longitudinal studies have been used to improve policies surrounding low socioeconomic status (UKRI, 2011). The findings of longitudinal studies may assist with determining the amount of funding that should be allocated for educational services for children with disabilities (Halfon, 2013). Similarly, longitudinal studies looking at children with hearing disabilities can be used for school reform to improve educational outcomes, progression and experiences of children with disabilities (UKRI, 2011). Policies regarding inclusion within the education system also provide clear benefits for children and their families, as well as the general public as a whole. Separation of students with disabilities from those who are able-bodied contributes to stigmatization of disabilities. Even today, schools may continue to separate students with disabilities, failing to provide inclusive experiences for all students. From external research, an effective quality scale framework for inclusion suggests learning policies must be reformed to cater to individual and unique experiences of all children to prevent the placement of the burden to fit in on children and their families. This can include making sign language and braille a part of the curriculum. These methods of communication have also shown to be outlets of effective communication in children, in preverbal stages, and to communicate complicated feelings (Halton & Friendly, 2013)

References

Baum, S., & Owen, S. V. (1988). High ability/learning disabled students: How are they different? *Gifted Child Quarterly*, *32*(3), 321–326. https://doi.org/10.1177/001698628803200305

Centers for Disease Control and Prevention. (2021, September 23). *Child development basics*. Centers for Disease Control and Prevention. Retrieved October 11, 2021, from https://www.cdc.gov/ncbddd/childdevelopment/facts.html.

Child Care Canada. (2018). *Deafness and Hearing Impairment and Learning* . New program aimed at preschool children a 'huge win for the Deaf Community'. Retrieved December 13, 2021, from https://childcarecanada.org/documents/child-care-news/18/07/new-program-aimed-preschool-children-huge-win-deaf-community.

Choi, S. M., Kei, J., & Wilson, W. J. (2019). Hearing and auditory processing abilities in primary school children with learning difficulties. *Ear & Hearing*, *40*(3), 700–709. https://doi.org/10.1097/aud.0000000000000652

Conference Board of Canada. (2015). *Health*. The Conference Board of Canada. Retrieved December 13, 2021, from https://www.conferenceboard.ca/hcp/provincial/health.aspx#top.

Fletcher, Jack M., Foorman, Barbara R. Learning disabilities: Issues on definition. (1991). https://doi.org/10.1044/policy.rp1991-00209

Garnett, K. (2017, November 15). What are classrooms like for students with learning disabilities? Reading Rockets. Retrieved October 11, 2021, from https://www.readingrockets.org/article/what-are-classrooms-students-learning-disabilities

Halfon, S. (2013, July). Inclusion of young children with ... - childcarecanada.org. Childcare Canada . Retrieved December 13, 2021, from https://childcarecanada.org/printpdf/7335.

Inclusion of young children with ... - childcarecanada.org. (2003). Retrieved November 10, 2021, from https://childcarecanada.org/printpdf/7335.

Is hearing loss holding your student back? Audiology Hearing Services of Charlotte. (2020, October 22). Retrieved November 10, 2021, from https://www.audiologycharlotte.com/2019/03/22/is-hearing-loss-holding-your-student-back/.

Marschark, M., & Wauters, L. (2008). Language comprehension and learning by deaf students. In M. Marschark & P. C. Hauser (Eds.), *Deaf cognition: Foundations and outcomes* (pp. 309–350). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195368673.003.0012

McGrady, H. J., & Olson, D. A. (1970). Visual and auditory learning processes in normal children and children with specific learning disabilities. *Exceptional Children*, *36*(8), 581–589. https://doi.org/10.1177/001440297003600803

Mourad, M., Hassan, M., El-Banna, M., Asal, S., & Hamza, Y. (2015). Screening for auditory processing performance in primary school children. *Journal of the American Academy of Audiology*, *26*(04), 355–369. https://doi.org/10.3766/jaaa.26.4.4

Norman, G. R., & Streiner, D. L. (2014). *Biostatistics: The bare essentials*. People's Medical Pub. House.

Ontario Ministry of Education. (2014). How Does Learning Happen? Ontario’s Pedagogy for the Early Years. https://files.ontario.ca/edu-how-does-learning-happen-en-2021-03-23.pdf

Raising Children Network. (2019, June 24). *Learning in the baby to preschool years*. Raising Children Network. Retrieved October 11, 2021, from https://raisingchildren.net.au/babies/play-learning/learning-ideas/learning-baby-to-preschool.

UKRI, E. R. S. C. (2011, September 1). Longitudinal studies: Child development and social mobility. AHRC. Retrieved December 5, 2021, from https://esrc.ukri.org/news-events-and-publications/evidence-briefings/longitudinal-studies-child-development-and-social-mobility/.

Victory, J. (2020, June 9). *How does hearing loss affect school performance?* Healthy Hearing. Retrieved November 10, 2021, from https://www.healthyhearing.com/report/52433-How-hearing-loss-affects-school-performance.

Vosniadou, S. (2003). How children learn. Successful schooling, 16. http://www.ibe.unesco.org/sites/default/files/resources/edu-practices_07_eng.pdf

GROUP 6: ASSIGNMENT 2 - FINAL MANUSCRIPT

Examining the impact of Personal Protective Equipment (PPE) on Nurses health during the COVID-19 Pandemic

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Introduction

SARS-CoV-2 or COVID-19, also known as the coronavirus, is a diverse family of viruses that can cause respiratory illnesses in both humans and animals (Mayo Clinic Staff, 2021). These illnesses can range from minor ailments like a common cold to life-threatening infections (Mayo Clinic Staff, 2021). SARS-CoV-2 is primarily transmitted in two methods (Centers for Disease Control and Prevention, 2021). The CDC, Centers for Disease Control and Prevention (2021), stated that the first way is to come into direct physical contact with an infected person or a contaminated object or surface. The second way is through an infected individual's respiratory droplets, which are expelled by coughing, sneezing, breathing, or speaking, and the danger is especially high for those who are in close proximity to one another (Centers for Disease Control and Prevention, 2021). The virus can also be transferred by small particles that stay airborne for minutes to hours and can travel long distances, however, this is believed to be a less typical mode of transmission (Centers for Disease Control and Prevention, 2021).

The best approach to limit the risk of developing COVID-19, according to specialists, is to take prophylactic steps (Centers for Disease Control and Prevention, 2021). The CDC recommends wearing cloth face coverings in public places where it may be difficult to execute other social distancing measures along with other personal protective equipment (PPE) such as masks and face shields (Centers for Disease Control and Prevention, 2021).

Health care workers (HCWs), such as nurses, doctors, and personal support workers (PSWs) are particularly susceptible to contamination, however many are neglected without proper precautions, such as personal protective equipment (PPE) (Alam, 2020). Nurses have been central to preventing COVID-19 transmission and the treatment for individuals who have tested positive, especially in hospitals and nursing/long-term care homes (Alam, 2020). In these homes more than 80% of COVID-19 deaths occurred from March through August

2020 (Clarke, 2021). This resulted in nurses being under an increased amount of mental and physical stress, along with symptoms of depression and anxiety becoming more frequent (Sampaio et al., 2020).

In March 2020, Ontario implemented new regulations requiring HCWs to utilise N95 respirators, face shields, and gowns when working with anyone who may or may not have COVID-19, in order to limit contraction and spread of the disease. (Public Health Ontario, 2020). U.S. Centres for Disease Control and Prevention recommended that HCWs should be equipped with respirators such as N95 masks or powered air-purifying respirators whenever they come into contact with suspected or confirmed cases (Chang et al., 2020). However, the CDC then reduced its guidelines, proposing the use of just surgical masks for when performing non-aerosolizing treatments (Centres for Disease Control and Prevention, 2021). It has been stated that this was a supply-driven decision rather than a science-driven one (Brosseau, 2020).

A study conducted in China shows that infection rates dropped significantly when increased levels of protection were supplied to HCWs (Zhu & Zong, 2020). The use of highly-effective PPE such as N95 masks instead of medical surgical masks were credited in part for the significant difference (Zhu & Zong, 2020).

The global lack of PPE, particularly medical N95 masks, complicated the protection of HCWs. When it came to purchasing and storing N95 masks and other medical equipment, Ontario had followed these guidelines, however, once the respirators expired, the government disposed of the supplies and failed to replace them (Leo, 2020).

An understanding of the correlation between exposure and infection is paramount. McIntosh (2021) highlighted a positive correlation between COVID-19 exposure, vulnerability and infection. The researchers conducted a study of over 2500 people in Taiwan who came into close contact with 100 COVID-19 patients (McIntosh, 2021). After close examination of exposed contacts, the study showed that only 850 exposed contacts did not show symptoms within the set interval of 6 days. (McIntosh, 2021).

In 2020, Baker et al. identified that 18% of 26,69,810 employees worked where exposure to disease and infection occurred more than once a month and 10% of 14,425,070 employees worked where exposure to infection occurred more than once a week. Out of all identified employees at high risk of infection, researchers identified that 90% worked as health and occupational practitioners (Baker et al., 2020).

From March of 2020 onwards, though traces of COVID-19 could be found all over Canada, Ontario – due to its population – was a province with one of the most, if not the highest number of cases of COVID-19 (Canada Public Health, n.d.). The impact of COVID-19 in Ontario, combined with a lack of free hospital beds, respirator machines, and PPE, had overwhelmed physicians and healthcare workers (Nielson, 2021). Through observing the correlation between access to PPE and its influence on self-reported perceived health, this could help fill a knowledge gap to assess the strain put on front line/healthcare workers.

There is a knowledge gap in this area where we are assessing the correlation between the accessibility of PPE and the general health of healthcare workers. Though it is a given that hospital facilities should fund or provide PPE because of the global pandemic, some implications of clinical practices could result in inadequate healthcare services. We analysed nurses that were 54 years of age or younger in order to increase our sample size of nurses assessed under these circumstances.

An adequate supply of PPE would help healthcare workers treat positive COVID-19 patients which would subsequently decrease the rate of transmission. The risks that Ontario HCWs had encountered have had an impact on their sense of security and well-being, culminating in mental health effects that could have been avoided by imposing stronger and more effective protection methods (Smith et al., 2020).

Research Question: Among Ontario nurses aged 54 years old or younger, who work from March 2020 onwards, do nurses with sufficient access to PPE, i.e. access to masks and access to gloves, demonstrate improved levels of self-reported perceived health when compared to nurses without sufficient access to PPE?

Methods

Study Design and Database

We selected an observational cross-sectional study from the Ontario Data Documentation, Extraction Service and Infrastructure (ODESI) Scholars Portal, to conduct a meta-analysis on health workers from different provinces in Canada. ODESI published the database on September 28, 2021, titled "Impacts of COVID-19 on Health Care Workers: Infection Prevention and Control, 2020 [Canada] (ICHCWIPC 2020)". Statistics Canada conducted the study using a sampling procedure to select 18,139 participants assessing 101 variables. The researchers used structured questionnaires to gather information from their participants through a survey in which the data collection period lasted from November 11, 2020, to December 13, 2020.

Study Participants

When creating our final database, we considered the PICO criteria (Participants; Intervention/Exposure; Control/Comparison; Outcomes). As per our research question, we intentionally selected the following as inclusion criteria for our study. Participants (P): among healthcare workers listed in the database, we chose the age cut-off to be 54 years old (54 inclusive). Intervention/Exposure (I/E): we selected nurses including and below the cutoff age and excluded those above 54 years of age because the majority of nurses that worked full-time/part time fell between the chosen age group. Control/Comparison (C): our study focused on a group of nurses who reported sufficient access to personal protective equipment (PPE), specifically masks and gloves. We compared this group to those who reported insufficient access to PPE. Outcome (O): our study outcome focused on the correlation between the sufficiency of PPE and nurses perceived health.

Study Outcomes

The primary findings of this study assessed the sufficiency of PPE and the perceived health of nurses. For PPE, gloves and masks were focussed on, since they are the essential equipment that was accessible to the majority of participants in the survey. Nurses' response to the following question determined the sufficiency of PPE: *"Since March 2020, how would you describe your access to the following PPE at your primary job location?"*. Participants' responses were categorised based on the following: "not needed for the job"; "always available when needed"; "usually available when needed"; "sometimes available when required"; "never available when needed". Choices 6-9 consisted of "Valid skip"; "Don't Know"; "Refusal"; "Not stated". We deleted all missing data in choices 6-9 and regrouped the participants' responses to better suit our research question. Participants who responded to the question with "Always available when needed" were categorised as having sufficient access to that particular PPE. We organised the remaining responses as insufficient access to PPE. Researchers repeated the same question for masks as well. The participants responded to the following question to report their perceived health: *"In general, how would you describe your health? 'Health' refers to not only the absence of disease or injury, but also to physical, mental and social well-being."* Akin to the PPE group, we applied the same rationale to the perceived health responses. Answers labelled "excellent", "very good",

"good" were relabelled as "improved perceived health" while "fair" and "poor" were all categorised as "no improved perceived health."

While analysing the original database, it was evident that most nurses reported sufficient access to PPE, and a higher proportion reported no improvement in perceived health. Therefore, we selected these outcome variables to determine whether there was a significant correlation.

According to the data retrieved from the supplementary information on ODESI, researchers collected the data to assess the impact of PPE and infection prevention and control (IPC) measures in the workplace on a probabilistic approach. Participants were not randomly selected like other Statistics Canada surveys. Therefore, the outcome from this study cannot be generalised to a larger population or other health care workers, as the data only pertain to the selected participants.

Additional Data Collection

Additional variables in our database include the age group of nurses. Nurses initially had three groups (<35, 35-44 and 45-54), and this descriptive variable shows the population range. We selected nurses who work in Ontario to help narrow down the varying effects of exposure. Gender is another descriptive variable included in the database, as this analysis also considered males and females. We also included nurses' work status - whether it be full time or part-time to help assess exposure via the hours they had worked.

Statistical Analysis

Since our data set consisted of only categorical variables, we used SPSS to summarise all variables based on their frequency. The number of nurses (N) was reported for all variables in Table 1. In response to the research question, we used the chi-square test (P-value= 0.05) to assess the difference in distribution between the PPE group and the perceived health. We had limited options that would help analyse our data, however, the chi-squared analysis was efficient in helping us answer our research question.

Results

Amongst the 18,139 healthcare workers included in the analysed database, a total of 1249 healthcare workers were nurses that worked in Ontario and were 54 years old or younger. We chose seven variables from the 101 available in the database. The nurses were all aged 54 years old and under, with these ages being compartmentalised into three groups; nurses less than 35 years of age, nurses between 35 and 44 years of age, and nurses aged 45 to 54. There were 567 nurses aged younger than 35 in this study, making it the largest age group amongst the 1249 nurses. Gender was also a descriptive characteristic, with 163 of the nurses being male and 1086 female. For employment status, amongst the two options of full-time and part-time employment, 949 nurses were employed full time and 300 were employed part time. The key characteristics of access since March 2020 to PPE and the perceived health of nurses were analysed. 1055 nurses had sufficient access to gloves, and 194 nurses did not have sufficient access. Amongst nurses, the access to masks since March 2020 shows that 901 nurses had sufficient access to masks, and 348 nurses had insufficient access. When analysing how many nurses there were for each option of perceived health, the summary of nurses using SPSS found that 218 of 1249 nurses had improved perceived health, while the other 1031 nurses (82.54% of total nurses observed) experienced no improved perceived health during this same period.

Table 1: Nurses with access to PPE versus nurses without access to PPE since March 2020 and their perceived health (N=1249)

	Variable		Frequency (N)
	Occupation (Nurses) Region: Ontario		1249
AGE GROUP (years)	<35		567
	35 to 44		377
	45 to 54		305
PPE	Gloves	Sufficient-	1055
		Insufficient-	194
	Mask	Sufficient-	901
		Insufficient-	348
GENDER	Male		163
	Female		1086
STATUS	Full-time		949
	Part-time		300
	Nurses with improved health		218
	Nurses without improved health		1031

Table 1. Displaying descriptive characteristics of Ontario nurses aged 54 years old and below who did not have continuous access to PPE compared to nurses who did have continuous access to PPE. Perceived Health is also included in Table 1 (See: with or without improved health).

*$p < 0.05$ considered significant.

*Mean (SD) and median (IQR) are not reported in Table 1

PPE: Personal Protective Equipment

Perceived health: 'Health' refers to not only the absence of disease or injury, but also to physical, mental and social well-being.

Figure 1: Access to gloves and masks and classification of who amongst these groups experienced improved or declined perceived health

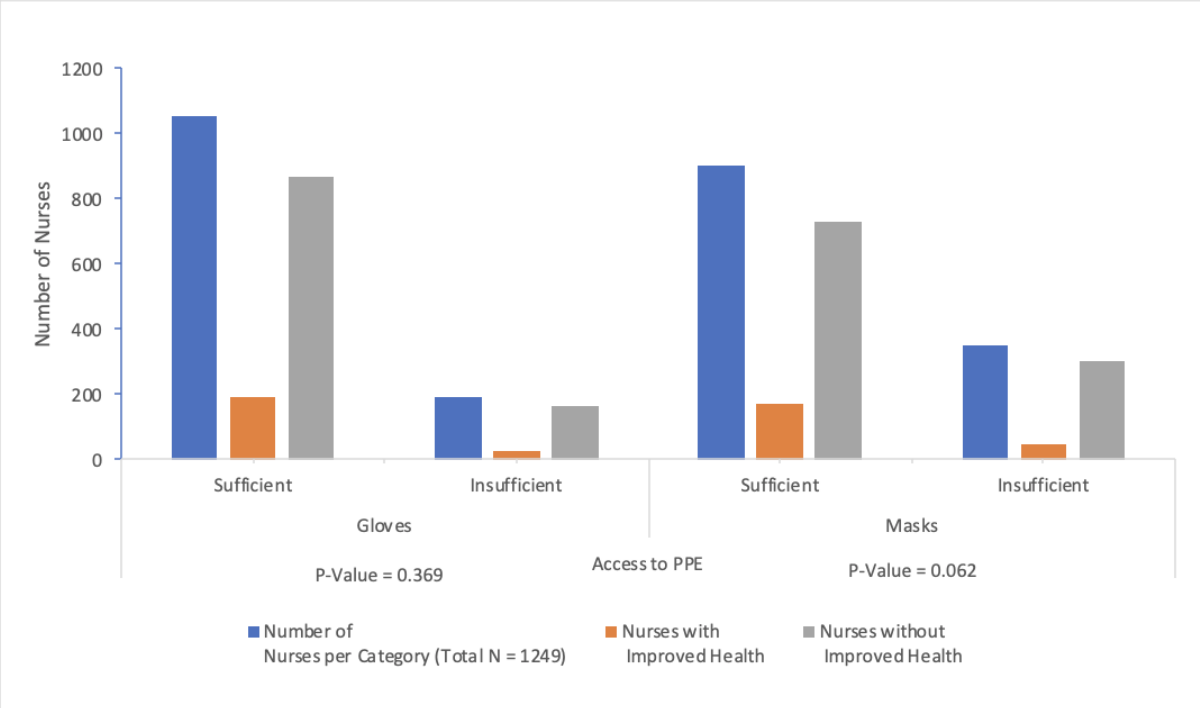

Figure 1. Access to personal protective equipment and its effect on perceived health. Level of access to gloves and masks (either sufficient or insufficient) to nurses aged 54 years old or younger working in Ontario and whether the nurses experienced improved perceived health. P-values for both access to gloves and masks and the correlation with perceived health are displayed in Figure 1.

*P < 0.05 considered significant.

*P-value for gloves is 0.369, and 0.062 for masks. Both are greater than 0.05

After categorising the Ontario nurses used in this study and collecting the demographic information of the nurses, the correlation between access to personal protective equipment and perceived health of the nurses was calculated. The correlation between these two variables did not factor in the gender or employment status of the nurses analysed. Of the 1055 nurses which had sufficient access to gloves, 189 had reported improved personal health, with 866 nurses reporting no improvement. 29 nurses with insufficient access to gloves still experienced improved health, and 165 of the 194 nurses with insufficient access had no improvement in perceived health. When analysing access to masks and perceived health, of the 901 nurses with sufficient access, 169 had improved health, and 732 did not have any improvement in perceived health. Of the 348 nurses that did not have sufficient access to masks, 49 had experienced an improvement in perceived health, and 299 had no improvement. Using the chi-square test to determine correlation, the effects that a lack of access to these two types of personal protective equipment have on perceived health was analysed. The p-value of 0.05 is used, and values lower than 0.05 were considered significant. For the access to gloves, the p-value calculated was 0.369 and the p-value for access to masks was 0.062. Since these values are both larger than the value 0.05, there was no significance between access to gloves and masks, both sufficient and insufficient, and the improvement of perceived health of the nurses. Therefore, we fail to reject the null hypothesis.

Discussion

Main Findings

COVID-19, being an infectious disease and now a worldwide public health emergency, poses a novel challenge to our healthcare professionals, impacting not only their daily job but also their social surroundings (Markwell et al., 2020). Healthcare workers are likely to encounter new obstacles as we transition to adapt to the new ways of living following COVID-19.

The results indicated that among Ontario nurses aged 54 years old or younger, who worked from March 2020 onwards, nurses with sufficient access to PPE, i.e. access to masks and access to gloves, did not demonstrate improved levels of self-reported perceived health when compared to nurses without sufficient access to PPE.

Contrary to the associated hypothesis, we could not observe a significant improvement in Ontario nurses' perceived health despite the participants indicating they had sufficient access to PPE. Rather, the data showed that more often, nurses who did have access to sufficient PPE still indicated no improvement in perceived health, where 82% and 81% of nurses reported no improvement in health when they had sufficient access to gloves and masks, respectively.

One possible explanation for our findings was that enhanced use of PPE may have caused adverse side effects which resulted in physical and mental distress to the users (Swaminathan et al., 2020). This could be due to the novel discomfort of the many layers of PPE and visual obstructions, as well as difficulty breathing through several masks and a face shield. Although, we believed that as access to PPE became more widely available to nurses, their perceived health should, in return, improve, many studies have reported that prolonged use of PPE can result in mental and physical ailments (Swaminathan et al., 2020).

We hypothesised that as nurses receive sufficient access to PPE, in return their personal health should improve - but it is important to note that other factors also play a role in determining one’s health. Other personal elements could have an impact, such as home life, pre-existing health conditions, and financial circumstances. Sufficient and insufficient access to PPE would not be the sole factor influencing one’s health.

Comparison of findings with those reported in the literature

Limited studies researched the impact of access to PPE on nurses working during the COVID-19 pandemic. The reasons for this are unknown. The majority of the research studies differ from our study because they primarily assess PPE and its direct impact on healthcare workers, aka. how its usage affected surgical performance (Benitez et al., 2020), or caused a negative physical impact on healthcare workers (Davey et al., 2021). Contrary to our research question, many studies found a positive correlation between usage of PPE and worsened self-reported health and well-being, as mentioned in the 2020 study by Swaminathan et al. There were not many limitations with these other studies that would be considered significant in relation to our study.

We discovered only one research study that was similar to ours, which assessed personal protective equipment and mental health symptoms among nurses during the COVID-19 pandemic. A study conducted by Arnetz et al. in 2020 focused on nurses in the United States and the findings followed that which we had expected of our study as well. Their study results stated that nurses lacking access to adequate PPE were more likely to report symptoms of depression, anxiety and post-traumatic stress disorder (Arnetz et al., 2020). Between this study and ours, it can be agreed that the main takeaways were similar - organisations should be aware of the magnitude of mental health problems among nurses and be vigilant in providing them with adequate PPE as the pandemic continues (Arnetz et al., 2020). The results from this study could have differed from our study due to the prevalence of cases in the United States being greater than Ontario's which could explain why nurses in the States were under more mental duress. This could be why access to PPE made a more significant difference for nurses in the States than it did for nurses in Ontario. Our findings can add to this field of study because due to the contradictory evidence behind whether PPE can improve nurses' and other healthcare workers' self-reported perceived health or not, further research can be conducted to specify what 'sufficient' or 'insufficient' access is, which can help develop methods to address these concerns.

Strengths and Limitations

A notable strength of our research study is that we attempted to look into a novel research topic. We felt that it was a really important topic to learn more about because nurses play an integral role in healthcare and are often overlooked. Especially during the COVID-19 pandemic, there was a greater strain on nurses because of understaffing and many incoming patients. As such, we hypothesised that during a global pandemic, when stress is at an all-time high, not having access to sufficient PPE would indicate that nurses would report worsened self-reported health and well-being. The uncertainty of the disease itself, tied with the risk of being exposed to it daily, could make anyone in this situation more stressed and concerned for their own health which could result in worsened self-reported health.

A significant limitation for our research study was the lack of prior background research available. Due to this being such a novel topic to be researched, we did not have a lot of supporting research. As such, we were very limited when it came to obtaining external data. Another limitation for our study was that sufficient and insufficient access can be quite subjective and not everyone would agree on what is defined as sufficient or insufficient access. Due to the subjectivity of these terms, which could vary between the nurses, this could have influenced the results. We also could have considered a different format for organising our research. Had we categorised our findings into sections based on PPE restrictions, which could have been heavily influenced by inventory for respective locations, we could have been able to break down who had sufficient access. By grouping sections based on the restrictions they had for PPE usage - such as needing to reuse PPE or request permission to obtain PPE, this could have been a next step for outlining further classification distinctions within our study. Seeing as we only considered nurses working in Ontario under the age of 54, and did not classify them any further, this could have influenced our *p*-values, therefore our conclusion.

We had very limited options when it came to analysing our data, since we only had categorical data. Though we could have done a regression analysis, the associated complications would not be beneficial for analysing our data. For this reason, we had used the chi-squared analysis because this served as the most effective when it came to addressing our research question. The varying workplace environments of nurses were also another limitation because it could have influenced the usage of PPE. For example, there may be more PPE required in the emergency ICU department, compared to a long-term care home, which could have subsequently influenced the supply and demand for PPE.

Implications

Despite these limitations, these findings suggest several theoretical and practical implications. While the COVID-19 pandemic has been largely contained in certain regions, the situation in other regions remains adverse. To avoid a repetition of this pandemic, we must take the necessary precautions. Government officials should recognize the importance of PPE, especially in the setting of healthcare workers, and ensure that PPE is always stocked so no shortages can be experienced in the future. This would help to keep medical personnel and patients as safe as possible and prepared in case another outbreak occurs. As the circumstances of COVID-19 worsen, we believe that a psychological and physical examination and timely professional assistance for healthcare workers are required to prevent the ongoing outbreaks from having a more acute impact on their health.

Although this study fails to support our research hypothesis, the most important contribution may be that it raises intriguing questions for future study. An intriguing question for future directions can assess how periodic discussions on the justification for PPE usage, as well as empirical evidence from frequent risk assessments help to increase coping strategies and aid the general wellbeing of medical personnel. The correlation of PPE on the physical and mental well-being of healthcare workers during COVID-19 should definitely be further investigated, as there is contradictory evidence on whether it enhances or decreases one's perceived health. A correlation between consistent usage of PPE and decreased mental and physical health should also be further researched, as it can aid in our knowledge of the impact of pandemics on the mental health of medical professionals and will propose actions to take.

Reference List

Alam, H. (2020, September 19). Nearly 20 percent of covid-19 infections in Canada among health-care workers by late July. Toronto Star. Retrieved October 2, 2021, from https://www.thestar.com/news/canada/2020/09/19/nearly-20-per-cent-of-covid-19-infections-in-canada-among-health-care-workers-by-late-july.html.

Arnetz, Judith E. PhD, MPH; Goetz, Courtney M. BA; Sudan, Sukhesh MPH; Arble, Eamonn PhD; Janisse, James PhD; Arnetz, Bengt B. MD, PhD Personal Protective Equipment and Mental Health Symptoms Among Nurses During the COVID-19 Pandemic, Journal of Occupational and Environmental Medicine: November 2020 - Volume 62 - Issue 11 - p 892-897 doi: 10.1097/JOM.0000000000001999

Baker, M. G., Peckham, T. K., & Seixas, N. S. (2020, April 28). *Estimating the burden of United States workers exposed to infection or disease: A key factor in containing risk of COVID-19 infection*. PLOS ONE. Retrieved October 3, 2021, from https://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0232452#sec008.

Brosseau, L. (2020, March 16). Commentary: Covid-19 transmission messages should hinge on science. CIDRAP. Retrieved October 2, 2021, from https://www.cidrap.umn.edu/news-perspective/2020/03/commentary-covid-19-transmission-messages-should-hinge-science.

Canada, P. H. (2021, May 28). COVID-19 daily epidemiology update. Retrieved from https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html

Centers for Disease Control and Prevention. (2021). Coronavirus disease 2019 (covid-19). Centers for Disease Control and Prevention. Retrieved October 3, 2021, from http://www.cdc.gov/coronavirus/2019-ncov/index.html.

Chang, D., Xu, H., Rebaza, A., Sharma, L., & Dela Cruz, C. S. (2020). Protecting health-care workers from subclinical coronavirus infection. *The Lancet Respiratory Medicine*, *8*(3). https://doi.org/10.1016/s2213-2600(20)30066-7

Clarke, J. (2021, June 10). *CanadaImpacts of the COVID-19 pandemic in nursing and residential care facilities in Canada*. Statistics Canada. Retrieved October 3, 2021, from https://www150.statcan.gc.ca/n1/pub/45-28-0001/2021001/article/00025-eng.htm.

Davey, S. L., Lee, B. J., Robbins, T., Randeva, H., & Thake, C. D. (2021). Heat stress and PPE during COVID-19: Impact on healthcare workers' performance, safety and well-being in NHS settings. *Journal of Hospital Infection,108*, 185-188. doi:https://doi.org/10.1016/j.jhin.2020.11.027

Leo, G. (2020, April 16). Health minister reviewing management of Canada's emergency stockpile | CBC news. CBCnews. Retrieved October 3, 2021, from https://www.cbc.ca/news/canada/saskatchewan/heath-minister-emergency-stockpile-1.5530081.

Markwell A, Mitchell R, Wright AL, Brown AF. Clinical and ethical challenges for emergency departments during communicable disease outbreaks: can lessons from Ebola virus disease be applied to the COVID-19 pandemic? Emerg Med Australas. 2020;32(3):520–4 https://doi-org.knowledge.idm.oclc.org/10.1111/1742-6723.13514.Mayo Clinic Staff. (2021, September 25). Coronavirus disease 2019 (covid-19).

Mayo Clinic. Retrieved October 3, 2021, from https://www.mayoclinic.org/diseases-conditions/coronavirus/symptoms-causes/syc-20479963.

McIntosh, K. (2021, September 20). *COVID-10: Epidemiology, virology, and prevention.* . UpToDate. Retrieved October 3, 2021, from https://www.uptodate.com/contents/covid-19-epidemiology-virology-and-prevention.

Nielsen, K. (2021, May 10). A timeline of COVID-19 in Ontario. Retrieved from https://globalnews.ca/news/6859636/ontario-coronavirus-timeline/

Public Health Ontario. (2020, March 12). IPAC recommendations for use of personal protective ... Public Health Ontario. Retrieved October 2, 2021, from https://www.publichealthontario.ca/-/media/documents/ncov/updated-ipac-measures-covid-19.pdf?la=en.

Sampaio, F., Sequeira, C., & Teixeira, L. (2020). Impact of covid-19 outbreak on nurses' Mental Health: A Prospective Cohort Study. *Environmental Research*, *194*, 110620. https://doi.org/10.1016/j.envres.2020.110620

Smith, P. M., Oudyk, J., Potter, G., & Mustard, C. (2020). The association between the perceived adequacy of workplace infection control procedures and personal protective equipment with mental health symptoms: A cross-sectional survey of Canadian health-care workers during the COVID-19 pandemic. The Canadian Journal of Psychiatry, 66(1), 17–24. https://doi.org/10.1177/0706743720961729

Statistics Canada. (2020). Impacts of COVID-19 on Health Care Workers: Infection Prevention and Control, 2020 [Canada]: ICHCWIPC 2020 (5340). http://odesi2.scholarsportal.info.libaccess.lib.mcmaster.ca/webview/

Swaminathan R, Mukundadura BP, Prasad SImpact of enhanced personal protective equipment on the physical and mental well-being of healthcare workers during COVID-19 *Postgraduate Medical Journal* Published Online First: 03 December 2020. doi: 10.1136/postgradmedj-2020-139150

Yánez Benítez, C., Güemes, A., Aranda, J. *et al.* Impact of Personal Protective Equipment on Surgical Performance During the COVID-19 Pandemic. *World J Surg* 44, 2842–2847 (2020). https://doi.org/10.1007/s00268-020-05648-2

Zhu, S., & Zong, Z. (2020). Why did so few healthcare workers in China get COVID-19 infection. QJM: An International Journal of Medicine, 114(4), 225–226. https://doi.org/10.1093/qjmed/hcaa254

Analysis of the Relationship that Patterns of Cigarette Consumption Among Adults 20 to 64 years in Ontario have with Employment Status and Other Factors

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Introduction

The current global pandemic has forced workplaces all around Canada to shut down in attempt to contain the spread of COVID-19. Many people were obligated to work from home, whereas several other individuals with hourly wages lost their jobs entirely (Lemieux et al., 2020). Lemieux and colleagues (2020) conducted an experiment where they found a 32% decline in weekly work hours (Lemieux et al., 2020) among the typical working-class individuals aged 20-64 years of age. More specifically, the researchers found that aggregate hours fell by about 34% for women and 31% for men (Lemieux et al., 2020), within this age range. Studies have found that employment status can contribute to whether an individual is likely to smoke or not (Prochaska et al., 2013). Prochaska and colleagues (2013) conducted an experiment where they looked at the likelihood of tobacco use among job-seeking unemployed individuals (Prochaska et al., 2013). Their research found that job-seeking unemployed individuals had the highest smoking prevalence rate (20.9%) compared to non-job seeking unemployed (15.9%) and employed individuals (14.8%) (Prochaska et al., 2013). Much of the research they conducted also found that men had a higher prevalence to smoking than women (Prochaska et al., 2013). Learning how to deal with unemployment is important, however, many individuals around the globe depend on drug use to cope with employment loss (Nagelhout et al., 2017). Nagelhout and colleagues (2017) conducted an experiment which looked at how unemployment can affect drug use (Nagelhout et al., 2017). The researchers found that economic recessions and unemployment can increase psychological distress; therefore, increasing drug use and consumption (Nagelhout et al., 2017). COVID-19 is considered an economic recession which is why it is important we access its intensity closely (Costa et al., 2021). With the shutdown of workplaces and the growing need of consecutive lockdowns, many countries' Gross Domestic Product (GDP) has dropped by 10% in 2020 (Costa et al., 2021). With safety measures in place, there were many shortages in local drugs, for which, people began to use replacement drugs (Costa et al., 2021). For this reason, in the first few weeks of the lockdown in European countries, there was a frequent pattern of increased drug consumption which further led to increased mental health problems (Costa et al., 2021). It is important to inspect the aspects of employment status and smoking status, especially during COVID-19 pandemic. Studies show that smoking tobacco can lead to increased risk of respiratory tract infections (van Zyl-Smit et al., 2020). As we get deeper into the pandemic, it is important that we assess these problems and look for solutions to promote not only overall physical health but also mental well-being.

As outlined by many research studies (Costa et al., 2021; Nagelhout et al., 2017; Prochaska et al., 2013), your employment status can often lead to negative consequences such as increased drug consumption; however, there are also some circumstances of positivity. A study (Yang & Ma, 2021) completed in China during COVID –19 pandemic found that many individuals' smoking habits changed during the pandemic. Results showed that many decreased the number of cigarettes smoked a day or even quit smoking (Yang & Ma, 2021). Many of the participants realized that there was an increased health risk from the respiratory disease of COVID-19, and worried that smoking could interfere and make them more susceptible to contracting the virus (Yang & Ma, 2021). Those who decreased their smoking intake reported feeling more physically healthy along with a better emotional well-being (Yang & Ma, 2021).

Aside from the various stress factors such as living in a global pandemic and having to face employment issues, there could be other variables that could increase how addicted someone is to smoking cigarettes such as the age they started smoking and their marital status. According to the American Lung Association (2020), individuals who start smoking at an earlier age are more likely to develop a nicotine addiction compared to those who start later (American

Lung Association, 2020). The marital status of individuals could also be analyzed as a contributing stress factor, resulting in an increase in negative smoking habits. Studies (Lindstrom, 2010) show that unmarried or divorced individuals significantly smoked more compared to those who were married or in a relationship (Lindstrom, 2010).

With the varying factors that could affect whether people increase or decrease the number of cigarettes they intake daily, there is still little understanding as to how someone's employment or marital status could be associated with daily cigarette consumption. Or factors including their level of education and the age at which they started smoking. It is important to look at these factors in relation to cigarette consumption to understand if there are interventions needed to decrease this ongoing health risk and to implement more preventative measures.

Therefore, our research question for this study is, among Ontario adults (20-64 years of age) what is the relationship between the working-class individuals and the number of cigarettes they smoke daily, compared to the non-working individuals of the same age group?

Methods

Study Design and Database

The design of this study was a cross sectional observation. Using the website Odesi, the database "smoking habits of Canadians, 1981" was downloaded onto the SPSS software. This database was designed to evaluate the smoking trends amongst Canadians 15 years old and older. The main focus using this database was to assess the 3 different subgroups: non-smoker, regular cigarette smokers and occasional cigarette smokers. The data from this database was collected on behalf of Health and Welfare Canada and the participants were surveyed using a Labour force survey.

Study Participants

The database originally assessed a population of Canadians from all provinces which included a total of 39137 participants. However, we solely looked at Ontarians. We included men and women participants who were over the age of 19 and under the age of 65 to analyze the working-class population which consisted of a total 4301 participants. We also deleted data that had missing values for the variables that we were mainly testing which were employment status and cigarettes smoked daily.

Study Outcomes

The primary study outcome is evaluating the number of cigarettes smoked daily in relation to working class individuals compared to non-workers. To analyze the primary study outcomes of cigarette smoked daily, the variable used in the dataset was "CIGANO" the participants listed the number of cigarettes smoked per day. We used the variable of labour force status "LFS" to evaluate the participant's employment status. In the database the participants were put into 2 groups (1=employed, 2= unemployed). To ensure that we were using people who are in the working class we used the age group variable "AGEGP" and only evaluated 5 categories (3= 20 to 24, 4= 25 to 34, 5= 35 to 44, 6= 45 to 54, 7= 55 to 64).

Additional Data Collection

Additionally, we assessed 4 more variables from the database. The education level of the patients was assessed to analyze the association of a person's highest degree of education with employment status which may increase the number of cigarettes smoked. This variable is listed as "EDUC" in SPSS and the participants were divided into 5 categories (1 = non or elementary, 2 = high school, 3 = some post-secondary, 4 = post-secondary certificate or diploma, 5 = university degree). Education status was recoded into two categories (0 = university degree, 1 = no university degree) to compare how high or low education levels influenced smoking status. Using the marital status variable "MSTAT" the respondents were assessed and were divided into 3 groups (1=single, 2=married, 3=other). Marital status was recoded into two categories (0 = married, 1 = not married) to compare how such a relationship played a role on smoking status. The variable "SEX" which divided the participants (1=male, 2=female), was used to assess the gender influences on smoking status. The variable to measure the age at which one started smoking was "AGSTART" the participants listed the age in years in which they started smoking. This was used to assess whether the age of onset influences a person's smoking behaviours when they get older.

Statistical Analysis

Descriptive information was calculated for demographic characteristics, as well as for primary and secondary relations of all participates. These characteristics were compared between employed and unemployed status. The Shapiro-Wilk test was performed to analyze the normality distribution of continuous variables, 'age at which started smoking' and 'number of cigarettes smoked daily' (Table 2). 'Number of cigarettes smoked daily' was converted into a dichotomous categorical variable to identify smoking status, in which participants who reported smoking zero cigarettes were categorized into "non-smoker" and responses of one or more cigarettes smoked were categorized into "smoker". Using this new smoker status variable, we performed a bivariate analysis using a chi-square, non-parametric test of association to test for associations between marital status (married or not married), education status (university degree or no degree), and sex (male or female) with smoking status (smoker or non-smoker). Using nnonparametric testing allowed us to analyze skewed, nominal, ordinal, and nonnormal data that did not meet parametric statistical assumptions. A significance level of P <0.05 was determined using Yate's Correction for Continuity. Microsoft Excel was used to construct the bar charts that reported the data collected from the chi-square tests (Figure 1). Our dataset was analyzed using the SPSS software (IBM Corp, 2017).

Results

Table I displays the baseline participant characteristics by employment status of employed or not employed, along with the supporting explanatory variables. The statistical significance of between group difference is present in Table I. We analyzed 4301 participants, of whom 2539 were male (59%) and 1762 were female (41%). In this cohort, a majority of the participants were employed (n=4039), while unemployed participants represented the minority (n=262). Of those 4039 employed, 3304 reported to not being married (81.8%), and 1400 had education greater than high school level (34.6%). The employed group had a mean (SD) number of cigarettes smoked per day of 19 (11), and age at which started smoking of 17 (4.1). Of those unemployed, 196 reported to not being married (74.8), and 51 had education greater than high school level (19.5%). The unemployed group had a mean (SD) number of cigarettes smoked per day of 21 (12.3), and age at which started smoking of 16 (3.27). There is a statistically significant difference between groups in age, marital status, and education as it relates to employment status, "employed" and "unemployed". In our sample, sex, number of cigarettes smoked daily, and age at which started smoking did not have any significant effect on employment status, variables "employed, and "unemployed". Our primary analysis showed no significant difference between number of cigarettes smoked daily, whether the participant was employed or not.

Table 1. Characteristics of the baseline sample by labour status [n=4301]

Variables	All (n=4301)	Employed (n=4039)	Unemployed (n=262)	P-Value (<0.05)
Age group, N (%), y				
20-24	671 (15.6)	597 (14.8)	74 (28.2)	<0.01
25-34	1274 (29.6)	1182 (29.3)	92 (35.1)	
35-44	990 (23)	947 (23.4)	43 (16.4)	
45-54	864 (20.1)	831 (20.6)	33 (12.6)	
55-64	502 (11.7)	482 (11.9)	20 (7.6)	
Sex, N (%)				
Male	*2539 (59)*	2391 (59.2)	147 (56.1)	0.357
Female	*1762 (41)*	1648 (40.8)	115 (43.9)	
Number of cigarettes smoked, mean (SD)				
-	*19.41(11.2)*	19.32(11)	20.54(12.3)	0.520
Marital Status, N (%)				
Single	*3180 (73.9)*	3009 (74.5)	171 (65.3)	0.004
Married	*801 (18.1)*	735 (18.2)	66 (25.2)	
Other	*320 (7.4)*	295 (7.3)	25 (9.5)	
Education, N (%)				
None or Elementary	*694 (16.1)*	636 (15.7)	58 (22.1)	<0.001
High School	*2156 (50.1)*	2003 (49.6)	153 (58.4)	
Some Post-Secondary	*379 (8.8)*	361 (8.9)	18 (6.9)	
Post-Secondary Cert. or Dip.	*542 (12.6)*	522 (12.9)	20 (7.6)	
University Degree	*4301 (12.3)*	517 (12.8)	13 (5)	
Age at which started smoking, mean (SD), y				
-	*17.31 (4.1)*	17.36(4.1)	16.40(3.27)	0.086

Values are presented as number (%) unless otherwise noted. SD = standard deviation. Statistical significance is calculated at the p<0.05 level.

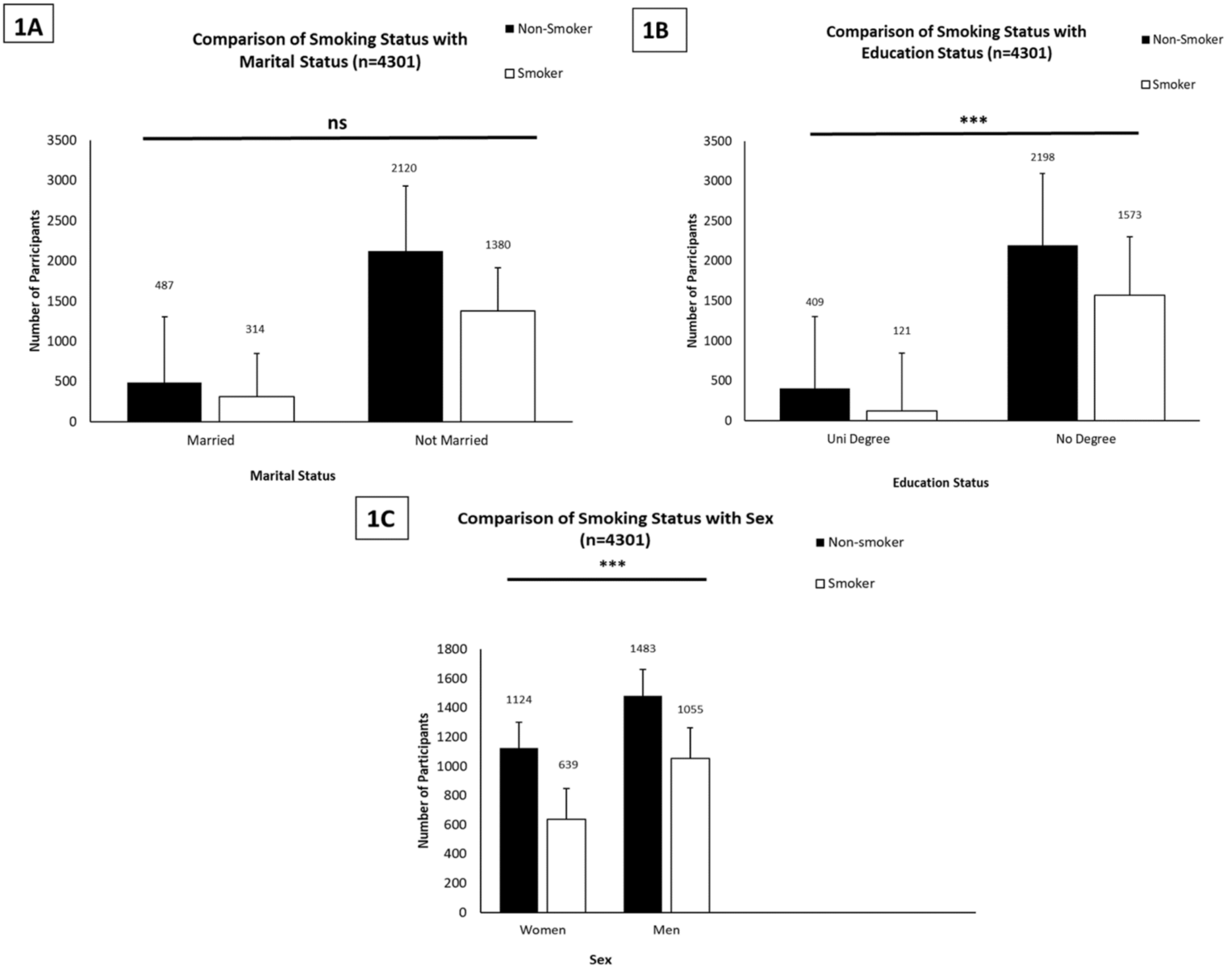
The results of the normality table below shows that our continuous variables, number of cigarettes smoked daily and age at which started smoking, are significantly different from the normal ($p<0.001$). The median was used to report the measurement of central tendency.

Table 2. Test of Normality

Variable	**Shapiro-Wilk significance value**	**Normal or not?**	**Measure of central tendency to be reported**
Number of cigarettes smoked	<0.001	Not normal	Median
Age at which started smoking	<0.001	Not normal	Median

Shapiro-Wilks test of normality with statistical significance defined at $p < 0.05$.

The graphs below are made from the results of a bivariate analysis using a chi-square to test for difference between 2 dichotomous categorical variables among a total of 4301 participants, with smoking status being compared in every graph. The graph compares expected and observed results for sex, education status, and marital status between the smoker group and the non-smoker group. We used Yate's Correction for Continuity to test for independence in a 2x2 contingency table and define the P-value. Three asterisks (***) on each graph represent the P-value to be <0.001, indicating statistically significant association between match-pairs. Figure 1B and Figure 1C show that differences between smokers and non-smokers are significant when being plotted against education status and when plotted against sex. This significance infers that sex and education status may influence the number of cigarettes smoked per day between adults ages 20 to 64. Those who did not have an education higher than high school or were of the male sex had a larger frequency of smoker status. In Figure 1A, we indicate that differences between smokers and non-smokers when plotted against marital status is not significant, as the continuity correction P-value is 0.937.



Discussion

From the primary findings of our study, we were not able to conclude that employment status has a direct influence on the number of cigarettes an individual smokes daily. Our secondary findings suggested that participants who did not have an education higher than high school or were of the male sex were more likely to be smokers that those who had an education higher than high school or of the female sex.

Overall, a negative result was produced, failing to reject the null hypothesis. As there was no significant evidence to prove the research hypothesis, it can be deemed that an individual's employment status, whether they are employed or not, does not influence their daily consumption of cigarettes. There was also no significance between other covariates including sex and age at which an individual started smoking in relation to employment status. A plausible explanation for this finding may be that cigarette smoking is a result of culture influence and stress. Those two factors which we did not directly assess in our study, could be more related to cigarette smoking as psychological determinant. Since everyone's mental strength and response to peer influence and stress might vary a large amount in a population, employment status comes across as a weak determinant of drug consumption.

There are two studies to which we would like to compare our findings with. The first study was conducted by Lee and colleagues (1991) on Cigarette smoking and employment status of 10,000 participants aged 40-59 in Scotland (Lee et al., 1991). The researchers found that the unemployed group had a higher number of smokers and that unemployed smokers had started smoking at an earlier age, with significantly more smoking while in school (Lee et al., 1991). Among current smokers, they found that unemployed men smoked fewer cigarettes daily than employed men (Lee et al., 1991). They also contrarily found that unemployed women smoked more cigarettes daily than employed women (Lee et al., 1991). Although we tested for such relationships between sex and age at which an individual starts smoking, the low statistical significance did not allow us to make the same inference. Considering the differences with our study, a limitation that must be addressed is the unavailability of information on the length of time between job loss, changes in smoking behaviour, and re-employment.

Another study conducted by Prochaska and colleagues (2013) looked at tobacco use among 68,501 job-seeking unemployed individuals aged 20-65 (Prochaska et al., 2013). They found that job seeking unemployed individuals had the highest smoking prevalence rate and this prevalence rate was higher in men and people with lower levels of education (Prochaska et al., 2013). A limitation to this study mentioned in the paper was that data was derived from self-reports, which means social desirability could have undermined the accuracy of smoking status (Prochaska et al., 2013). Another limitation to the study was that data was collected from a state in recession and with strong tobacco control law enforcement, which could have largely limited the population's consumption of tobacco specifically (Prochaska et al., 2013).

In addition to the absence of significant results in our study, it's also important to note how the design and analysis of data are different between our study and the studies conducted by Lee and colleagues (1991) and Prochaska and colleagues (2013). In our present study, we did not directly compare age, sex, education, age at which started smoking, and marital status to number of cigarettes smoked daily. Instead, we compared these variables to employment status. This way, we were not able to conduct the same analysis as the papers mentioned above. We did however compare sex, marital status, and education to a smoker status variable in our secondary analysis and found similar results to those papers suggesting that participants who did not have an education higher than high school or were of the male sex were more likely to be smokers.

Although we could not offer any distinct findings to this research field based on our negative results alone, we could reflect on what is missing from our analysis and its limitations and use that to better design future studies with different approaches. Based on the explanation given for our negative results, perhaps future prospective studies could assess this phenomenon with a psychological viewpoint and collect results from participants' self-reports of their mental health and how they view their life being impacted. As mental health is a growing topic of awareness, its association to cigarette smoking could shed more light on health status of Canadians.

With what was considered and accounted for during the interpretation of the results gathered in this study, the overall conclusion could have potentially been limited by the experimental design. Due to the restricted nature of our selected database, there were no requirements of distribution that needed to be met by the variables in our dataset to comply with any statistical assumptions. Assumptions like normality were violated, resulting in limited options for the use of other data analysis models to test for association and account for more covariates. Some other components of our study that must be considered are the sample size, the population distribution of Ontario, and the relatively large age scale utilized in our research. Considering our study only looked at one province, the sample size is too small to make concrete conclusions about the study. The overall sample size of this study consisted of 4301 participants out of which 4039 of the participants classified as being employed. The ratio between employed and unemployed participants is more one-sided towards the employed individuals; thus, a balanced relationship between the two groups could not be explored.

We must also consider the demographics of the province when trying to draw concrete conclusions. Ontario is a province where most of the population resides in the southern part. With the population density being more clustered towards the south, many of our study participants are more subject to similar living conditions, employment opportunities, and thus smoking habits. By taking an approach to studying only Ontario, we are limiting ourselves and allowing for less variation of our results when drawing conclusions. If perhaps we used data from more provinces, the increased sample size could have allowed the ratio between employed and unemployed to have been more balanced, allowing for a more thorough analysis of the results. With the addition of data from more provinces, people would also be subject to different living conditions allowing for greater variation.

Another limitation that must be pointed out is the large age scale. We studied the smoking habits of the ages of 20-64. This large scale could have affected the results as younger adults may have been more likely to smoke than those in their 60s. Perhaps splitting up the age groups into two categories would allow for deeper analysis. Instead of using an age group of 20-64, we could have done something like 20-45 and 46-64. By having these two groups, we would be able to investigate deeper between-group differences for the two age ranges.

Last, we could study different cultures and ethnic groups to account for religious and cultural beliefs. This database showed general data for Ontario adults and their smoking habits; however, accounting for religion and culture would allow us to factor out unemployed individuals who are not smoking due to religious reasons. The survey's set criteria were not available to us for use when coming to these conclusions. We were able to distinguish between smokers and non-smokers; however, all surveys are subject to biases that we cannot account for. All the results were naturally considered accurate, and we had to believe participant answers were as honest as possible.

Although limitations are subject to our results, our overall findings are still able to make a difference when future studies are being conducted. Our findings provide the fundamental relationship of smoking and employment status for the province of Ontario. With our results, future studies should be able to better understand the trend being proposed by our findings and should be able to come up with more thorough results. Our database is from 1981. With new settlements of populations in the 21st century, more accurate and reliable results in Ontario itself should be able to be produced. A more balanced ratio of employed and unemployed could now be proposed with the sudden increase in population and future research should consider investigating our findings further. With more recent findings, significant results could propose alternatives for the betterment of public health. Studying smoking habits provincially could help provincial health officials to investigate which communities need help and provide resources to those trying to quit smoking. Information from newer studies could also help social workers raise awareness about the potential trends discovered and help make a more meaningful impact when serving the community.

Ultimately, the study design may have slightly hindered the potential of our findings. However, our findings themselves do present as a foundation to the relationship between smoking status and employment status. Our results may not have shown a significant relationship, but with future studies, a more concrete relationship could be discovered, and the public health of Ontario residents could be set into a healthier direction.

References

American Lung Association. (2020, April 3). *Tobacco Use Among Children and Teens.* https://www.lung.org/quit-smoking/smoking-facts/tobacco-use-among-children

Costa Storti, C., Bretteville-Jensen, A., De Grauwe, P., Moeller, K., Mounteney, J., & Stevens, A. (2021). The Double Effect of COVID-19 Confinement Measures and Economic Recession on High-Risk Drug Users and Drug Services. *European Addiction Research*, *27*(4), 239-241. doi: 10.1159/000513883

IBM Corp. (2017). *IBM SPSS Statistics for Windows*. Armonk, NY: IBM Corp. https://hadoop.apache.org

Lee, A.J., Iain, K., Smith, C.W., & Tunstall-Pedoe, H. (1991). Cigarette Smoking and Employment Status. *Social Science and Medicine*, *33*(11), 1309-1312. doi: 10.1016/0277-9536(91)90080-V

Lemieux, T., Milligan, K., Schirle, T., & Skuterud, M. (2020). Initial Impacts of the COVID-19 Pandemic on the Canadian Labour Market. *Canadian Public Policy*, *46*(s1), S55-S65. doi: 10.3138/cpp.2020-049

Lindsrtom, M. (2010). Social capital, economic conditions, marital status and daily smoking: A population-based study. *Public Health, 124*(2), 71-77. doi: https://doi.org/10.1016/j.puhe.2010.01.003

Nagelhout, G., Hummel, K., de Goeij, M., de Vries, H., Kaner, E., & Lemmens, P. (2017). How economic recessions and unemployment affect illegal drug use: A systematic realist literature review. *International Journal Of Drug Policy*, *44*, 69-83. doi: 10.1016/j.drugpo.2017.03.013

Prochaska, J., Shi, Y., & Rogers, A. (2013). Tobacco use among the job-seeking unemployed in California. *Preventive Medicine*, *56*(5), 329-332. doi: 10.1016/j.ypmed.2013.01.021

van Zyl-Smit, R., Richards, G., & Leone, F. (2020). Tobacco smoking and COVID-19 infection. *The Lancet Respiratory Medicine*, *8*(7), 664-665. doi: 10.1016/s2213-2600(20)30239-3

Yang, H., Ma, J. (2021). How the COVID-19 pandemic impacts tobacco addiction: Changes in smoking behaviours and association with well-being. *Addictive Behaviours, 119,* 1-5. doi: https://doi.org/10.1016/j.addbeh.2021.106917

The effect of light to moderate alcohol drinking on serum low-density lipoprotein levels in males, aging 45 to 65: An observational and cross-sectional study

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LIFESCI 3LL3: Living Systems Laboratory Practicum

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Introduction

Throughout history, various culturally distinct groups have used alcohol for a multitude of reasons. It has been incorporated into cooking, social influence, medicine, and other areas. Alcohol is typically regarded as a sedative-hypnotic substance, indicating that at greater dosages it depresses the central nervous system while at lower amounts it stimulates feelings of pleasure and heightened self-expression (Grønbaek, 2009). In the absence of oxygen, alcohol is produced via the breakdown of carbohydrates in various foods (Grønbaek, 2009). Examples include wine which is derived from grapes, cider from apples, and vodka from potatoes or beets (Grønbaek, 2009).

Cholesterol is a wax-like lipid that regulates the characteristics of all of the body's cell membranes (Beckerman, 2020). It aids in the synthesis of hormones, vitamin D, and chemicals that help with food digestion (Beckerman, 2020). While all needed cholesterol is produced by the body, it may also be derived from the intake of foods such as egg yolks, meat, cheese, and other animal sources (Beckerman, 2020). Although cholesterol is needed by the body it exists in both good and bad forms (Fernandez & Webb, 2008). Good cholesterol, also known as high-density lipoprotein, functions to transport cholesterol from the bloodstream to the liver, where the liver works to remove it from the body (Fernandez & Webb, 2008). Bad cholesterol, also called low-density lipoprotein (LDL), circulates in the bloodstream and has the ability to clump together on artery walls, creating a plaque lining that may obstruct blood flow (Fernandez & Webb, 2008). This study focuses on the correlation between blood cholesterol levels and alcohol intake. Excessive alcohol intake is known to enhance LDL production since both the digestion of alcohol and the synthesis of cholesterol takes place in the liver (De Oliveira e Silva, 2000). Alcohol has also been shown to raise triglyceride levels in the body by increasing food and drink consumption, which presents the body with extra calories that, if not used for energy, are converted to triglycerides (Baek et al., 2021).

There have not been a lot of recent studies which investigate the effects of alcohol consumption on cholesterol levels. The most recent study that addressed such effects was published in 2010 by Perissinotto et al. In this study, they investigated the effects of moderate alcohol consumption on cardiovascular risk factors in 65 to 84 year old Italian men, where 98% percent of the participants were lifelong wine drinkers (Perissinotto et al., 2010). Risk levels for cardiovascular factors were estimated by comparing drinkers with people who abstain completely from alcoholic beverages (Perissinotto et al., 2010). The researchers found that moderate alcohol consumption in seniors was associated with healthier hematological markers such as HDL levels (Perissinotto et al., 2010). However, it was also found to be associated with more adverse hematological markers like systolic pressures and LDL cholesterol (Perissinotto et al., 2010).

There are studies that investigate cholesterol concentrations, however they do not place emphasis on the specific relationship between alcohol and cholesterol. For instance, Chyou et al. (2000) studied the impact of serum cholesterol concentrations on the total mortality risk in people aged 65 and older. In this study researchers used patient history files to evaluate the combination of age, sex, and cholestrol on all-cause mortality (Chyou et al., 2000). Although alcohol consumption was included in the patients' history it was not the focus of the study as the research examined other factors such as BMI, smoking status, BP, diabetes, cancer, and stroke (Chyou et al., 2000). In a study on Finnish men (Paunio et al., 1994), there was considerable evidence, indicating that low serum levels of HDL cholesterol is a risk factor for coronary artery disease. Although this study is relevant to our hypothesis, it provides limited information regarding alcohol intake in middle aged individuals (Paunio et al., 1994). Reducing LDL concentrations in the body is beneficial and many studies seem to focus on the negatives of moderate alcohol consumption on the liver and the circulatory system (Paunio et al., 1994). There is a large knowledge gap on the benefits of alcohol to the cardiovascular system. Since drinking alcohol is a part of Canadian culture, it is important to research and understand both its positive and negative impacts on people's health . The objective of this study is to examine whether light to moderate alcohol consumption in males aged 45-65 years reduces the concentration of LDL cholesterol in their blood when compared to males of the same age group who do not drink or rarely drink alcohol. Reducing LDL cholesterol is beneficial to cardiovascular health, so it is also important to study the positive health impacts of alcohol consumption.

Methods

In our observational and cross-sectional study, we used previously collected data from the "Canadian Heart Health database" which contains an integration of data from heart health surveys, conducted in 10 Canadian provinces, between 1986 and 1992. The primary investigator for the data collection, which was the Canadian heart health database center from Memorial University, used a stratified multistage probability sample design to yield independent samples in each province. There were two stages in data collection from the selected cases: First, They were interviewed at their homes for collection of basic demographic data. Then, those who responded to the first stage, attended a medical clinic for anthropometric measurements including plasma LDL levels. All the measurements were collected by trained nurses. The database consisted of data from 23129 individuals, aging 18 to 74. In this study, we investigated serum low density lipoprotein concentration (LDL) in males aging 45 to 65.

We removed all the 11753 female cases from the database as well as 9158 male cases who aged either below 45 or above 65. In our study, the missing data was tackled by removing the cases that had missing LDL concentration measurement, and/or daily and monthly alcohol consumption habits. Therefore, we removed 1356 cases with missing data. We also removed 11 cases who had non-fasting cholesterol measurement. Diet impacts cholesterol levels, which is why a non-fasting condition could make changes to the measured LDL concentration (shekelle). We divided 580 cases into an experimental and control group based on the alcohol drinking status of the participants. The database had two variables for monthly and daily alcohol consumption which were specified for the reported number of drinks respondents had on a monthly and daily basis, respectively. For monthly alcohol consumption, there were “not applicable” and “< once a month” categories for respondents who never or rarely drank. Based on both of the variables, we created a categorical variable called “alcohol drinking status” which was used as our independent variable and had two categories of “non-drinkers” and “Light to moderate drinkers”. The non-drinker category was assigned as the control group which consisted of 299 respondents who reported either “non-applicable” or “< once a month” as their monthly alcohol consumption frequency. The

Light to moderate drinkers formed our experimental group which consisted of 281 individuals with variable monthly alcohol consumption, but having either 1 or 2 drinks per day which was the inclusion criteria for this group. The remaining 271 cases were removed due to failure in meeting the definitions and inclusion criteria, which were adapted from Siscovick et al. (1986), and Abel et al. (1998). The inclusion criteria ensured the exclusion of heavy drinkers, and inclusion of the individuals in the experimental group with a regular but moderate alcohol drinking habits.

The primary outcome in this study was the measured concentration of low density lipoprotein (LDL) in mmol/L. During the data collection, the serum LDL concentration was measured in the clinic and reported in mmol/L for each participant.

We used SPSS version 28 to conduct all the statistical analysis in this study. A Shapiro-wilk test was conducted for determining the normality of LDL serum concentration for each group with a significance value of $p > 0.05$. According to table 2, LDL concentration follows a normal distribution in both experimental and control groups. Therefore, we conducted a student t-test for determining the difference in the primary outcome with a significance value of $p < 0.05$. Levene's test was conducted for determining the equality of variances with a significance of $P > 0.05$. It is important to note the maintenance of the human lipid profile is a complicated process which can be impacted by several factors including Body mass index - For short BMI - (Wonisch et al., 2012), exercise (Muscella et al., 2020) and smoking status (Hallit et al., 2017). Therefore, a second statistical analysis method was considered for controlling for potential confounding factors. Specific variables from the database for each potential factor were chosen and intended to be used for a logistic regression analysis (p <

0.05), followed by a spearman rho correlation analysis with the correlation being significant at 0.01. The shapiro-wilk test was used for determining the normality of continuous potential factors ($p > 0.05$). For the correlation analysis, we specified that a value of $r => 0.8$ is a strong correlation between the factors and considered a cut-off value for each factor. We also specified a value of $r <= 0.3$ is a weak correlation between each factor and the primary outcome, and a cut-off value for the corresponding factor. From the database, we chose a categorical variable that represented the smoking status of the respondents. They were asked to state their smoking status by choosing between “Non-smoker” and “Regular smoker” categories. For BMI, we chose a variable which was specified for BMI value in kg/m^2, and was calculated from the measured height and weight of the respondents. Finally, for exercise, we chose a categorical variable which was specified to whether participants exercised regularly or not, with two categories of “Yes” and “No”. For this variable, The respondents were asked whether “they engaged in physical activity more than once a week over the past month”. A summary of respondent characteristics for each variable can be found in table I.

Results:

Table 1: Respondent characteristics in the experimental and control groups

Variable	**Non- D**rinkers (control group) N = 299	Light to moderate Drinkers (Experimental group) **N = 281**	P-value
Age -- median (IQR)* Unit: Years	57(12)	56 (12)	0.460
BMI -- median (IQR) Unit: kg/m^2	27.6 (5.8)	26.6 (4.4)	0.022
LDL serum concentration -- mean (SD)** Unit: mmol/L	3.501 (0.8375)	3.513 (0.0459)	**0.913**
Smoking Status -- n (%)*** Non-smoker Regular smoker	210 (70.2) 89 (29.8)	216 (76.9) 65 (23.1)	0.087
Exercise -- n (%) Yes No	140 (46.8) 159 (53.2)	54 (54.8) 127 (45.2)	0.066

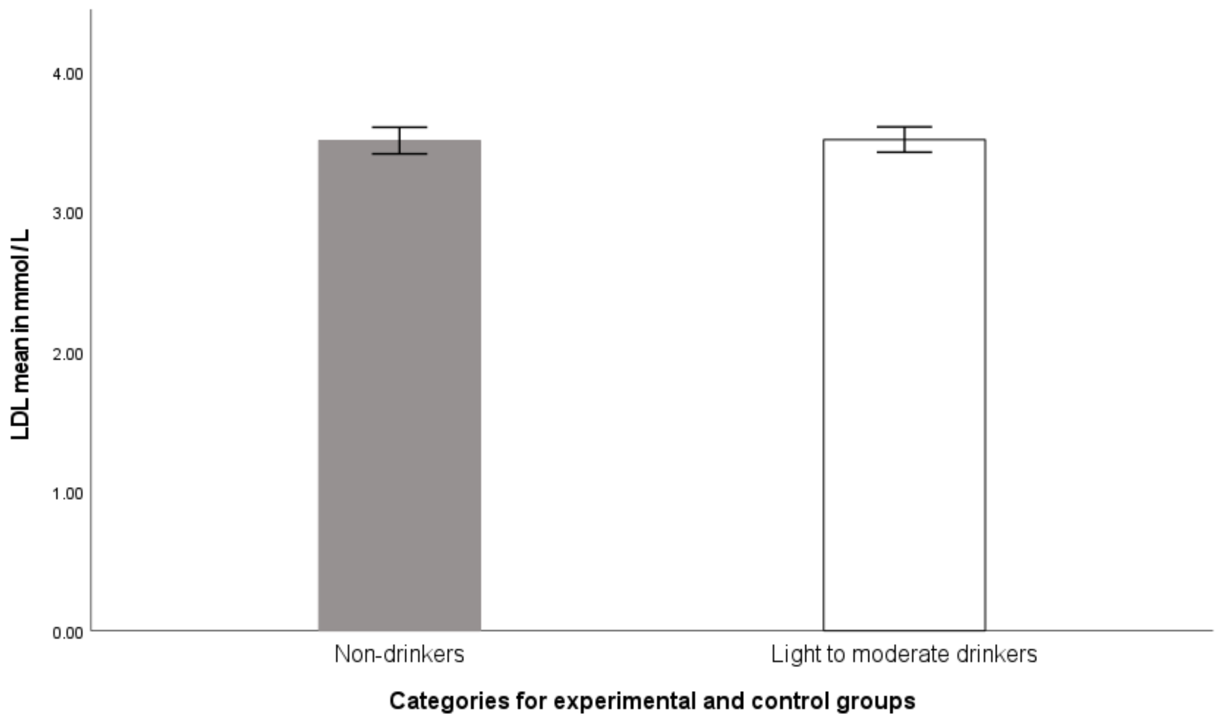
The method of expression and the units are stated next to the variable name. Mean (SD) was only used for normally distributed data in both samples. IQR means interquartile range, “SD” standard deviation, and “n” frequency of data.

All the 580 subjects in this study were males aging 45-65. 281 light to moderate drinkers were included in the experimental group and 299 non-drinkers made up the control group. As shown in table 1, The median age for the control and experimental groups were 57 (12) and 56 (12), respectively and there was no significant difference for this variable (p = 0.46). The exercise and smoking status of both groups weren't significantly different, as well (p = 0.087 and 0.066, respectively). BMI was the only variable which was significantly different between both groups and significantly higher in non-drinkers (p = 0.022). According to table 2, LDL serum concentration was the only continuous variable that followed a normal distribution in both groups. The mean of LDL serum concentration, which was 3.506 ± 0.8375 for non-drinkers, and 3.513 ± 0.0459 for light to moderate drinkers, was shown not to be significantly different between both study groups (p = 0.913). This P-value was reported given the assumption of equality of variances since a p value of 0.222 (significance value > 0.05) was obtained from the Levene's test. The 95% confidence interval of difference was [-0.1388, 0.1241], further showing no statically significant difference between the study groups. A summary of the difference in means between non-drinkers and light-to moderate drinkers is shown in figure 1. There were 3 outliers in the control group and 4 outliers in the experimental group. However, we did not remove the outliers from our study groups since doing so didn't cause major changes in the p value (p = 0.778 when outliers were removed, assuming equality of variances). In addition, we can understand from figure 1 that the spread of data is quite similar when we don't consider the outliers, which further indicates no statistically significant difference between the groups.The results for the spearman rho correlation analysis is summarized in table 3. All of the correlations between the LDL serum concentration and each potential confounding factor are too weak to meet the requirement of $r > 0.3$. The correlation between LDL and BMI is 0.71 while that between LDL and smoking status is 0.033. In addition, the correlation between LDL and exercise status is -0.01. The correlation between each pair of the potential factors are weak which meets the requirement for $r < 0.8$. Due to very weak correlations between LDL and each factor, we did not proceed with conducting a regression analysis.

Table 2: The results of the shapiro-wilk test for LDL and BMI.

	Non-drinkers	**Light to moderate drinkers**
LDL Serum concentration (mmol/L)	0.081	0.066
BMI (kg/m^2)	0.007	< 0.001

The alpha level is $p > 0.05$



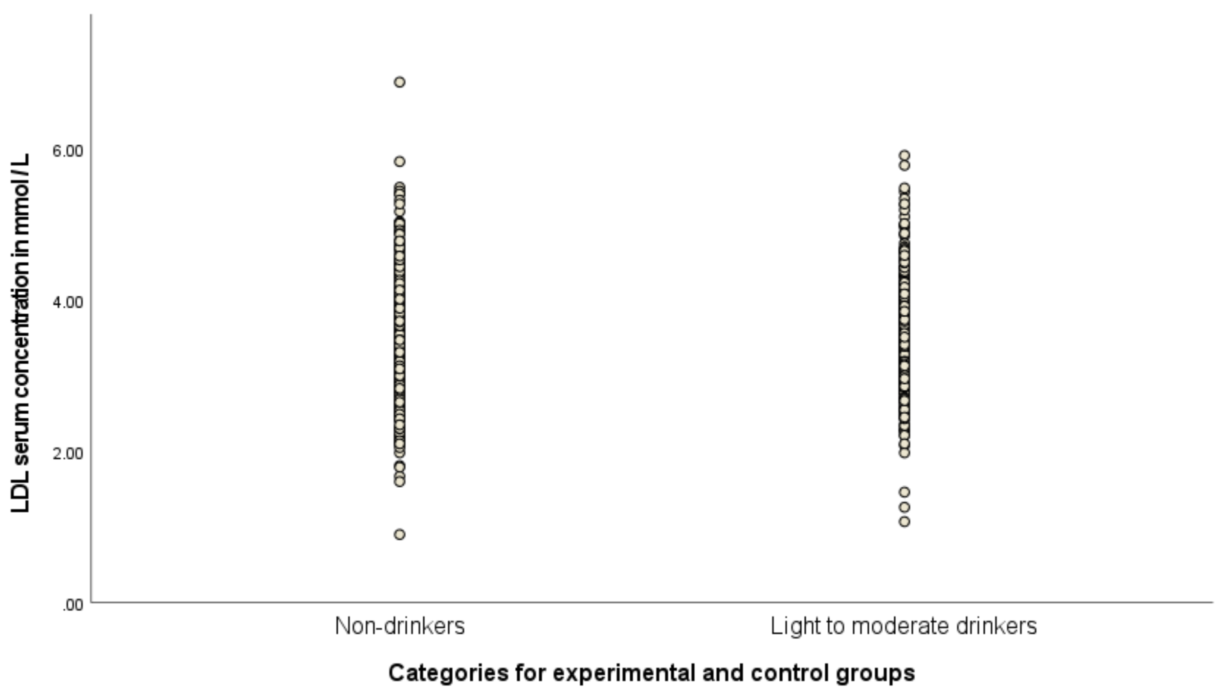


Figure 1: Independent samples t-test bar chart (top) and scatter plot (below). Both plots indicate the difference in LDL serum concentration between the experimental and control groups. The error bars in the bar chart represent 95% confidence intervals. The scatter-plot shows the distribution of individual data in each group. The mean for non-drinkers is 3.506 ±

0.8375, and 3.513 ± 0.0459 for light-to moderate drinkers. The two-sided p value is 0.913 (alpha level is 0.05). Outliers weren't removed for both groups.

Table 3: The results of the spearman rho correlation analysis between LDL serum concentration and each potential confound variable which are BMI, smoking status and exercise status.

			LDL SERUM CONCENTRATION (MMOL/L)	BMI (KG/M^2)	EXERCISE STATUS	SMOKING STATUS
Spearman's rho	LDL SERUM CONCENTRATION (MMOL/L)	Correlation Coefficient	1.000	.071	-.010	.033
		Sig. (2-tailed)	.	.087	.802	.430
		N	580	580	580	580
	BMI (KG/M^2)	Correlation Coefficient	.071	1.000	-.079	-.147**
		Sig. (2-tailed)	.087	.	.057	<.001
		N	580	580	580	580
	EXERCISE STATUS	Correlation Coefficient	-.010	-.079	1.000	-.040
		Sig. (2-tailed)	.802	.057	.	.342
		N	580	580	580	580
	SMOKING STATUS	Correlation Coefficient	.033	-.147**	-.040	1.000
		Sig. (2-tailed)	.430	<.001	.342	.
		N	580	580	580	580

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

We were unable to conclude that light to moderate alcohol consumption in males aged 45-65 years lowers the concentration of LDL cholesterol in their blood when compared to males of the same age group who do not or rarely drink alcohol. Our inconclusiveness was due to no significant difference in LDL cholesterol levels between those who light to moderately drink and those who do not. In contrast to our findings, Sohel et al. (1994) evaluated the relationship between alcohol consumption and serum lipids in Japanese men. After correcting for age, BMI, and the number of cigarettes smoked per day, they discovered that higher alcohol intake increased HDL levels while lower alcohol consumption decreased LDL levels in a multiple regression study of 832

Japanese males aged 35 to 59 years old (Sohel et al. 1994). They found that although daily alcohol consumption was shown to have a substantial positive association with HDL-cholesterol ratio and a significant negative correlation with LDL-cholesterol, the type of alcoholic beverage did not affect the blood HDL-cholesterol or LDL-cholesterol levels. Although there are limited publications on the direct impact of BMI on LDL and HDL cholesterol levels, Mohammad et al. (2010) investigated the impact of BMI on a variety of cardiovascular risk variables, including blood cholesterol levels. The association between BMI and mean cholesterol levels was found to be minimal in this investigation (Mohammad et al. 2010). This coincides with the finding of our study as we identified a weak correlation between BMI and and LDL cholesterol levels in our study population. The impact of smoking on low-density lipoprotein cholesterol levels and high-density lipoprotein subfraction distribution was examined by Freeman et al. (1993). Smoking was shown to be strongly associated with an increase in HDL as well as the HDL/LDL ratio in blood, according to the findings of his study (Freeman et al. 1993).

Vasankari et al. (1998) discovered that following a 10-month training program, male and female participants had a significant 15 percent increase in HDL cholesterol levels and a significant 10 percent decrease in LDL cholesterol levels in the blood. The quality of the circulating LDL improved as a result of the constant activity offered by their workout routine, according to this study. As we found weak correlations between serum LDL cholesterol levels and the BMI, smoking, and exercise variables, we were unable to use a regression analysis to test our results.

There were some limitations associated with our study that may have resulted in the insignificant difference between the LDL cholesterol levels in light to moderate drinkers and non drinkers. The first limitation comes from the fact that we had to omit a variety of cases from the database due to missing data. Inaccuracies were discovered in several of the survey questions as well. Participants were, for example, questioned about their exercise habits, such as how often they exercise on a weekly basis. This is a wide subject since different forms and intensities of exercise can have varied effects on LDL cholesterol levels in different people. Lira et al. (2009) found that acute high-intensity exercise with low energy expenditure decreased LDL-c and total cholesterol levels in males in a research study. Another issue with this question is that individuals only have to work out once a week to be classified as someone who regularly exercises, when different frequencies of exercise in individuals may affect LDL cholesterol levels. Since all the data on smoking status was reported rather than monitored, the results may have been biased by the reporting individual's emotions, perceptions, or recollections at the time of responding to questions. Our study identified an overall high significance value for the LDL cholesterol level in all participants. This significance value could have been a result of the fact that we had to remove a lot of cases and they had missing information that could have caused inaccuracy in our findings. Another explanation for the high significance value found could be that diet was not included as a variable in the database, despite the fact that diet has been linked to the effect of HDL and LDL cholesterol levels. In Marcia et al.'s (1998) study of the effect of diet and exercise in men and postmenopausal women with low levels of HDL cholesterol and high levels of LDL cholesterol, it was identified that there was a significant reduction in LDL cholesterol levels in individuals who took on a low-fat diet as well as consistent exercise (Stefanick et al. 1998). When assessing the women and men in the diet only group of participants they found that there was not a significant change in LDL cholesterol level (Stefanick et al. 1998). The failure to include this variable in our study could have hindered the results of the study as we may have been able to better understand any variances identified in LDL cholesterol levels across individuals in the study.

References

Abel, E. L., Kruger, M. L., & Friedl, J. (1998). How do physicians define "light," "moderate," and "heavy" drinking?. *Alcoholism, clinical and experimental research*, *22*(5), 979–984. https://doi.org/10.1111/j.1530-0277.1998.tb03692.x

Baek, W., Lee, J.-W., Lee, H. S., Han, D., Choi, S.-Y., Chun, E. J., Han, H.-W., Park, S. H., Sung, J., Jung, H. O., Lee, H., & Chang, H.-J. (2021). Concurrent smoking and alcohol consumers had higher triglyceride glucose indices than either only smokers or alcohol consumers: A cross-sectional study in Korea. Lipids in Health and Disease, 20(1). https://doi.org/10.1186/s12944-021-01472-2

Beckerman, J. (2020). Understanding cholesterol levels: LDL, HDL, total cholesterol, and triglyceride levels. WebMD. Retrieved October 8, 2021, from https://www.webmd.com/cholesterol-management/guide/understanding-numbers.

Chyou, P.-H. (2000). Serum cholesterol concentrations and all-cause mortality in older people. Age and Ageing, 29(1), 69–74. https://doi.org/10.1093/ageing/29.1.69

De Oliveira e Silva, E. R., Foster, D., McGee Harper, M., Seidman, C. E., Smith, J. D., Breslow, J. L., & Brinton, E. A. (2000). Alcohol consumption raises HDL cholesterol levels by increasing the transport rate of Apolipoproteins A-I and A-II. Circulation, 102(19), 2347–2352. https://doi.org/10.1161/01.cir.102.19.2347

Fernandez, M. L., & Webb, D. (2008). The LDL to HDL Cholesterol Ratio as a Valuable Tool to Evaluate Coronary Heart Disease Risk. Journal of the American College of Nutrition, 27(1), 1–5. https://doi.org/10.1080/07315724.2008.10719668

FREEMAN, D. J., GRIFFIN, B. A., MURRAY, E., LINDSAY, G. M., GAFFNEY, D., PACKARD, C. J., & SHEPHERD, J. (1993). Smoking and plasma lipoproteins in man: Effects on low density lipoprotein cholesterol levels and high density lipoprotein subfraction distribution. European Journal of Clinical Investigation, 23(10), 630–640. https://doi.org/10.1111/j.1365-2362.1993.tb00724.x

Grønbaek, M. (2009). The positive and negative health effects of alcohol- and the Public Health Implications. Journal of Internal Medicine, 265(4), 407–420. https://doi.org/10.1111/j.1365-2796.2009.02082.x

Hallit, S., Zoghbi, M., Hallit, R., Youssef, L., Costantine, R., Kheir, N., & Salameh, P. (2017). Effect of exclusive cigarette smoking and in combination with waterpipe smoking on lipoproteins. *Journal of epidemiology and global health*, *7*(4), 269–275. https://doi.org/10.1016/j.jegh.2017.08.00

Lira, F. S., Zanchi, N. E., Lima-Silva, A. E., Pires, F. O., Bertuzzi, R. C., Santos, R. V., Caperuto, E. C., Kiss, M. A., & Seelaender, M. (2009, June 24). Acute high-intensity exercise with low energy expenditure reduced LDL-C and total cholesterol in men - European Journal of Applied Physiology. SpringerLink. Retrieved December 11, 2021, from https://link.springer.com/article/10.1007/s00421-009-1115-5.

Muscella, A., Stefàno, E., & Marsigliante, S. (2020). The effects of exercise training on lipid metabolism and coronary heart disease. *American journal of physiology. Heart and circulatory physiology*, *319*(1), H76–H88. https://doi.org/10.1152/ajpheart.00708.2019

Paunio, M., Heinonen, O. P., Virtamo, J., Klag, M. J., Manninen, V., Albanes, D., & Comstock, G. W. (1994). HDL cholesterol and mortality in Finnish men with special reference to alcohol intake. Circulation, 90(6), 2909–2918. https://doi.org/10.1161/01.cir.90.6.2909

Perissinotto, E., Buja, A., Maggi, S., Enzi, G., Manzato, E., Scafato, E., Mastrangelo, G., Frigo, A. C., Coin, A., Crepaldi, G., & Sergi, G. (2010). Alcohol consumption and cardiovascular risk factors in older lifelong wine drinkers: The Italian Longitudinal Study on Aging. Nutrition, Metabolism and Cardiovascular Diseases, 20(9), 647–655. https://doi.org/10.1016/j.numecd.2009.05.014

Shekelle, R. B., Shryock, A. M., Paul, O., Lepper, M., Stamler, J., Liu, S., & Raynor, W. J., Jr (1981). Diet, serum cholesterol, and death from coronary heart disease. The Western Electric study. *The New England journal of medicine*, *304*(2), 65–70. https://doi.org/10.1056/NEJM198101083040201

Siscovick, D. S., Weiss, N. S., & Fox, N. (1986). Moderate alcohol consumption and primary cardiac arrest. *American journal of epidemiology*, *123*(3), 499–503. https://doi.org/10.1093/oxfordjournals.aje.a114265

Stefanick, M. L., Mackey, S., Sheehan, M., Ellsworth, N., Haskell, W. L., & Wood, P. D. (1998). Effects of diet and exercise in men and postmenopausal women with low levels of HDL cholesterol and high levels of LDL cholesterol. New England Journal of Medicine, 339(1), 12–20. https://doi.org/10.1056/nejm199807023390103

VASANKARI, T., KUJALA, U., VASANKARI, M.; AHOTUPA, U. (1998). Reduced oxidized LDL levels after a 10-month exercise program. Medicine &

Science in Sports & Exercise, 30(10), 1496–1501. https://doi.org/10.1097/00005768-199810000-00005

Wonisch, W., Falk, A., Sundl, I., Winklhofer-Roob, B. M., & Lindschinger, M. (2012). Oxidative stress increases continuously with BMI and age with unfavourable profiles in males. *The aging male : the official journal of the International Society for the Study of the Aging Male*, *15*(3), 159–165. https://doi.org/10.3109/13685538.2012.669436

High Cannabis Use Frequency and Having No one to Talk to Predicts Poor Self-reported Mental health: A Cross-sectional Study

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Introduction

Studying trends and common observations among individuals who face similar circumstances allows prominent factors affecting mental health to become more evident. A study done by Debowska et al. (2020) found an increase in participant's depressive symptoms and identified loneliness as being one of the contributing factors to depression throughout the COVID-19 pandemic. A substantial amount of research has surmised how personal, social, and environmental conditions play a prominent role in one's mental health. Research has shown that social support is associated with mental health (Hefner et al., 2009). Specifically, as perceived quality of social support increased, the likelihood of mental health disorders such as depression, anxiety, and suicidality decreased (Hefner et al., 2009). Individuals who form meaningful and positive social relationships tend to experience better feelings of cognitive and mental health (Silva et al., 2019). When Durkheim introduced a study in 1987 that found greater suicide rates more closely associated with single individuals in comparison to those who were married or in a relationship, there has been great interest in the scientific community about the connection between external social environments, relationships, and personal health (Silva et al., 2019). A prime example of indicative external factors can be illustrated in individuals who have immigrated to a new country as they may face job insecurity or difficulties adjusting to a different culture, resulting in increased stress levels (Gonzales, 2013). Evidently, personal and social circumstances prompt an appreciable discussion in research on mental health.

In addition to social relationships and demographic characteristics, the connection between mental health and substance use is intriguing, since cannabis is trailing behind tobacco and alcohol as one of the most widely used drugs in the world (Caulkins, 2016). Following its legalization in Canada in 2018, the reported use of cannabis between 2018 and 2019 in people aged 15 and older has increased from 14.9% to 16.8% (Rotermann, 2020). The most prevalent of concerns, with an increase in cannabis use in Canadians, is the effect cannabis can have on mental health (Rotermann, 2020). Research by Degengardt et al. (2012) has found a positive association between frequent cannabis use in adults and negative mental health effects—mainly for psychosis, depression, and anxiety. Research done by Hudson & Hudson in 2020 wanted to explore if there was an association between increased cannabis use in elders (65+) and mental illness. Results found that frequent use of cannabis was associated with increased risk for mental illness, but this was dependent on the reasons for use, mainly when using it to cope and using it to help you sleep.

A large amount of research has been conducted throughout the course of the pandemic in relation to mental health, the effect of increased cannabis use on self-reported mental health remains largely unclear, particularly in the context of the pandemic. Although research seems to suggest a negative effect on mental health with an increased use and potency of cannabis, there is conflicting research on participants reporting more positive mental health after cannabis use (Health Canada, 2017). Additionally, most studies have looked at side effects associated with the potency of cannabis used and not the frequency. Similarly, apart from limited studies highlighting the importance of social identification and positive social relationships on good mental health, no studies to our knowledge have examined whether positive social relationships, or even something as simple as having a person you trust that you can talk to is a predictor of good mental health.

In this study, we primarily aim to understand how cannabis use frequency and a perceived presence of someone close to confide in, predicts self-reported mental health status in Canadians aged 15 or older during the pandemic. We hypothesize that increased cannabis use frequency and having no one to talk to will predict poor mental health in Canadians aged 15-75. Our secondary aim is to discover if there is a difference in the number of participants with high frequency cannabis use, low frequency cannabis use, or no use of cannabis and good vs. poor self-reported mental health. According to the PECO method, P (participants) are Canadians aged 15 or older, E (exposure) is cannabis use frequency and presence of someone to talk to, there is no C (comparator group), and our O (outcome) is self-reported mental health.

Methods

Study Design and Database

Our analyses were based on the sixth survey of the Canadian Perspectives Study Series (CPSS). This survey was designed to produce data on the use of substances, such as cannabis and opioids during the pandemic, on a national level. The study design used was observational cross-sectional. The survey was administered between January 25, 2021 and January 31st 2021 by Statistics Canada and individuals who had previously participated in the Impacts of COVID-19 crowdsource collection study were invited to participate in this study. They used a Sign-Up method in order to collect the participants for this study. Inclusion criteria were residents of all 10 Canadian provinces aged 15 or older. Those who were living on reserves and other Aboriginal settlements, or living in the territories were excluded. Institutionalized individuals and individuals living in households in areas with a very low population size were also excluded from the study. The initial Sign-Up had 31,896 randomly selected individuals aged 15 or older from LSF households. Of those people, 3,941 participated in the study.

Study Participants

Participants were included in our analysis if they were a Canadian citizen, between the ages of 15 and 75, and, if they were not missing information on our variables of interest. Individuals younger than 15, or older than 75 or people who had missing data for our variables of interest were excluded from our study. For both of our predictor variables, cannabis use frequency in the past 30 days and presence of someone to talk to, and for our dependent variable, self-reported mental health, anyone who answered “valid skip”, “don’t know”, “refusal”, or “not stated”, were excluded from our analysis. Thankfully, no participants selected these categories, and so our sample size was not affected by this exclusion. However, there were a total of 10 missing cases for our variables of interest, which will be discussed in more detail in the results.

Study Outcomes

This study was primarily conducted to conclude if high frequency cannabis users and having no one to talk to predicted poor self reported mental health in participants who are between the ages of 15 to 75. We also aimed to discover if there was a difference in the number of participants with high frequency cannabis use, low frequency cannabis use, or no use of cannabis and good vs. poor self-reported mental health. We chose these outcomes due to previous research by Hefner et al. (2009) indicating that as perceived quality of social support increased, likelihood of mental health disorders decreased. The pandemic has certainly contributed to increased social isolation (Hwang et al., 2020), and this in turn could cause people to increase their cannabis use frequency, and feelings of having no one to talk to, which is why it is more important now more than ever, to understand the risks of high cannabis use and having no people to talk to. For the ordinal variable, perceived mental health, participants were originally presented with the following options in response to the question “In general, how would you describe your mental health?” “Poor”, “Fair”, “Good”, “Very good”, “Excellent”, “Valid skip”, “Don’t know”, “Refusal”, “Not stated.” For the purpose of our analyses, these outcomes were transformed into a dichotomous variable, 1= Poor (this includes participants who selected poor or fair originally) and 2= Good (this includes participants who selected good, very good or excellent originally). In response to the question “In the past 30 days, how often did you use cannabis?", participants had the option to choose from "Never used cannabis", "No, not during the past 30 days", "1 day in the past 30 days", "2 or 3 days in the past 30 days", "1 or 2 days per week", "3 or 4 days per week", "5 or 6 days per week", "Daily", "Valid skip", "Don't know", "Refusal", "Not stated." These were transformed to become 0= Never used in past 30 days (includes participants who selected options 1 or 2), 1= Low frequency cannabis use in the past 30 days (includes participants who selected options 3 or 4), and 2=High frequency in the past 30 days (includes participants who selected options 5-8). For the presence of people to talk, participants could choose between "No people to talk to", "People to talk to", "Valid skip", "Don't know", "Refusal" "Not stated". These were transformed to become 0= "People to talk to" (includes option 1), and 1= "No people to talk to" (includes option 2).

Additional Data Collection

A chi-squared test will be conducted on five descriptive variables to report their p-value scores and determine whether there is a difference in the number of people reporting poor vs. good mental health for each descriptor variable. Descriptive variables being reported include marital status [PMARSTC], employment status [PEMPSTC], amount of stress in a participant's life since the pandemic [STRESS], child under 18 on January 25, 2021 resides in dwelling [PCHILD], immigration status [IMMIGRNC], sex [SEX], and age [AGEGRP]. The results of our chi-square test are depicted in Table 1. There was some missing data for these variables and as such, 16 cases were deleted from the variable measuring stress levels [STRESS] and 101 cases were deleted from the employment status variable [PEMPSTC]. This data will be collected to assess if there is a difference in the proportion of responses of these variables with poor vs. good self-reported mental health. This information is valuable to understand as, if any of these variables are more likely to report poor mental health, they can potentially be confounders to our results, whereby these variables might indirectly affect cannabis use frequency and presence of someone to talk and subsequently mental health.

Statistical analyses

We used SPSS software version 26 to conduct a binary logistic regression analysis in order to address whether cannabis use frequency in the past 30 days, and presence of people to talk to were predictors of perceived mental health. A Spearman Rho correlation coefficient of at least 0.10 was chosen as our proposed cut-off value in order to determine whether or not our predictor variables were significantly related to the dependent variable or to each other as suggested in previous research (Ranganathan et al., 2017). A p-value of 0.05 was used to indicate statistical significance for all analyses. After running our Spearman Rho analysis, we found that both of our predictor variables are related to our dependent variable, perceived mental health, with $p>0.05$ for both variables. Our predictor variables were not significantly related to each other ($0.229 > 0.05$). With a sample size of well over 20, (3,814 participants) and no outliers, we proceeded with the logistic regression. Next, a chi-square analysis was run to find the frequency of responses for each category with either poor vs. good perceived mental health and whether or not the difference in proportions are significant. Descriptive statistics of our study population are presented in Table 1. The data was obtained using chi-square tests between the variables having people to talk to or frequency of cannabis use in the past 30 days, and perceived mental health. Furthermore the p-value produced by the test was used to determine if there was a significant difference in the proportion of responses to either option. For each variable we see the sample size, number of responses for each category, and the frequency of either poor or good mental health.

Results

Participants

Our database had a total of 3,941 participants. The number of participants included in our analyses was a total of 3,931 participants. A total of 10 cases were missing across our dependent and independent variables. Missing data was minimal for our initial analysis. 7 cases were missing for perceived mental health, 2 cases were missing for frequency of cannabis use in the past 30 days and 1 case was missing for having people you feel close to and that you can talk to. Descriptive characteristics of the population can be found in Table 1. The sample contained more women than men, and most people included in the study were between the ages of 55-64. Most people reported little to no stress, had no child under 18 living with them, were employed, never used cannabis, had someone they could talk to, were born in Canada, and were married.

Table 1. *The statistics of independent and descriptive variables shown on the left, and their ability to predict the dependent variable, perceived mental health* [N=3941].

		Percieved Mental Health		
Variables	**N**	**Good**	**Poor**	**P-value**
Age of Respondent (years)	3833			<.001
15-24	124	57% (70)	43% (54)	
25-34	467	62% (290)	38% (177)	
35-44	616	71% (438)	29% (178)	
45-54	648	77% (500)	23% (148)	
55-64	906	81% (737)	19% (169)	
65-74	802	88% (704)	12% (98)	
75 and Older	270	92% (249)	8% (21)	
Amount of Stress in Life	3817			<.001
Large Amount of Stress	1622	59% (958)	41% (664)	
Little to no Stress	2195	92% (2016)	8% (179)	
Child Under 18 Resides in Dwelling	3833			<.001
Yes	889	73% (647)	27% (242)	
No	2944	80% (2341)	20% (603)	
Employment Status	3833			<.001
Employed	2147	77% (1643)	23% (504)	
Unemployed or Out of Work	1686	80% (1345)	20% (341)	
Frequency of Cannabis Use	3814			<.001
Never Used	2722	82% (2232)	18% (490)	
Low Frequency	721	74% (533)	26% (187)	
High Frequency	371	57% (211)	43% (160)	
Having Someone You Feel Close to and Can Talk	3832			<.001
People to Talk to	3665	79% (2905)	21% (760)	
No one to Talk to	167	49% (82)	51% (85)	
Immigration Status	3833			0.767
Born in Canada	3182	78% (2477)	22% (705)	
Born Outside of Canada	651	78% (511)	22% (140)	
Marital Status	3833			<.001
Married	2028	82% (1659)	18% (369)	
Not Married	1805	74% (1329)	26% (476)	
Sex of Respondent	3833			<.001
Male	1754	80% (1410)	20% (344)	
Female	2079	76% (1578)	24% (501)	

Values in brackets represent the frequency of responses for each of the predictor and descriptive variables to a distinct category of the dependent variable. Percentages represent each frequency reported as a percent.

Bivariate associations

The results of the first chi-squared test are presented in Figure 1. As we can see, people who used a high frequency of cannabis in the past 30 days were more likely to report poor mental health (160/371 or 43%) compared to people who used a low frequency (184/721 or 26% or no use of cannabis in the past 30 days (499/ 2722 or 18%). The difference in the proportion of responses to poor mental health was significantly different between categories of cannabis use ($p<0.01$). Results of the second chi-square analysis can be found in Figure 2. As we can see, participants who reported having no people close that they could talk to were more likely to report poor mental health (85/167 or 51%) compared to participants who reported having people they could talk to (758/3647 or 21%). The difference in the proportion of responses to poor mental health was significantly different between categories of having people to talk to with a continuity correction of $p<0.01$.

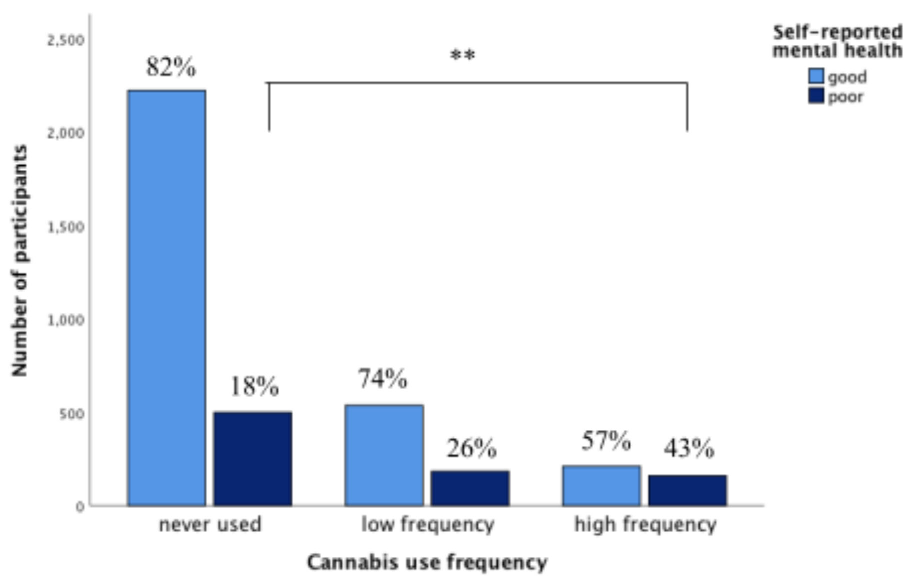

Figure 1: Frequency of cannabis use in the past 30 days among those who experienced good self-reported mental health vs. poor self-reported mental health (n= 3,931). A chi-squared analysis was run to find between group differences in proportion of responses to self-reported mental health and past 30 day cannabis use frequency. The percent of responses to “good” vs “poor” mental health for each category is indicated above the bars. The significance (p-value) is also reported. * represents statistical significance and a $p<0.05$, ** represents a $p<0.01$.

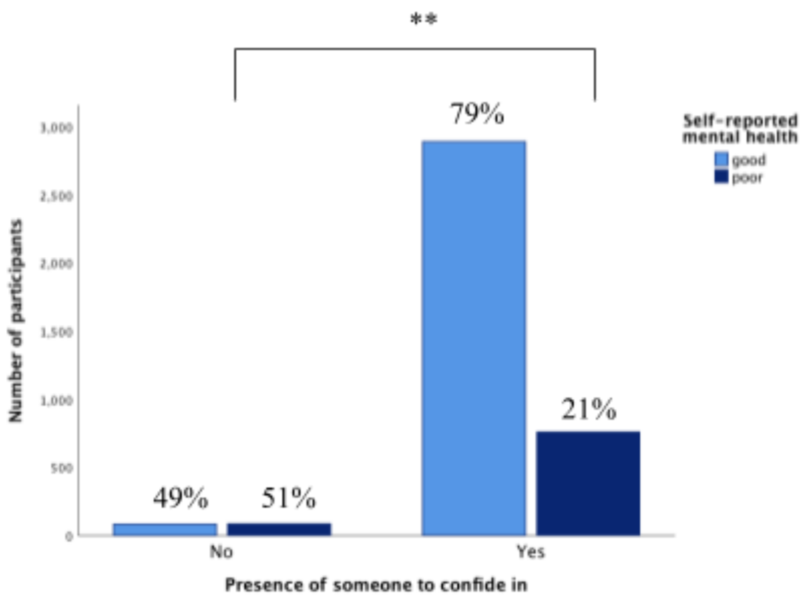

Figure 2: Number of participants who had someone to confide in among those who experienced good vs. poor self-reported mental health (n= 3,931). A chi-squared analysis was run to find between group differences in proportion of responses to self-reported mental health and presence of someone close to talk to/confide in. The percent of responses to "good" vs "poor" mental health for each category is indicated above the bars. The significance (p-value) is also reported. * represents statistical significance and a $p<0.05$, ** represents a $p<0.01$.

Multivariate analyses

The results of the regression analysis without any of our predictor variables included in the model indicated that SPSS correctly classified 77.8% of cases that it guessed or predicted would have good self-reported mental health. SPSS did not do a good job predicting cases that would have poor self-reported mental health as there are no predicted cases for the "poor" category. The results of our logistic regression with the predictors included indicated that 78% of all cases were correctly classified by our model, which is slightly better than 77.8% from before our predictors were included. Our percentage accuracy in classification (PAC) is 78% for our model. The Hosmer and Lemeshow Test indicated a chi-square of 0.127 and P=0.721, meaning our model is a good fit ($p > 0.05$). According to the Omnibus Tests of Model Coefficients, the full model containing both predictors were statistically significant (Chi-squared=181.035, p=0.00), suggesting that the model was able to predict cases who had poor self-reported mental health, versus those who had good self-reported mental health. The model correctly classified 78% of cases. As we can see in Table 2, both predictor variables made a unique, significant contribution to the predictive ability of our model (p<0.01). Table 2 depicts how the most important predictor of poor mental health was a high cannabis use frequency in the past 30 days. The odds of having a poor self-reported mental health was 3.4 (95% CI 0.189-0.357) times higher for those who had a high frequency of cannabis use than for respondents who had low cannabis use frequency or no use of cannabis at all. The odds of having poor self-reported mental health was 1.6 times higher for those who had a low frequency of cannabis use as compared to those who did not use it at all. Finally, the odds of having poor self-reported mental health was 0.3 times higher for those who did not have anyone close to talk to as compared to those who did.

Table 2: Binary logistic regression results examining the association between self-reported mental health with frequency of cannabis use and presence of someone to talk to (n= 3,931). B is the regression coefficient which indicates the direction of the relationship between predictor and outcome variable and the amount of change in the predictor variable that results in a change in the probability of developing the outcome of interest. S.E is the standard error and represents the average distance that the observed values fall from the regression line. Exp(B) is the odds ratio for developing the outcome of interest. Wald test indicates how much each predictor variable contributes to the model. The p-value indicates if the predictor variable is a significant contributor to the model.

Predictor variable	B	S.E	Wald	Exp(B)	P-value	95% CI for Exp(B)
Presence of someone to talk to that you trust (no/yes)	-1.348	0.163	68.623	0.260	.000	(0.189, 0.357)
Never used cannabis in past 30 days			115.938		.000	
Low frequency of cannabis use in the past 30 days	0.441	0.098	20.115	1.554	.000	(1.282, 1.884)
High cannabis use frequency in the past 30 days	1.212	0.115	110.737	3.360	.000	(2.681, 4.211)

Discussion

Main findings

It is distinguished that all descriptive variables besides immigration status, represent a significant difference in the proportion of negative mental health presence. We found that cannabis use frequency and presence of someone to talk to that you trust, were both predictors of decreased mental health, supporting our hypothesis. People who use cannabis at a high frequency are more likely to report poor mental health compared to people who never use it or use it at a low frequency. More participants reported poor self-reported mental health in the population of individuals that did not have people they felt they could talk to. These findings coincide with a study administered by Vidal et al. (2019), which found that adults with low perceived social support were more likely to experience depressive and anxiety symptoms, confirming other research regarding the connection between social relationships and mental illnesses. As Kawachi and Berkman (2001) surmised in their article, feeling included in a social circle is a positive indicator of good mental health by facilitating favorable sentiments such as a sense of belonging or by regulating levels of stress during stressful situations (Kawachi and Berkman, 2001). An individual's perception of available moral support during a stressful situation could create a more cordial approach to the dilemma or a positive social relationship could help to mitigate a negative reaction to the event (Kawachi and Berkman, 2001). However, researchers have also substantiated that individuals can experience greater stress caused by social relationships, due to unhappiness with their current social circle, or pre-existing poor mental health fuelled by believing or creating worse social relationships (Silva et al., 2019). Our main finding was that the most important predictor of poor mental health was a high frequency of cannabis use in the past 30 days. Individuals who reported a high frequency of cannabis use in the past 30 days had 3.4

times higher odds of having poor mental health compared to those in the low or never used cannabis use frequency category. This provides evidence that high cannabis use frequency contributes to poor mental health and can increase your risk of poor mental health, and subsequently of possible mental health disorders, more than threefold. It is important to consider that both low frequency cannabis use and presence of people to talk to were also found to increase the odds of having poor self-reported mental health by 1.6 times and 0.3 times respectively. These odds are visibly lower than the likelihood of high cannabis use frequency corresponding to poor mental health, which indicates that a lack of meaningful social relationships has less effect on self-reported mental health compared to cannabis use frequency. This finding is supported by research by Degengardt et al. (2012) who found that adults who used cannabis on a daily basis and those who had a cannabis dependence, had 2.3 times higher odds and 2.5 times greater odds of meeting the criteria for an anxiety disorder compared to non-users, respectively. Our results are also consistent with research done by Hines et al. (2020) who found that high-potency cannabis was more common in people with depression, generalized anxiety disorder, psychotic experiences, alcohol use disorder, and frequent cannabis use. Evidently, the results of our study are well justified by external research and other studies, while also shedding light on how frequency of cannabis use (not just potency) and a lack of a close confidante can affect mental health.

Limitations

There are inherent limitations of observational cross sectional studies, including the lack of causal inference, since all the data was assessed at one point in time. Another limitation is that the dependent variable needed to be dichotomous to run binary logistic regression, thus the responses were accounted for as poor or good mental health. In actuality, we may have interpreted people's mental health as poor, when they felt it was fair, or as good, when they felt it was excellent. Additionally, it may not be accurate to deem that high cannabis use frequency predicts poor mental health since our database only reported on past 30 day cannabis use. The long term effects of cannabis use beyond 30 days was not explored and the 30 day timeframe used in the study may not be representative of the participant's cannabis use habits, since it could have been an irregular month where cannabis was used more or less than normal. Additionally, since we ran a chi-square test for cannabis use frequency (which has more than 2 categories), even though we found a $p<0.01$, we can't tell what is significant from what. Another important limitation to our study is the difference in responses for each category of our variables. For example, only 167 people reported having no people to talk to as opposed to the 3647 people who reported that they did have someone to talk to. It makes sense to see a higher percentage of people reporting poor mental health when they have no one to talk to since the denominator is much lower. The same problem is seen for cannabis use frequency, since only 371 reported high frequency, as opposed to 2722 reporting never used. Finally, there are confounding variables that might be responsible for the results that we found. For example, the amount of stress in your life, and employment status are potential confounders in our study. Research shows that cannabis is used more chronically for people who use it as a stress-coping strategy (Hyman & Sinha, 2009), and that stress (especially over a prolonged period of time, increasing the risk of mental health problems like anxiety, depression and substance use problems (CMHA, 2021**)**. Similarly, research has found that the risk of mental disorders was higher among the unemployed than amongst the employed (Honkonen et al., 2007), and that cannabis use is directly associated with job loss, and thus unemployment (Airagnes et al., 2019).

Future directions and implications

The findings of this study highlight how mental health can be predicted by a perceived presence of no one to talk to and cannabis use. Future studies should observe how certain factors such as age, sex, amount of stress in your life, employment status and socioeconomic status (SES) affect our results. For example, being of a certain age, gender, or SES might increase cannabis use frequency or perceived presence of someone to talk to and subsequently self-reported mental health, making our findings due to these external factors rather than to our variables. Since our study examined past 30 day cannabis use frequency, future studies should look at a longer time period, such as cannabis use frequency over a year, to get a better understanding of participants actual cannabis use patterns and how this might affect their mental health. Future studies should increase their sample size, while also examining reasons for cannabis use since people who use cannabis medically might report better mental health as opposed to those who use it recreationally. Finally, future studies should seek replication of results in different populations, such as other countries.

Although more research is needed to confirm our findings, we should err on the side of caution by increasing warnings associated with cannabis use through informative labels on government-purchased cannabis. Another implication of our research may be to target individuals who perceive that they have no one to talk to. Especially in the midst of the pandemic with social isolation increasing (Hwang et al., 2020), figuring out a way to make people feel less alone could help prevent mental illness and protect the lives of Canadians. Programs could be put in place such as daily or weekly zoom calls with peers for those who feel as though they have no one to talk to, and if they have a diagnosis of a mental disorder, they can be provided with options such as therapy and other forms of treatment that may have an effect of improving the individual's mental health. Overall, our findings highlight the potential negative side effects of high frequency cannabis use and having no people to talk to on mental health, which can be translated into real-world change.

References

Airagnes, G., Lemogne, C., Meneton, P., Plessz, M., Goldberg, M., Hoertel, N., ... & Zins, M. (2019). Alcohol, tobacco and cannabis use are associated with job loss at follow-up: Findings from the CONSTANCES cohort. *PloS one, 14*(9), 1-16. doi: 10.1371/journal.pone.0222361

Canadian Mental Health Association. (CMHA). (2021). Stress. Retrieved from https://www.camh.ca/en/health-info/mental-illness-and-addiction-index/stress

Caulkins, J. P. (2016). The real dangers of marijuana. National Affairs, (Winter 2016), 2134.

Debowska, A., Horeczy, B., Boduszek, D., & Dolinski, D. (2020). A repeated cross-sectional survey assessing university students' stress, depression, anxiety, and suicidality in the early stages of the COVID-19 pandemic in Poland. *Psychological Medicine,* 1-4. doi:10.1017/S003329172000392X

Degenhardt, L., Coffey, C., Romaniuk, H., Swift, W., Carlin, J. B., Hall, W. D., & Patton, G. C. (2012). The persistence of the association between adolescent cannabis use and common mental disorders into young adulthood. *Addiction, 108*(1), 124–133. doi:10.1111/j.1360-0443.2012.04015.x

Gonzales, R.G., Suárez-Orozco, C., & Dedios-Sanguineti, M.C. (2013). No place to belong: contextualizing concepts of mental health among undocumented immigrant youth in the United States. *American Behavioural Scientist, 57*(8), 1174-1199. doi:10.1177/0002764213487349

Health Canada. (2017). Canadian cannabis survey 2017. Retrieved from https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/canadian-cannabis-survey-2017-summary.html

Hefner, J., & Eisenberg, D. (2009). Social support and mental health among college students. *American Journal of Orthopsychiatry, 79*(4), 491–499. doi:10.1037/a0016918

Hines, L. A., Freeman, T. P., Gage, S. H., Zammit, S., Hickman, M., Cannon, M., ... &

Honkonen, T., Virtanen, M., Ahola, K., Kivimäki, M., Pirkola, S., Isometsä, E., ... & Lönnqvist, J. (2007). Employment status, mental disorders and service use in the working age population. *Scandinavian journal of work, environment & health,* 29-36.

Hudson, A., & Hudson, P. (2021). Risk factors for cannabis-related mental health harms in older adults: a review. *Clinical Gerontologist, 44*(1), 3-15. doi:10.1080/07317115.2020.1808134

Hwang, T. J., Rabheru, K., Peisah, C., Reichman, W., & Ikeda, M. (2020). Loneliness and social isolation during the COVID-19 pandemic. *International psychogeriatrics, 32*(10), 1217-1220. doi: 10.1017/S1041610220000988

Hyman, S. M., & Sinha, R. (2009). Stress-related factors in cannabis use and misuse: implications for prevention and treatment. *Journal of substance abuse treatment, 36*(4), 400-413. doi: 10.1016/j.jsat.2008.08.005

Kawachi, I., & Berkman, L.F. (2001). Social ties and mental health. *Journal of Urban Health, 78*(3), 458-467. doi: 10.1093/jurban/78.3.458

Ranganathan, P., Pramesh, C.S., & Aggarwal, R. 2017 Common Pitfalls in statistical analysis: Logistic regression. Perspect Clin Res, 8(3):148-51)

Rotermann, M. (2020, February 19). *What has changed since cannabis was legalized?* Government of Canada, Statistics Canada. Retrieved October 8, 2021, from https://www150.statcan.gc.ca/n1/pub/82-003-x/2020002/article/00002-eng.htm.

Silva, D.R.P.D., Werneck, A.O., Agostinete, R.R., Fernandes, R.A., Ronque, E.R.V., & Cyrino, E.S. (2019). Self-perceived social relationships are related to health risk behaviours and mental health in adolescents. *Cien Saude Colet, 26*(3), 5273-5280. doi:10.1590/1413-812320212611.3.15912019

Vidal, C., Silverman, J., Petrillo, E.K., & Lilly, F.R.W. (2019). The health promoting effects of social flourishing in young adults: a broad view on the relevance of social relationships, *Western Social Science Association,* 1-10. doi: 10.1016/j.soscij.2019.08.008

A cross-sectional observational study on the impact of folic acid consumption on gestational diabetes diagnosis in 25-50 year old Canadian women of different BMI categories: No significant difference in GDM diagnosis through taking FA amongst BMI groups

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Introduction

Folic acid (FA) is a supplement that is universally recognized to aid with neurodevelopment and cognitive development in offspring (Li et al., 2019). However, multiple studies have recently claimed that there is a potential association between FA consumption and many adverse effects such as gestational diabetes mellitus (GDM) in pregnant women (Li et al., 2019). GDM is diabetes that is first diagnosed during pregnancy and is characterized by the inability to tolerate blood glucose (Zhuang et al., 2020). Short-term and long-term effects associated with GDM include: hypertension, birth injury, increased caesarean section, miscarriage, fetal malformation and post–natal diabetes (Zhuang et al., 2020). Research identifies body mass index (BMI) as a predictor for the risk of development of GDM. Women with prepregnancy BMI of either overweight or obese were found to be at an increased risk of developing GDM (Shin & Song, 2015). Currently, there are limited studies looking at the potential relationship between FA intake of expecting mothers and GDM.

Studies propose that pregnant women may develop GDM due to an imbalance of vitamin B12 and folate, caused by the consumption of FA supplements, which leads to a decline in resistance to insulin (Zhu et al., 2016). Researchers believe that unmetabolized plasma FA leads to a decrease in natural killer cell cytoactivity, resulting in the development of GDM (Zhu et al., 2016). In a past study by Obeid et al. (2010), the presence of unmetabolized FA has been confirmed to be in the maternal serum. Due to the popular intake of FA supplement, there has been overconsumption of FA going past the recommendation of 400μg per day (Kelly et al., 2016). This raises the concern for potential undesirable effects that may arise due to its consumption. The adverse effects of high FA consumption have been previously observed in animal models. Kelly et al.'s (2016) study found that a high FA diet resulted in increased weight gain, increased fat mass, and adipose tissue inflammation. A similar study found that a high FA intake by rats induced insulin resistance and impaired glucose tolerance (Kintaka et al., 2020). These are all factors that contribute to the diagnosis of GDM. Another study looked at the duration of FA consumption and observed how an increased duration of FA use is correlated with an increased risk for GDM (Cheng et al., 2019).

Although extensive studies have been made in the past, it is unclear whether the risk of GDM is associated with the intake of FA supplements. A study by the Slone Epidemiology Center Birth Defects in the United States and Canada examined the association between FA supplementation to gestational hypertension and preeclampsia (Hernández-Díaz et al., 2002). They suggest multivitamins containing FA reduces the risk of gestational hypertension and preeclampsia (Hernández-Díaz et al., 2002). Hypertension intensifies the risk of cardiovascular diseases causing diabetes while the risk of preeclampsia increases with GDM, although the common pathophysiological pathway is uncertain (Petrie et al., 2018; Weissgerber et al., 2016). Similarly, another study concluded that the risk of preeclampsia is reduced by multivitamins containing FA in the second trimester. In 2,951 women, multivitamins increased serum folate by 10.52 μmol/L, decreased plasma homocysteine by 0.39 μmol/L, and lowered the risk of preeclampsia by 0.37 (Wen et al., 2008). These two studies suggest that FA supplement consumption decreases the risk for the development of GDM.

Despite there being many studies done on the importance of FA supplements and their use in decreasing the risk for birth defects, it is still unclear as to whether taking FA supplements can increase the risk of diabetes in pregnant women. The limited number of studies on this topic have highlighted a controversial research area - it is known that taking FA supplements can decrease the risk of birth defects, however it remains contradictory whether FA supplements may also increase the risk of GDM which in turn can increase the risk of birth abnormalities (Cheng et al., 2019). Furthermore, other factors that may have impacted previous studies done on this topic such as the timing of the intervention, the dose of folic acid, and the population (Li et al., 2013). Therefore, using data collected from the 2017-2018 Canadian Community Health Survey, we would like to see if there is a clear link between the consumption of FA supplements and the risk of developing diabetes in pregnant women.

Another key factor to consider is the specific ethnicities of pregnant women. A study done by Huang et al. (2019) suggested that the risk of GDM was more pronounced among Indian women with the consumption of FA supplements. However, no substantial association was seen in Chinese and Malay women. This inconsistent relationship between FA intake and risk for GDM is another reason our study is relevant and important today. Given that women globally are taking FA supplements both pre-pregnancy as well as during pregnancy, it is important to investigate the potential effects it may impose on their health and weigh out both the pros and cons of FA consumption. Additionally, diabetes during pregnancy can impose negative effects on the fetus such as miscarriage and fetal malformation (Zhuang et al., 2020). It is important that there is a greater overall understanding on this matter. Thus, we would like to investigate the possible connection between FA consumption and the increased risk for GDM with respect to BMI. Specifically, whether there is a potential risk for developing GDM in Canadian women between the ages of 25-50 who consume FA supplements everyday for the first trimester when compared to women who do not consume FA supplements across varying BMI categories.

Methods

Study Design and Database

Our study is observational and cross-sectional using data collected from the year between 2017-2018 Canadian Community Health Survey (CCHS). The Canadian Institute for Health Information, Statistics Canada and Health Canada created the CCHS in 1991 due to several issues being reported regarding the health information system (Statistics Canada, 2018). The survey collects information pertaining to health status, health utilization and health determinants for the Canadian population with the purpose of developing health surveillance programs and providing a single data source for a community of users (Statistics Canada, 2018). Questionnaires were administered using computer-assisted interviews (CAI) in English or French in 2001, 2003 and 2005, and then annually since 2007. CAI allows for a reliable case management system and automatically schedules calls; it checks for inconsistent answers and can skip questions that are not applicable to the respondent (Statistics Canada, 2018).

75% of respondents completed the survey over the phone while 25% completed it in person using the CAI (Statistics Canada, 2018). There was a total of 130,000 respondents with 120,000 aged >18 years and 10,000 respondents aged 12 to 17 years (Statistics Canada, 2018). For each age group, the sample size of each province was assigned using a power allocation of 0.75 according to the size of their respective population. Each province's sample is then allocated among its health regions (HRs) using a power allocation of 0.35 according to the size of the population in each HR (Statistics Canada, 2018). The Canadian Child Tax Benefit (CCTB) frame was used to sample respondents aged 12-17 years and the Area frame was used to select respondents aged 18 and over (Statistics Canada, 2018).

Study Participants

We had a total of 4386 participants in our study. Participants had to be pregnant Canadian women and between the age of 25-50. Participants also fell into the category of either saying yes to taking FA supplements for the first 3 months of pregnancy everyday for our experimental group or answering no to folic acid supplements for the first 3 months of pregnancy for the control group. We had 40 valid cases for those diagnosed with GDM. Our number of valid participants significantly dropped due to missing cases and filtering for age and gender. There were 223 missing cases for weight, 336 missing cases for height, and 325 missing cases for age. This also impacted the number of valid cases for BMI.

Study Outcomes

Our study sought out to find a possible correlation between FA consumption and GDM, in which an increased risk of GDM may be found with FA intake. BMI was used as a way to check for significant group differences as higher BMI is indicative of a greater risk of GDM diagnosis (Shin & Song, 2015). Our independent variable (FA consumption) was split into two groups - those who took FA every day for the first 3 months of pregnancy and those who did not take FA during the first three months of pregnancy. In order to obtain values for our control group we utilized the survey question "Did you take it every day or almost every day?" with the options of Yes, No, Valid Skip, Don't Know, Refusal and Not Stated. We utilized the survey question "During the first three months of your pregnancy, did you take a folic acid supplement or a multivitamin containing folic acid?" for the control group, as answering no to the everyday variable could still indicate some amount of consumption of FA. Our dependent variable (GDM diagnosis) was derived using the survey question "Were you pregnant when first diagnosed with diabetes?" with the options of Yes, No, Valid Skip, Don't know, Refusal, and Not stated. Height and weight were self-reported values from the survey which the BMI variable was derived from using SPSS. BMI was split into 4 groups: BMI <18.5 = underweight, BMI 18.5-24.9 = healthy, 25.0-29.9 = overweight, 30.0+ = obese. We expected the underweight and healthy groups to have a significant difference between FA consumption groups for GDM diagnosis as BMI would not have a significant impact. Contrastingly, we expected to see no significant difference between FA consumption groups for GDM diagnosis in the overweight and obese categories as high BMI is a precursor to GDM (Shin & Song, 2015).

Additional Data Collection

The study also looked at the province of respondents in order to assess the demographic. Participants could select from a list of each province and territory as well, a Valid Skip, Don't Know, Refusal, and Not Stated option was included. By confirming a proportionate spread of respondents this ensured equal representation of females across the country, allowing for more generalizable results.

Statistical Analysis

SPSS software was used for all analyses. Histograms and Q-Q plots showed deviation in our data, showing that our data was not normally distributed. A Shapiro-Wilk test was also used to check for normality, where a p-value of 0.05 was used for significance. We obtained a value less than 0.05, confirming our data was not normally distributed. Chi-squared tests were used to check for between group differences. The test was run four times, filtering for a specific BMI group each time. We ran the test with the variables "FA consumption" and "GDM Diagnosis" where a p-value of 0.05 for significance was used.

Results

Our study looked at 4, 386 women older than 25 years old, compared to the original database of 130, 000 participants. We had 325 missing cases for age, 223 missing cases for weight, and 336 missing cases for height. Our focus was to investigate whether FA supplementation impacted GDM diagnosis in women of different BMI categories. It was found that only two individuals were diagnosed with GDM and took FA. 13 individuals who consumed FA and were healthy weight or overweight had GDM. Seven obese women were also found to be taking FA supplements and had GDM.

Table I: Descriptive Characteristics of Canadian Community Health Survey Participants

Variable	Consumption of FA supplement during first 3 mon. of preg. (N = 3973)	No consumption of FA supplement during first 3 mon. of preg. (N = 413)	p-Value
Province of respondent			
Newfoundland and Labrador	87 (2.2)	5(1.2)	< 0.001
Prince Edward Island	61 (1.5)	2(0.5)	
Nova Scotia	136 (3.4)	11(2.7)	
New Brunswick	88 (2.2)	13 (3.1)	
Quebec	812 (20.4)	116 (28.1)	
Ontario	1128 (28.4)	91(22.0)	
Manitoba	235 (5.9)	33(8.0)	
Saskatchewan	203 (5.1)	26(6.3)	
Alberta	623 (15.7)	55(13.3)	
British Columbia	493 (12.4)	36(8.7)	
Yukon	42 (1.0)	5 (12.2)	
Northwest Territories	42 (1.1)	9 (2.2)	
Nunavut	26 (0.7)	11 (2.7)	
Age			
25 – 29	792 (19.93)	122(29.5)	
30 – 35	1552 (39.06)	141 (34.1)	
35 – 39	1144 (28.79)	95 (23.0)	
40 – 44	420 (10.57)	41 (9.9)	
45 – 49	58 (1.49)	13(3.1)	
Weight before pregnancy (in kilograms)	66.9780 (15.07)	67.7925 (16.61)	< 0.001
Self-reported height	1.6453 (0.67)	1.6414 (0.69)	< 0.001
Diabetes diagnosed during pregnancy			
Yes	35 (0.90)	5 (1.2)	
No	3938 (99.1)	408 (98.8)	
BMI (kg/m^2)			
< 18.5	171 (0.43)	22(5.3)	
18.5 - 24.9	2303 (58.00)	205(49.6)	
25.0 – 29.9	914 (23.00)	107(25.9)	
30.0 +	585 (14.7)	79 (19.1)	
Consumption of folic acid supplement every day during first 3 months of pregnancy			
Yes	3973(90.58)	-	< 0.001
No	413 (9.42)	-	

Data are presented as frequency in percentage (%) of individuals unless otherwise stated. Weight before pregnancy and self-reported height is shown in mean (standard deviation), respectively.

Four Chi-Squared Tests were performed to analyze the group differences in proportions between FA consumption habits during the first trimester and GDM diagnosis in individuals of varying BMIs. Participants with a BMI (kg/m$^{2)}$ below 18.5 are underweight, 18.5-24.9 are healthy weight, 25.0-29.9 are overweight, and 30.0 or above are obesity.

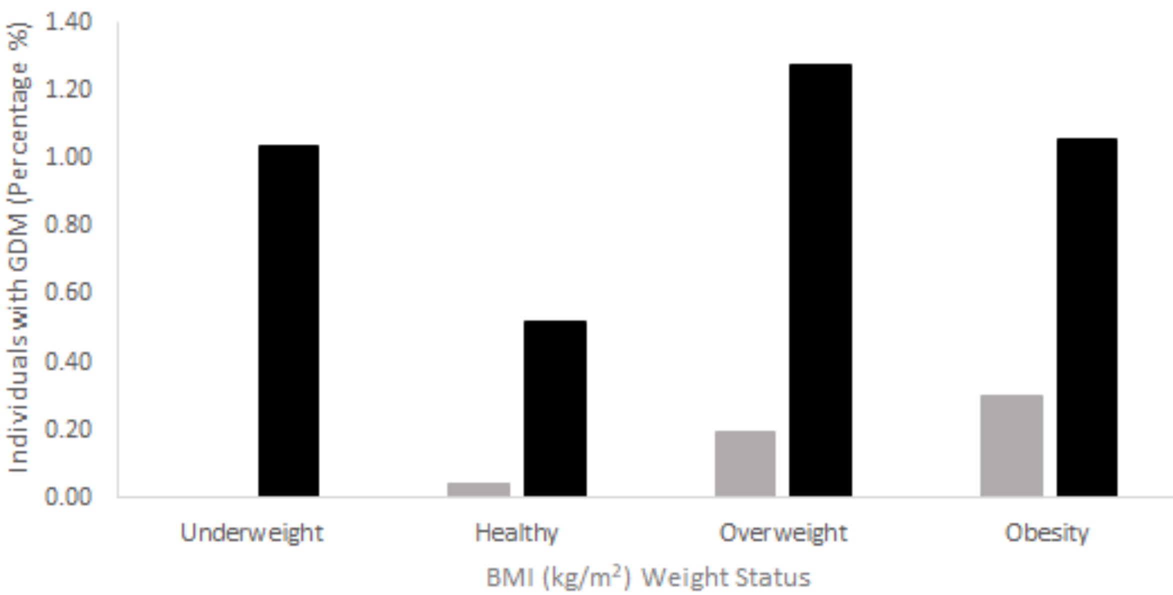

Figure 1: Percentage of participants with gestational diabetes mellitus. N = 193 for individuals with BMI below 18.5. N = 2, 508 for individuals with BMI 18.5 - 24.9. N = 1, 021 for individuals with BMI 25.0 - 29.9. N = 664 for individuals with BMI 30.0 and above. Individuals who consumed FA everyday during the first three months of pregnancy are shown in black, and individuals who did not consume FA everyday during the first three months of pregnancy are shown in grey.

In our study, the number of individuals with GDM, but were not consuming FA daily during the first three months of pregnancy, increased with BMI. These outcomes were expected as they aligned with knowledge from previous research studies. However, no trends were found in participants who were consuming FA every day during the first three months of pregnancy and GDM diagnosis. We expected those who consumed FA with a higher BMI value to experience a higher risk of GDM, compared to those who did consume FA with a lower BMI. Results showed that GDM among participants who consumed FA everyday was random. The percentage of women with GDM was highest in the category overweight, while healthy weight had the lowest percentage of women who were affected. Underweight and obesity, both had a near identical percent of individuals with GDM.

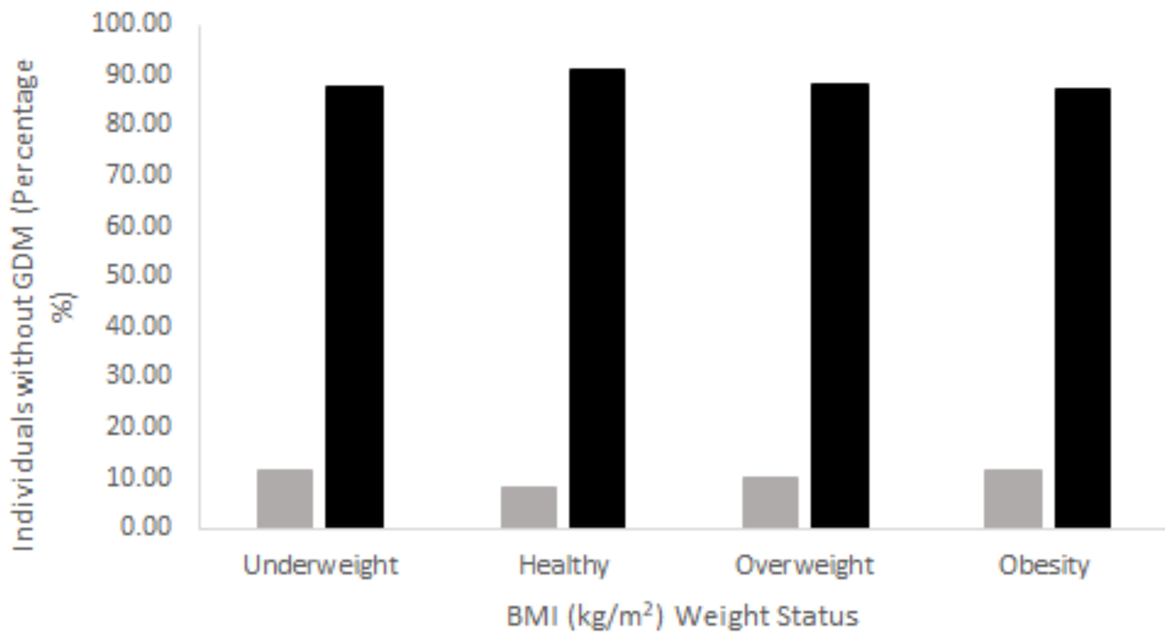

Figure 2: Percentage of participants without gestational diabetes mellitus. N = 193 for individuals with BMI below 18.5. N = 2, 508 for individuals with BMI 18.5 - 24.9. N = 1, 021 for individuals with BMI 25.0 - 29.9. N = 664 for individuals with BMI 30.0 and above. Individuals who consumed FA everyday during the first three months of pregnancy are shown in black, and individuals who did not consume FA everyday during the first 3 months of pregnancy are shown in grey.

While GDM was observed in individuals who both consumed and did not consume FA, it was also found that GDM was not detected in a small number of individuals with varying FA consumption habits. We expected individuals who did not consume FA everyday during their first three months of pregnancy and had a BMI less than or equal to 24.9, to have little or no risk of GDM. Our results instead suggested that the absence of GDM is consistent throughout all 4 BMI categories for both FA consumption and no FA consumption. Results of GDM diagnosis in participants were opposite to our predictions.

Table II: Chi-Squared Tests for BMI and FA consumption. Four Chi-Squared Tests were performed on the BMI categories underweight, healthy weight, overweight, and obesity, to examine group differences between FA consumption habits during the first trimester and GDM diagnosis. Significance values for each Fisher's Exact Test are reported.

BMI Category	Fisher's Exact Test Sig. (2-sided)
Underweight	1.000
Healthy Weight	1.000
Overweight	.665
Obesity	.291

Due to the small sample size and observed values less than 5 in the 2x2 tables, Fisher's exact test significance values were used, specifically the 2-sided p values, since it is more conservative. There were no significant differences between FA consumption and all BMI categories including underweight, healthy weight, overweight, and obesity, $p = 1.000$, 1.000, 0.665, and 0.291, respectively. If there were any p values reported less than 0.05, the proportions between that specific BMI category and FA consumption would be considered significantly different.

Discussion

There were unexpected outcomes in our results, which led to insignificant results when running a statistical analysis. Results presented in Figure 1 is inconsistent with our hypothesis. We expected that the group of individuals consuming FA in BMI categories such as overweight and obesity would have higher frequencies of GDM diagnosis. However, we observed that the frequency of GDM were similar in the underweight and obesity category. The percentage of participants without GDM diagnosis, shown in Figure 2, also did not meet our expectations as frequency of GDM in all BMI categories were consistent. Results in Table II indicates that our data is insignificant. Our findings suggest there is no correlation between the consumption of FA supplements everyday for the first trimester in pregnant women aged 25 to 50 year old, and the risk for GDM diagnosis. This contradicts our original hypothesis that looked at the potential increased risk for GDM diagnosis of Canadian pregnant women between the ages of 25 to 50 consuming FA supplements daily during their first trimester.

Reflecting on the data, we considered multiple limitations that may have contributed to the potential insignificant results. One statistical limitation includes the assumptions in each statistical analysis. Our data only allowed for the statistical analysis of a Chi–Squared Test, which limited the variety of perspectives in different analyses to draw possible conclusions. Through a Q-Q plot, the Shapiro-Wilk test, and histogram shape distribution, we learned that our data was not normally distributed. When conducting the Shapiro-Wilk test, a p - value of less than 0.05 would suggest the data is not normally distributed. In our analysis, we had a significance level of less than 0.001, thereby indicating to us the data was not normally distributed. The histogram that was generated with the selection of a plot analysis on SPSS allowed us to see that the data shape distribution was left skewed. Upon the confirmation that our data was not normally distributed, we were limited in our choice of statistical tests such that student t – test which required normal distribution.

The Mann Whitney U test can be used to compare differences between two independent groups when the dependent variable is not normally distributed. However, were also limited to this analysis since our variables used categorical data, which did not align with the requirement for the dependent variable to be continuous. We considered using a logistic regression analysis which would have allowed us to make predictions on the potential relationship between FA consumption and GDM risk. To perform a logistic regression, our Pearson's coefficient would need to be greater than 0.30 in a Spearman's rho analysis. However, the test found our value to be 0.043, ruling out the possibility of a logistic regression. Moreover, it should be recognized that we considered using BMI as a continuous variable to provide more flexibility in statistical analyses. Due to that fact that our research question and primary outcomes focused on FA consumption and GDM diagnosis, we did not want our data primarily focusing on BMI. Ultimately, our study was limited to using a Chi-Squared Test for statistical analysis. We ran four Chi-Squared analyses, each with a filter for one of the four BMI categories. This was performed to counter the problem of the analysis itself being limited to looking at two variables as our study investigated three variables. The test examined group differences between if FA was consumed and if they were diagnosed with GDM.

Another limitation to consider is the sample size. The database our study reflected was by CCHS, which conducted interviews for over 130 000 individuals. The original database is not a pregnancy or diabetes specific survey, causing many cases to be filtered out. This resulted in a total of only 4, 386 relevant individuals to our study. Our sample size does not allow us to be confident in representing a good measure for the greater population. Among the 4, 386 individuals, only 40, or 0.91%, were diagnosed with GDM, while 3, 938 of the 4, 386 participants, or 89.76%, were not diagnosed with GDM. The sample sizes for these groups are imbalanced which may have led to skewed results. We also want to note that only 0.91% of participants were diagnosed with GDM. This percentage highly deviates from the typical rate of GDM diagnosis in the Canadian population of 5.45% (Government of Canada, 2014.). This suggests our data may have been impacted as there is a gap in rate for GDM diagnosis. Potential future studies may want to consider utilizing larger and more proportionate sample groups to give better precision of results.

To add, the dosage of FA consumption was not studied in the survey. In previous literature, it was noted that women typically consumed FA dosages over the recommended amount due to the popularity of fetal benefits (Li et al., 2019). Certain foods also have a higher concentration of FA such as vegetables and cheese compared to meat (Öhrvik et al., 2018). Moreover, our data did not consider how much FA one consumed, but rather if they consumed supplements or not. This could impact the study because one individual could be taking more FA than another, and still be grouped under the same category. This may have resulted in our Chi-Squared analyses being insignificant. We want to consider this data as inconclusive as the results potentially may be different if we had the opportunity to control for FA dosage. Many studies that did find a potential risk for increased GDM when consuming FA, controlled the amount of FA consumed (Huang et al, 2019; Li et al., 2019). A study by Li et al. (2019) controlled for FA amounts grouped in <400µg, 400 – 799 µg and >800µg, and found that women in the >800µg consumption group had a greater risk for GDM. Contrary, other studies that have countered this claim there is no risk of GDM when consuming FA supplements (Petry et al., 2021).

Current research makes claims on both sides, suggesting that there is a conflicting understanding of the health benefits or detriments of FA consumption on the expecting mother (Greenberg et al, 2011). Further research could potentially explore the FA consumption and how it can influence people of different ethnic groups, as there are studies that show FA consumption and GDM risk is different between ethnicities (Chen et al., 2019). In our data, of the 40 individuals who were diagnosed with FA, only 16 cases were Caucasian, and most were of different races. Research suggests that there is greater risk for Indian women to be diagnosed with GDM while consuming FA, compared to Malaysian or Chinese women believed to have little or no risk (Huang et al., 2019). Although our study produced negative results to our hypothesis, this suggests that current literature needs further research to better grasp this potential relationship between FA consumption and GDM diagnosis.

References

Chen L., Shi L., Zhang D., & Chao S.M. (2019). Influence of acculturation on risk for gestational diabetes among Asian women. *Preventing Chronic Disease,* 16. http://dx.doi.org/10.5888/pcd16.190212

Government of Canada (2014) Maternal diabetes in Canada. https://www.canada.ca/en/public-health/services/publications/healthy-living/maternal-diabetes-canada.html

Greenberg, J. A., Bell, S. J., Guan, Y., & Yu, Y. H. (2011). Folic Acid supplementation and pregnancy: more than just neural tube defect prevention. *Reviews in obstetrics & gynecology*, *4*(2), 52–59. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3218540/

Huang, L., Yu, X., Li, L., Chen, Y., Yang, Y., Yang, Y., Hu, Y., Zhao, Y., Tang, H., Xu, D., Zhao, M. (2019). Duration of periconceptional folic acid supplementation and risk of gestational diabetes mellitus. *Asia Pacific journal of clinical nutrition*, *28*(2), 321–329. https://doi.org/10.6133/apjcn.201906_28(2).0014

Li, Q., Zhang, Y., Huang, L., Zhong, C., Chen, R., Zhou, X., Chen, X., Li, X., Cui, W., Xiong, T., Gao, Q., Xu, S., Wu, Y., Wang, X., Zhang, G., Zhang, X., Lin, L., Gao, D., Xiao, M., Xiong, G., … Yang, N. (2019). High-Dose Folic Acid Supplement Use From Prepregnancy Through Midpregnancy Is Associated With Increased Risk of Gestational Diabetes Mellitus: A Prospective Cohort Study. *Diabetes care*, *42*(7), e113–e115. https://doi.org/10.2337/dc18-2572

Öhrvik, V., Lemming, E. W., Nälsén, C., Becker, W., Ridefelt, P., & Lindroos, A. K. (2018). Dietary intake and biomarker status of folate in Swedish adults. *European journal of nutrition*, *57*(2), 451–462. https://doi.org/10.1007/s00394-016-1328-4

Petry, C.J., Ong, K.K., Hughes, I.A., Dunger D.B. (2021). Folic acid supplementation during pregnancy and associations with offspring size at birth and adiposity: a cohort study. *BMC Res Notes,* 14(160). https://doi.org/10.1186/s13104-021-05575-y

Statistics Canada. *Canadian community health survey, 2017-2018: Annual component.* Health Statistics Division, Statistics Canada. Retrieved December 8, 2021 from http://odesi2.scholarsportal.info/webview/

Investigating the Effect of Education on Cardiovascular Disease Risk through Clinical and Lifestyle Markers of Cardiovascular Disease: A Cross-Sectional Study

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LIFE SCI 3LL3: Living Systems Laboratory Practicum

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Introduction

Current literature suggests that education is inversely correlated with the development of cardiovascular disease (CVD) in a general population (Dégano et al., 2017). Studies have found that body mass index (BMI) and blood pressure (BP) are factors associated with both education and CVD (Dégano et al., 2017). However, these studies have not been able to draw links between CVD and levels of education while accounting for the effects of frailty in a population (Dégano et al., 2017). Papers in this field have tended to generalize populations by samples aged between 25-34 years (Dégano et al., 2017). Frailty increases with age, and susceptibility for development of CVD increases with frailty (Vitale et al., 2018). Studies have found that men are typically more susceptible than women for CVD development (Bots et al., 2017). Current studies investigating the association between education and CVD do not account for the effects of frailty within their age group selection, including those over the age of 65 (Dègano et al., 2017; Xue, 2011). A gap in knowledge arises when frailty is not accounted for in participant groups. This can be overcome by limiting the study's scope to young adults.

BP consists of two readings, the systolic and diastolic BP. Systolic BP measures the maximum pressure of the left ventricle wall of the heart during its contraction–to circulate blood supply to the rest of the body (James & Gerber, 2017). Diastolic BP measures the force exerted on the cardiac walls during relaxation–when the heart is being refilled in preparation for its next contraction. (James & Gerber, 2017). It was found that level of education is inversely related to BP as well as the development of CVD (Dyer et al., 1976).

Interestingly, while systolic BP increases progressively with age until 80 years of age, diastolic BP increases gradually up to the age of 55 years then decreases. The gradual increase in systolic BP has become the leading cause of hypertension, making systolic BP a superior predictor of CVD risk compared to diastolic BP (Izzo et al., 2000). In a multifactor intervention program on coronary disease mortality called "Multiple Risk Factor Intervention Trial (MRFIT)", it was found that populations with high systolic BP combined with low diastolic BP had the worst prognosis (Neaton & Wentworth., 1992). In a longitudinal follow-up study, researchers have shown that men with increased systolic BP along with decreased diastolic BP had the greatest mortality rate (Benetos et al., 2000). These studies not only show the power of BP in predicting CVD risk, but also highlight the importance to consider the differences in systolic and diastolic BP and their combined effect on the risk of developing CVD.

Studies dating back decades have highlighted an association between education level and BP (Dyer et al., 1976). In a study in which the participants had levels of education ranging from high school to a graduate degree, it was found that mean systolic and diastolic BP decreases with increasing education (Dyer et al., 1976). An additional study that compared individuals with a graduate degree to those with a high school degree found that there were significantly lower systolic and diastolic BP readings in those with a graduate degree. This study also noted that those participants with a higher level of education also had a lower mean BMI and smoked fewer cigarettes per day (Liu et al., 2011).

BMI [kg/m^2] is generally an indicator of overall obesity (Benson et al., 2018). A cohort study investigated a population from age 14-22 in 1979 through age 47-55 in 2012 (Benson et al., 2018). In ages as early as 18, differences in BMI scores were observed throughout different educational groups, including high school diploma, and bachelor's degree (Benson et al., 2018). However, this longitudinal study also noted that education only predicted slight (10-30%) changes in BMI in women. This was a longitudinal study and is subject to the Hawthorne effect, an observer effect that alters participants' behaviors (Chen et al., 2015).

Higher BMI is a strong indicator of obesity, an independent CVD risk factor (Akil & Ahmad, 2011). There is a positive relationship between BMI and CVD risk, particularly, CVD mortality has found to increase with BMI (Akil & Ahmad, 2011). Atherosclerosis is a disease with pathology linked to accumulation of lipids in large arteries (Lusis, 2000). Atherosclerosis is a specific type of arteriosclerosis (Andrus et al., 2015). Atherosclerosis has been identified as a risk factor for CVD incidence (Lusis, 2000).

Our primary research question aims to fill this knowledge gap around accounting for frailty and is the following. Is there a relationship between higher education (attainment of a university degree) in middle-aged Canadian adults aged 25-34 and overall CVD incidence compared to overall CVD incidence in middle aged Canadian adults aged 25-34 with lower education (high school diploma)? A knowledge gap in many studies investigating risk factors is that they are subject to the Hawthorne effect, as they are longitudinal in nature. Our secondary research question addresses this knowledge gap and is the following. Is there a relationship between higher education (attainment of a university degree) in middle-aged Canadian adults aged 25-34 and risk factors for CVD incidence (systolic and diastolic BP, body mass index, arteriosclerosis, and self-reported stress) compared to these risk factors in middle-aged Canadian adults aged 25-34 with lower education (high school diploma)?

Methods:

The database used in this study is from the Social Science Data Centre at Queen's University. This cross-sectional study took place from 1988-1989. The study ran from 1986-1992. The rationale for creating this database was to estimate CVD risk factors at the provincial level; provide insight as to participants' awareness about CVD causes; determine awareness about CVD consequences and risk factors, including lifestyle factors. All units of analysis were at the individual level. The literature suggests that data in the database are sufficiently representative of the Canadian population and are reliable for producing public health policies in relation to cardiovascular health (CH) (Langille et al., 1999).

This database was designed by the Canadian Heart Health Database Centre at Memorial University. The design consisted of an inclusion criteria of participants individuals aged 18 to 74. Exclusion criteria–justified by operational concerns, included those who are full-time residents on military camps, Indian reserves, or in institutions.

Data collection took place in 10 Canadian provinces. Sampling frames were established using health insurance agencies (Langille et al., 1999). Initial stages of data collection aimed to collect demographic, CVD risk factor, and data related to opinions of CH. Within these initial states, public health nurses were employed to visit the respondents at their dwellings. Participants were instructed to fast for a minimum of 8 hours before their first clinical visit. Data collection consisted primarily of clinical visits and personal interviews.

Study Participants included in this survey included individuals surveyed from all ten provinces of Canada. Since our research aimed to limit the age range to young adults, we included people under the age of 25 and excluded people over the age of 34.

The primary outcome that is investigated in our research is the change in CVD risk with level of education. Level of education constitutes two levels, secondary school completion or attainment of a university degree. The secondary outcomes of the study include average systolic/diastolic BP and BMI as clinical indicators, and cigarette use as lifestyle indicators for CVD risk. History of heart attack and stroke are included to investigate a potential direct association between education and CVD.

Three additional variables were included in the dataset to serve as descriptive statistics. Descriptive statistics are important to control our population to limit confounding factors that may skew our data. The variables most descriptive of CVD risk per the literature are the age of the participants (systolic/diastolic BP increases with age) (Izzo et al., 2000). Therefore, age must be controlled in this study. Adjustments for age were done using the GPAGE2 variable to limit the sample size to middle aged Canadians aged 25-34 years old. The variable EDUC is included to provide insight into participants' level of academic attainment. HDART was used to determine whether participants had a heart disease due to arteriosclerosis. The remaining two variables, BMI and CIG_DAY, are included to provide details about participants' lifestyle factors.

All tests were performed using IBM SPSS version 28.0.0.0 (190). The initial sample size of the dataset was 17,995. The dataset underwent several adjustments. Education levels were narrowed using the EDUC variable to either "SECONDARY COMP" or "UNIVERSITY DEG" using the *if* function in select cases as follows: "GPAGE = 2 AND (EDUC = 2 OR EDUC = 4)". Missing cases were then deleted using the select cases feature in SPSS with the "delete unselected cases" function for all variables included in the analysis (Table 3). After adjusting the database to align with the research question, the total sample size decreased to 6,056. Normality tests were performed on all continuous, scalar variables to verify assumptions for Pearson and T-test analyses (Table 2).

Two biserial correlation analysis tests were performed, a Pearson and Spearman's rho. The Pearson test was used to investigate the degree of linear relationship between EDUC (a dichotomous categorical variable) and the following three CVD risk factors: BMI, MSYS, and MDIAS. The Spearman's rho test was performed to investigate the degree of linear relationship between EDUC and CVD risk factors that were non-normally distributed. These included blood cholesterol, excess fats, smoking and arteriosclerosis (Wu et al., 2015).

A chi-squared analysis was performed to calculate the difference in proportions between groups for EDUC and risk factors including: HDWGT, HDFATS, HDCHOLBD, HDSMOKE, HDHBP, HDART, HDSTRESS, HDSTRESS, and HDCHOLBD. The CIG_DAY variable was transformed from continuous to ordinal data through the binning function in SPSS. The first cut point location was 0, representing 0 cigarettes smoked per day with a width of 50. The label "None" represented 0 cigarettes smoked per day, represented by CIG_DAY = 0, while the label "Any" represented a CIG_DAY value >0. Average systolic and diastolic BP, binned CIG_DAY, and BMI were selected to undergo a T-test analysis to investigate potential statistical differences in the means of these variables between higher and lower education.

Results

	Education Level	
	High School Diploma N=4469(%)	University Degree N=1587 (%)
Smoking Status		
Smoker	2990 (66.9)	1300 (81.9)
Non-Smoker	1413 (31.6)	242 (15.2)
Missing Cases	66 (1.5)	45 (2.9)
History of Heart Attack		
Disease Incidence	13 (0.3)	6 (0.4)
No Disease Incidence	4441 (99.4)	1578 (99.4)
Missing Cases	15 (0.3)	3 (0.2)
History of Stroke		
Disease Incidence	24 (0.5)	6 (0.4)
No Disease Incidence	4436 (99.3)	1579 (99.5)
Missing Cases	9	2 (0.1)
Heart Attack Due to Fats		
Disease Incidence	798 (17.8)	347 (21.9)
No Disease Incidence	3671 (82.1)	1240 (78.1)
Missing Cases	0 (0)	0 (0)
Heart Attack Due to Smoking		
Disease Incidence	2550 (57.1)	940 (59.2)
No Disease Incidence	1919 (42.9)	647 (40.8)

Missing Cases	0 (0)	0 (0)
Heart Attack Due to Arteriosclerosis		
Disease Incidence	302 (6.8)	164 (10.3)
No Disease Incidence	4167 (93.2)	1423 (89.7)
Missing Cases	0 (0)	0 (0)
Heart Attack Due to Stress		
Disease Incidence	1818 (40.7)	745 (46.9)
No Disease Incidence	2651 (59.3)	842 (53.1)
Missing Cases	0	0
Age Group [e]		
25-34 years	6056 (100)	

Table 1. Baseline Characteristics of Population in Adjusted Dataset. Only participants aged 25-34 were included in this study. Participants with missing data for any of these variables were removed from the dataset. Since some participants did not answer certain questions on the survey, missing cases will exist for those variables. N denotes sample size.

Variable	Shapiro-Wilk Significance	Mean (Standard Deviation)
MSYS	0.650*	116.427 (11.818)
MDIAS	0.467*	73.980 (8.919)
BMI	0.659*	24.633 (4.339)
CIG_DAY	0.156*	5.07 (9.308)

Table 2: Shapiro-Wilk Normality Test Results.

Note: *Significant as $p < 0.05$

Variable	Variable Description
GPAGE2[A,I]	Grouped age bracket
EDUC[A,I]	Grouped education
EVERHA[A,D]	Ever Had a Heart Attack?
HDART[A,C]	Cause of heart disease: Arteriosclerosis?
EVERSTR[A,D]	Ever had a stroke?
MSYS[B,D]	Average Systolic BP
MDIAS[B,D]	Average Diastolic BP
BMI[B,D]	Body Mass Index

CIG_DAY (Binned)[A,D]	Daily Smoking Habits
HDFATS[A,D]	Cause of heart disease: excess fats

Table 3. Description of Variables Used in Statistical Analysis

Note: Superscripts denote the following [A]Nominal, [B]Scalar, [C]Independent, [D]Dependent

		[EDUC]	[BMI]	[MSYS]	[MDIAS]
[EDUC]	Pearson Correlation	1	-0.060***	-0.004	0.007
	Sig. (2-tailed)		< 0.001	0.745	0.574
	N	6056	5190	6048	6048
[BMI]	Pearson Correlation	-0.060***	1	0.393***	0.366***
	Sig. (2-tailed)	< 0.001		< 0.001	< 0.001
	N	5190	5190	5189	5189
[MSYS]	Pearson Correlation	-0.004	0.393***	1	0.712
	Sig. (2-tailed)	0.745	< 0.001		0
	N	6048	5189	6048	6048
[MDIAS]	Pearson Correlation	0.007	0.366***	0.712	1
	Sig. (2-tailed)	0.574	< 0.001	0	
	N	6048	5189	6048	6048

Table 4: Pearson Correlation Test Output. Note: ***Significant as $p < 0.001$

The results of the Pearson correlation analysis suggested that there was a weak, negative association between EDUC and BMI. The Pearson correlation value was found to be $r = -0.060$ and had a corresponding p value less than 0.001 ($p < 0.001$), statistically significant.

		[EDUC]	[HDFATS]	[HDSMOKE]	[HDART]
[EDUC]	Pearson	1	-0.045***	-0.019	-0.059***
	Sig. (2-tailed)		< 0.001	0.133	< 0.001
	N	6056	6056	6056	6056
[HDFATS]	Pearson	-0.045***	1	0.074***	0.082***
	Sig. (2-tailed)	< 0.001		< 0.001	< 0.001

	N	6056	6056	6056	6056
[HDART]	Pearson	-0.059***	0.082***	-0.038**	1
	Sig. (2-tailed)	< 0.001	< 0.001	0.003	
	N	6056	6056	6056	6056

Table 5. Spearman Correlation Output. *** $p < 0.001$, ** $p < 0.01$

The results of the spearman's rho analysis showed that there was a significant correlation between EDUC and risk factors of CVD. There was a weak, negative correlation of $\rho = -0.059$ between EDUC and HDART ($p < 0.001$).

In a chi square test, it was found that there was no significant difference in proportion between EDUC and the HDWEIGHT ($X^2 = 0.109$, p = 0.7411). The same was true for HDSMOKE ($X^2 = 2.174$, $p = 0.14$). Similar results were found for EDUC and heart attack history ($X^2 = 0.073$, $p = 0.788$). Finally, a significant difference in proportion was found between EDUC and HDFATS ($X^2 = 12.015$, $p <0.001$), HDART ($X^2 = 20.588$, $p <0.001$), HDSTRESS ($X^2 = 18.567$, $p <0.001$), and binned CIG_DAY ($X^2 = 152.048$, $p < 0.001$) (Figure 1).

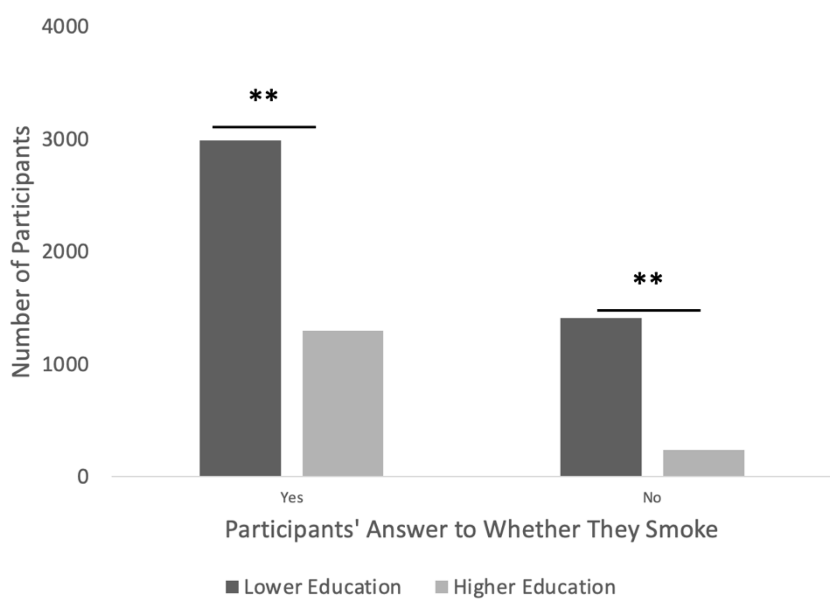

Figure 1. Comparison Between Groups: Lower vs Higher Education and Binned cigarettes smoked per day. **Significant at $p < 0.001$ level.

From the independent two-sample t-test, there was a statistically significant difference between the means of the participants' BMI. They were separated by those who attained a secondary school diploma and those who completed a university degree. The test revealed that there was a significant difference in the means of BMI ($T = 4.569$, $p < 0.001$) and CIG_DAY ($T=14.836$, $p <0.001$), between high school and university graduates.

		Levene's Test for Equality of Variances				Significance	
		F	Sig.	t	df	One-sided p	Two-sided p
[BMI]	EVA	27.339	<.001**	4.318	5188	<.001**	<.001**
	EVNA			4.569	2664.022	<.001**	<.001**
[CIG_DAY]	EVA	545.191	<.001**	12.439	5943	<.001**	<.001**
	EVNA			14.836	3938.052	<.001**	<.001**

Table 6: T-Test Analysis Output.

Note: Abbreviation "EVA": equal variances assumed. "EVNA": equal variances not assumed.

**Significant at the two tailed level.

<u>Discussion:</u>

In this study, we found limited significant relationship between education and risk factors of CVD. The Pearson correlation analysis indicated a weak correlation between EDUC and BMI, while the Spearman rho correlation analysis indicated EDUC to have weak correlation with HDART and HDFATS. The chi square analysis shows a difference in proportions between the groups for EDUC and, HDFATS, HDART, HDSTRESS, and binned (CIG_DAY); the T-test indicated significant differences in mean BMI and average cigarettes smoked per day for higher and lower education.

MSYS and MDIAS were selected for the Pearson correlation analysis to determine any correlation between education and CVD to address the first research question. BMI along with risk factors in other tests addressed the second research question. Previous studies have found that there is an inverse relationship between level of education and BP, in which those with a lower education were found to have a higher BP and increased mortality from CVD (Dressler, 1990). Another study found that those who achieved a higher degree attainment had a lower mean BMI (Liu et al., 2011). Since the objective of this study was to investigate the potential association between the level of education and CVD within the limit of a singular database, a correlation between education and the markers of CVD risk must first be established. Of the three variables that were examined in the Pearson correlation analysis, there was a statistically significant correlation in only one of the relations, education, and BMI. The Pearson correlation value for this relationship was $r = -0.060$ and had an associated p-value less than 0.001. The R^2 value represents the proportion of variance in the dependent variable (Hazra & Gagtay, 2016). For this analysis, the R^2 value was 0.0036. This tells us that 0.36% of the difference seen in BMI can be attributed to education. Since this value is less than 0.1 or 10%, this finding is insignificant. These findings, however, are inconsistent with the results of Liu et al. (2011) study in which they observed a significant inverse relationship between education and BP. They also found an association between education and BMI which is consistent with our results.

The variables, HDFATS and HDART were additionally selected for the Spearman Rho analysis. This is because high cholesterol in blood can induce arteriosclerosis (Zhao et al., 2018), and increased fats in diet may lead to obesity (Hohos & Skaznik-Wikiel, 2017). Together arteriosclerosis and obesity are predictors of CVD risk (Frostegård, 2013; Ortega et al., 2016). Arteriosclerosis was found to be weakly correlated with education ($p < 0.001$). Although there is an association between arteriosclerosis and CVD risk, these results suggest that education is not a CVD risk factor. The R^2 value for arteriosclerosis is 0.003481 This tells us that 0.3% of the difference seen in arteriosclerosis can be attributed to education. Since the R^2 value is less than 0.1 ($R^2 < 0.1$), this finding is insignificant. Another variable where $p < 0.05$ was HDFATS. However, to evaluate its potential association between education and CVD risk, the R^2 value must be considered. The R^2 value between excess fats and education is 0.002025. This means that 0.2% of the change observed in HDFATS can be attributed to education. Similar to HDARTS, since $R^2 < 0.1$, this correlation is insignificant. The research question looked at the effect of different education levels on markers such as average systolic and diastolic BP and BMI, because BP is a marker for arteriosclerosis (Huang et al., 2021) and BMI is associated with obesity (Vecchié et al., 2018).

The variables, HDFATS, HDART, HDSTRESS, Binned CIG_DAY, and EVERHA were selected for chi-square analysis. In this study, it was found that there was a significant difference in the proportion between groups for HDFATS, HDART, HDSTRESS, and binned CIG_DAY. The literature establishes a relationship between smoking cigarettes and coronary heart disease (Hackshaw et al., 2018). Studies have suggested that physiological stress is indirectly associated with CVD through contributing to the development of factors like obesity–although stress itself is not necessarily related to CVD development (Dar et al., 2019). Since studies have found that those in lower socioeconomic workplaces are often less educated and have higher stress levels–the association between stress related CVD risk and levels of education was an important factor to consider in this study (Lunau et al., 2015). Studies suggest that arteriosclerosis risk and educational attainment have an inverse relationship–with lower educated groups being more at risk (Kubota et al., 2017). It was important to investigate the difference in proportions between educated and lower-educated groups who had ever had a heart attack as studies have found that those with lower education have higher predisposition for adverse CVD related outcomes (Kelli et al., 2019). The findings with HDFATS were inconsistent with Mosli et al. (2017), where a correlation between education and obesity was established. HDART was unique as there are limited publications on the correlation between education and arteriosclerosis. A study by Xiuyun et al. (2020) looked at education and stroke incidence in a population of individuals who have atherosclerosis, however, the correlation was not measured between education and atherosclerosis. The participants in this study were separated by secondary education completed and bachelor's degree attained. Past studies have used chi-square analysis to investigate the potential association between education attainment and CVD risk (Ricceri et al., 2016). Studies have suggested that educational attainment can influence lifestyle factors which heavily influence CVD risk (Ricceri et al., 2016).

T-tests have been performed to investigate any statistical difference between the means of high school graduates and university graduates in two categories, BMI, and CIG_DAY. This means that there is a statistical difference in the average BMI and the average cigarettes smoked per day between high school graduates and university graduates. This suggests that there is a significant difference between the means of higher and lower education when comparing BMI and cigarettes smoked per day. This is inconsistent with a study by Leshargie et al. (2019) where they found that university students on average smoke more than high school students. This may be explained by the fact that this study was conducted in Ethiopia where the education system is not fully developed. In contrast, Canadian school curriculums are more developed and prevent or deter students from smoking cigarettes.

Limitations and Future Directions

Although this cross-sectional study filled some knowledge gaps, limitations still exist. Since this study was limited to a single database, often a variable may not be the perfect variable to measure the desired outcome. To measure CVD risk, the variables EVERHA and EVERSTR were assigned as dependent variables, however, both are nominal data. To circumvent this, a separate non-survey dataset can be incorporated; that way, there can be continuous data for CVD incidence and risk. This will allow for analyses such as ANCOVA which would be beneficial as we can remove certain variables to see their effect on the dependent variable.

Furthermore, in the variable EDUC, there is no option to select “some university”. Since this database classifies participants with some level of post-secondary education as “high school complete”, the age group had to be limited to 25-34, as the average age for completing an undergraduate degree in Canada is 25 (Statistics Canada, 2019). Future studies should use databases with more descriptive ways of indicating participants’ level of academic attainment whilst increasing the sample size in higher education which will increase the power of the study.

Implications:

This study sheds light on how differences in education may lead to increased risk of CVD. This is a critical topic as obesity rates continue to rise in Canada (Statistics Canada, 2018). Education may allow individuals to live a healthy lifestyle, however, it has been found that university students often opt for fast food over healthy alternatives (Jiang et al., 2019). The correlation between markers of CVD and education is a promising method to understand the rising obesity rates despite increasing higher education graduates (Statistics Canada, 2019).

These findings can also be used to help review high school curriculums to incorporate healthy lifestyle factors to prevent susceptibility for CVD risk if graduates choose not to attain a post-secondary degree.

References

Akil, L., & Ahmad, H. A. (2011). Relationships between Obesity and Cardiovascular Diseases in Four Southern States and Colorado. *Journal of Health Care for the Poor and Underserved*, *22*(4 Suppl), 61–72. https://doi.org/10.1353/hpu.2011.0166

Andrus, C., Allen, E., Merritt, H., Duff, L., Moore, R., Kendall, F., Shumacker, H., Levy, R., & Wright, I. (2015). The pathogenesis of arteriosclerosis. *International Journal of Epidemiology*, *44*(6), 1791–1793. https://doi.org/10.1093/ije/dyv347

Benson, R., von Hippel, P. T., & Lynch, J. L. (2018). Does more education cause lower BMI, or do lower-BMI individuals become more educated? Evidence from the National Longitudinal Survey of Youth 1979. *Social Science & Medicine*, *211*, 370–377. https://doi.org/10.1016/j.socscimed.2017.03.042

Benetos, A., Zureik, M., Morcet, J., Thomas, F., Bean, K., Safar, M., Ducimetière, P., & Guize, L. (2000). A decrease in diastolic BP combined with an increase in systolic BP is associated with a higher cardiovascular mortality in men. *Journal of the American College of Cardiology*, *35*(3), 673–680. https://doi.org/10.1016/s0735-1097(99)00586-0

Bots, S. H., Peters, S., & Woodward, M. (2017). Sex differences in coronary heart disease and stroke mortality: a global assessment of the effect of ageing between 1980 and 2010. BMJ global health, 2(2), e000298. https://doi.org/10.1136/bmjgh-2017-000298

Canadian Heart Health Database Centre. 1997. Canadian Heart Health Database [public use microdata file]. St. John's, Newfoundland: Memorial University: Canadian Heart Health Database Centre [producer and distributor].

Chen, L. F., Vander Weg, M. W., Hofmann, D. A., & Reisinger, H. S. (2015). The Hawthorne Effect in Infection Prevention and Epidemiology. *Infection control and hospital epidemiology*, *36*(12), 1444–1450. https://doi.org/10.1017/ice.2015.216

Dar, T., Radfar, A., Abohashem, S., Pitman, R. K., Tawakol, A., & Osborne, M. T. (2019). Psychosocial Stress and Cardiovascular Disease. *Current treatment options in cardiovascular medicine*, *21*(5), 23. https://doi.org/10.1007/s11936-019-0724-5

Dégano, I. R., Marrugat, J., Grau, M., Salvador-González, B., Ramos, R., Zamora, A., Martí, R., & Elosua, R. (2017). The association between education and cardiovascular disease incidence is mediated by hypertension, diabetes, and body mass index. Scientific reports, 7(1), 12370. https://doi.org/10.1038/s41598-017-10775-3

Dressler, W. W. (1990). Education, lifestyle and arterial BP. *Journal of Psychosomatic Research*, *34*(5), 515–523. https://doi.org/10.1016/0022-3999(90)90026-z

Dyer, A. R., Stamler, J., Shekelle, R. B., & Schoenberger, J. (1976). The relationship of education to BP: Findings on 40,000 employed Chicagoans. *Circulation*, *54*(6), 987–992. https://doi.org/10.1161/01.cir.54.6.987

Frostegård J. (2013). Immunity, atherosclerosis and cardiovascular disease. *BMC medicine*, *11*, 117. https://doi.org/10.1186/1741-7015-11-117

Hackshaw, A., Morris, J. K., Boniface, S., Tang, J. L., & Milenković, D. (2018). Low cigarette consumption and risk of coronary heart disease and stroke: meta-analysis of 141 cohort studies in 55 study reports. *BMJ (Clinical research ed.)*, *360*, j5855. https://doi.org/10.1136/bmj.j5855

Hazra, A., & Gogtay, N. (2016). Biostatistics Series Module 6: Correlation and Linear Regression. *Indian journal of dermatology*, *61*(6), 593–601. https://doi.org/10.4103/0019-5154.193662

Hermann, S., Rohrmann, S., Linseisen, J., May, A. M., Kunst, A., Besson, H., Romaguera, D., Travier, N., Tormo, M.-J., Molina, E., Dorronsoro, M., Barricarte, A., Rodríguez, L., Crowe, F. L., Khaw, K.-T., Wareham, N. J., van Boeckel, P. G., Bueno-de-Mesquita, H. B., Overvad, K., … Peeters, P. H. (2011). The association of education with body mass index and waist circumference in the EPIC-PANACEA study. *BMC Public Health*, *11*(1), 169. https://doi.org/10.1186/1471-2458-11-169

Hohos, N. M., & Skaznik-Wikiel, M. E. (2017). High-Fat Diet and Female Fertility. *Endocrinology*, *158*(8), 2407–2419. https://doi.org/10.1210/en.2017-00371

Huang, Z., Wang, G., Jonas, J. B., Ji, C., Chen, S., Yuan, Y., Shen, C., Wu, Y., & Wu, S. (2021). BP control and progression of arteriosclerosis in hypertension. *Journal of hypertension*, *39*(6), 1221–1229. https://doi.org/10.1097/HJH.0000000000002758

Izzo, J. L., Jr, Levy, D., & Black, H. R. (2000). Clinical Advisory Statement. Importance of systolic BP in older Americans. *Hypertension (Dallas, Tex. : 1979)*, *35*(5), 1021–1024. https://doi.org/10.1161/01.hyp.35.5.1021

James, G. D., & Gerber, L. M. (2018). Measuring arterial BP in humans: Auscultatory and automatic measurement techniques for human biological field studies. *American journal of human biology : the official journal of the Human Biology Council*, *30*(1), 10.1002/ajhb.23063. https://doi.org/10.1002/ajhb.23063

Jiang, Y., Wang, J., Wu, S., Li, N., Wang, Y., Liu, J., Xu, X., He, Z., Cheng, Y., Zeng, X., Wang, B., Zhang, C., Zhao, M., Su, Z., Guo, B., Yang, W., & Zheng, R. (2019).

Association between Take-Out Food Consumption and Obesity among Chinese University Students: A Cross-Sectional Study. International journal of environmental research and public health, 16(6), 1071. https://doi.org/10.3390/ijerph16061071

Jones, D. W., & Clark, D. C., 3rd (2020). Hypertension (BP) and Lifetime Risk of Target Organ Damage. *Current hypertension reports*, *22*(10), 75. https://doi.org/10.1007/s11906-020-01086-6

Kelli, H. M., Mehta, A., Tahhan, A. S., Liu, C., Kim, J. H., Dong, T. A., Dhindsa, D. S., Ghazzal, B., Choudhary, M. K., Sandesara, P. B., Hayek, S. S., Topel, M. L., Alkhoder, A. A., Martini, M. A., Sidoti, A., Ko, Y. A., Lewis, T. T., Vaccarino, V., Sperling, L. S., & Quyyumi, A. A. (2019). Low educational attainment is a predictor of adverse outcomes in patients with coronary artery disease. *Journal of the American Heart Association*, *8*(17). https://doi.org/10.1161/jaha.119.013165

Kubota, Y., Heiss, G., MacLehose, R. F., Roetker, N. S., & Folsom, A. R. (2017). Association of Educational Attainment With Lifetime Risk of Cardiovascular Disease: The Atherosclerosis Risk in Communities Study. *JAMA internal medicine*, *177*(8), 1165–1172. https://doi.org/10.1001/jamainternmed.2017.1877

Lahaye, S., Regpala, S., Lacombe, S., Sharma, M., Gibbens, S., Ball, D., & Francis, K. (2014). Evaluation of patients' attitudes towards stroke prevention and bleeding risk in atrial fibrillation. *Thrombosis and haemostasis*, *111*(3), 465–473. https://doi.org/10.1160/TH13-05-0424

Langille, D. B., Joffres, M. R., MacPherson, K. M., Andreou, P., Kirkland, S. A., & MacLean, D. R. (1999). Prevalence of risk factors for cardiovascular disease in Canadians 55 to 74 years of age: results from the Canadian Heart Health Surveys, 1986-1992. CMAJ :

Canadian Medical Association journal, 161(8 Suppl), S3–S9.

Lee, H., & Son, Y. J. (2019). Influence of Smoking Status on Risk of Incident Heart Failure: A Systematic Review and Meta-Analysis of Prospective Cohort Studies. International journal of environmental research and public health, 16(15), 2697. https://doi.org/10.3390/ijerph16152697

Leshargie, C. T., Alebel, A., Kibret, G. D., Birhanu, M. Y., Mulugeta, H., Malloy, P., Wagnew, F., Ewunetie, A. A., Ketema, D. B., Aderaw, A., Assemie, M. A., Kassa, G. M., Petrucka, P., & Arora, A. (2019). The impact of peer pressure on cigarette smoking among high school and university students in Ethiopia: A systemic review and meta-analysis. PloS one, 14(10), e0222572. https://doi.org/10.1371/journal.pone.0222572

Liu, S. Y., Buka, S. L., Linkletter, C. D., Kawachi, I., Kubzansky, L., & Loucks, E. B. (2011). The association between BP and years of schooling versus educational credentials: Test of the sheepskin effect. *Annals of Epidemiology*, *21*(2), 128–138. https://doi.org/10.1016/j.annepidem.2010.11.004

Lunau, T., Siegrist, J., Dragano, N., & Wahrendorf, M. (2015). The association between education and work stress: does the policy context matter?. *PloS one*, *10*(3), e0121573. https://doi.org/10.1371/journal.pone.0121573

Lusis A. J. (2000). Atherosclerosis. *Nature*, *407*(6801), 233–241. https://doi.org/10.1038/35025203

Mosli, H. H., Kutbi, H. A., Alhasan, A. H., & Mosli, R. H. (2020). Understanding the Interrelationship between Education, Income, and Obesity among Adults in Saudi Arabia. *Obesity facts*, *13*(1), 77–85. https://doi.org/10.1159/000505246

Morris, D. A., Johnson, K. S., Ammarell, N., Arnold, R. M., Tulsky, J. A., & Steinhauser, K. E. (2012). What is your understanding of your illness? A communication tool to explore patients' perspectives of living with advanced illness. Journal of general internal medicine, 27(11), 1460–1466. https://doi.org/10.1007/s11606-012-2109-2

Neaton, J. D., & Wentworth, D. (1992). Serum cholesterol, BP, cigarette smoking, and death from coronary heart disease. Overall findings and differences by age for 316,099 white men. Multiple Risk Factor Intervention Trial Research Group. *Archives of internal medicine*, *152*(1), 56–64.

Ortega, F. B., Lavie, C. J., & Blair, S. N. (2016). Obesity and Cardiovascular Disease. *Circulation research*, *118*(11), 1752–1770. https://doi.org/10.1161/CIRCRESAHA.115.306883

Ramôa Castro, A., Oliveira, N. L., Ribeiro, F., & Oliveira, J. (2017). Impact of educational interventions on primary prevention of cardiovascular disease: A systematic review with a focus on physical activity. The European journal of general practice, 23(1), 59–68. https://doi.org/10.1080/13814788.2017.1284791

Ricceri, F., Sacerdote, C., Giraudo, M. T., Fasanelli, F., Lenzo, G., Galli, M., Sieri, S., Pala, V., Masala, G., Bendinelli, B., Tumino, R., Frasca, G., Chiodini, P., Mattiello, A., & Panico, S. (2016). The Association between Educational Level and Cardiovascular and Cerebrovascular Diseases within the EPICOR Study: New Evidence for an Old Inequality Problem. *PloS one*, *11*(10), e0164130. https://doi.org/10.1371/journal.pone.0164130

Statistics Canada. (2018). Overweight and obese adults, 2018. https://www150.statcan.gc.ca/n1/pub/82-625-x/2019001/article/00005-eng.htm

Statistics Canada. (2019). Postsecondary graduates, by location of residence at interview and level of study. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710003101

Strandberg, T. E., & Pitkala, K. (2003). What is the most important component of BP: systolic, diastolic or pulse pressure?. *Current opinion in nephrology and hypertension*, *12*(3), 293–297. https://doi.org/10.1097/00041552-200305000-00011

Vecchié, A., Dallegri, F., Carbone, F., Bonaventura, A., Liberale, L., Portincasa, P., Frühbeck, G., & Montecucco, F. (2018). Obesity phenotypes and their paradoxical association with cardiovascular diseases. European journal of internal medicine, 48, 6–17. https://doi.org/10.1016/j.ejim.2017.10.020

Vitale, C., Spoletini, I., & Rosano, G. M. (2018). Frailty in Heart Failure: Implications for Management. Cardiac failure review, 4(2), 104–106. https://doi.org/10.15420/cfr.2018.22.2

Wu, C. Y., Hu, H. Y., Chou, Y. J., Huang, N., Chou, Y. C., & Li, C. P. (2015). High Blood Pressure and All-Cause and Cardiovascular Disease Mortalities in Community-Dwelling Older Adults. Medicine, 94(47), e2160. https://doi.org/10.1097/MD.0000000000002160

Xiuyun, W., Qian, W., Minjun, X., Weidong, L., & Lizhen, L. (2020). Education and stroke: evidence from epidemiology and Mendelian randomization study. Scientific reports, 10(1), 21208. https://doi.org/10.1038/s41598-020-78248-8

Xue Q. L. (2011). The frailty syndrome: definition and natural history. *Clinics in geriatric medicine*, *27*(1), 1–15. https://doi.org/10.1016/j.cger.2010.08.009

Zhao, Y., Xiang, L., Liu, Y., Niu, M., Yuan, J., & Chen, H. (2018). Atherosclerosis Induced by a High-Cholesterol and High-Fat Diet in the Inbred Strain of the Wuzhishan Miniature Pig. *Animal biotechnology*, *29*(2), 110–118. https://doi.org/10.1080/10495398.2017.1322974

The Role of Sun Exposure during Work and Leisure Activities and How it Correlates with the Risk of Skin Cancer and the Frequency of Sunscreen Usage

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Does sun exposure during work or leisure activities in the months of June to August have a positive correlation in causing skin cancer in males and females aged 15 to 65 or more years old in Canada and the frequency of sunscreen use?

The first instinct when there is a high UV index is to grab a beach towel and lay out for hours with the sun beating down. However, the thought of skin damage rarely crosses one's mind when tanning is the focus. The majority of the population knows that sunscreen is a key component when focusing on the ability to protect your skin from the harsh UV-rays (Nahar, 2016). Sunscreen contains a variety of different SPF (sun protection factor) levels. Studies have shown that sunscreens with an SPF ≥ 15 are greatly recommended over lower SPF levels (Autier, Boniol, & Doré, 2007). SPF levels generally correlate with individuals' pigmentation within their skin. A study showed that lighter skin pigmentation has a strong correlation with sunburns compared to darker skin pigmentation (Watts et al., 2018). A study identified that individuals who frequently use sunscreen are likely to burn more often when sunscreen is not applied due to the development of higher sun sensitivity (Autier, Boniol, & Doré, 2007). Experiments determined that sunscreen in addition to preventing sunburns, has the capability of reducing UV-induced skin lesions; skin cancer (Autier, Boniol, & Doré, 2007). It has been known that the risk of skin cancer has a higher chance of developing due to long durations of being exposed to the sun. Longer durations of sun exposure can occur during intentional (tanning) or unintentional (overcast day) activities and sunscreen is used more frequently during intentional activities (Autier, Boniol, & Doré, 2007). No matter the skin type being exposed to the sun through tanning, there is still an excessive amount of sun exposure that causes temporary change of skin tone (Idowu & Markiewicz, 2020). Therefore, whether your activity is intentional or unintentional, sunscreen should always be applied. Even though you can not see the sun, the potential of getting burned and causing damage to your skin can still arise. When looking at skin cancer due to sun exposure we see a pattern between males and females. Males typically contract cutaneous melanoma (CM) more than females do, due to ultraviolet light index (UVI) rays that they are exposed to (Liu-Smith et al., 2017). Melanoma in females typically shows a low association with UVI rays that they are exposed to. This could be because females have a higher frequency of using cosmetics on their face and many products have SPF in them to protect against the ultraviolet light index (Liu-Smith et al., 2017). Females are also more likely to use sunscreen on a daily basis to protect their skin, making them have a protected layer against the UVI. When looking at geographical location we see there is a difference in the incidence of melanoma depending on where you are living and what the UVI typically is on a day to day basis. People tend to be darker in more tropical places near the equator from the higher UV index compared to those that are further from the equator (Markiewicz & Idowu, 2020); which can damage people's skin pigments when traveling to tropical places from different demographics. However, when we look at the age association we see melanoma cases rise over the period of a life span. UVI was only responsible for 2% of cases of melanoma in females, 33% of cases in males, and about 13-15% of the entire population (Liu-Smith et al., 2017). It is important to consider these factors when you are exposed to the sun and to ensure that you protect your skin, especially if you are a male. When looking at the difference between genders in regards to developing melanoma we need to provide some background to the genetics and inheritability of skin cancer. Firstly, close to 10% of melanomas are inherited by mutations in the body's reproductive cell DNA (Ransohoff et al., 2016). Therefore, melanoma will pass down throughout a family's DNA. The DNA sequences found in each ethnic group contains variations of skin pigmentation that is determined by the different amounts of melanin found in the body

(Markiewicz & Idowu, 2020). Additionally, phenotypic traits like fair skin, freckles and red hair can increase the risk of melanoma by 2 to 3 times (Ransohoff et al., 2016). Furthermore, there are three different genetic mechanisms that can increase overall cancer risk. One being the activation of oncogenes, this specifically promotes cell proliferation, increasing tumor risk (Ransohoff et al., 2016). Next, genetic silencing and alterations in tumor suppressor genes lead to mutated proteins that fail at limiting cellular growth (Ransohoff et al., 2016). Lastly, mutations and inactivation of genes like BRCA1 and BRCA2 lead to predisposition of many types of cancer. It is evident that genetics plays a role in developing melanoma, with 5% to 12% of melanoma diagnoses being hereditary (Ransohoff et al., 2016). Overall, when focusing on the frequent use of sunscreen, gender and genetics it is noticeable that they are all linked to early stages of developing skin cancer in the long run (Markiewicz & Idowu, 2020).

Current literature provides data that shows the differences in behaviour correlated with UV exposure and how it has a great influence in the risk of developing skin cancer. However, there is very limited information about the relationship between UV exposure patterns and indoor work and/or leisure activities. It is shown that no matter if the individual is outside or inside their skin is still exposed to UV radiation however, to a lower degree if they are inside. What is not very well discovered is that the development of skin cancer can also come from a lower degree or indirect exposure from the sun during certain activities. However, from studies looking into the location of where individuals are performing certain activities, it has been found that outdoor activities have a significantly higher risk of causing skin cancer compared to indoor activities (Thieden et al., 2005). In order to move forward from this, people who tend to work or do leisure activities outdoors should; take frequent breaks indoors and apply sunscreen more often, to block the UV exposure at different time periods when the UV index is at its highest.

Methods

Study Design and Database

The design for the study was a cross-sectional observational study that was carried out with the information from our Odesi dataset. Odesi is a large database that contains thousands of datasets, this was used to find the primary research study which provided the information and variables used. The dataset captured information regarding sun exposure and other descriptive variables by using a large computer-assisted telephone interview completed by over 4000 people living within Canada. Statistics Canada were the primary investigators that completed this survey. The data in the survey was collected for approximately 5 weeks from September 1996 to November 1996. The main focus of the survey was to expand knowledge and gather information about Candians over the age of 15, and their responses to sun exposure. These responses included their mental thoughts about sun exposure and how they portrayed these thoughts in their daily behaviours. Our mission with this information is to explore if sun exposure correlates with the development of skin cancer in males or females, and the frequency of sunscreen use.

Study Participants

The study consists of seven variable groups; sun exposure questions, protective behaviour, attitudes-protection, background, demographics, derived variables, and sun exposure. Individuals aged 15-65 years old who lived in Canada were included in this study. Residents who lived in the Yukon and Northwest territories were excluded from this study. As well as individuals that lived in institutions on a full time basis; such as retirement homes and households that did not have an accessible phone in the home. There were approximately 3% of households that did not contain phones and these were accounted for by using survey estimates.

Study Outcomes

The primary outcome of the study examined the comparison between males and females and the amount of sunscreen applied between each group, and the impact it had with the amount of sun exposure during work or leisure activities. The responses collected were number based and were plotted on two bar graphs. One bar graph compares sun exposure at work to the daily duration of work, with separating the data based on the sex of the individual. While the other bar graph compares sun exposure during leisure hours to the leisure activities and were also separated based on sex. The secondary outcome of the study examined each valid participants' genetic history and compared their genetic history to being diagnosed with skin cancer. The genetic history of each participant consisted of looking at their country of birth, hair colour, and inner arm colour. An additional outcome that was examined was the comparison of males and females' concern levels with their skin being exposed to the sun. For all of the outcomes found, the data collected is categorical. Therefore, the kinds of categories formed had data that is considered as 'missing data', such as "valid skip", "don't know", "refused", or "not stated". These variables were not included in our study, but were still found in the database itself.

Additional Data Collection

There were numerous variables that were included in our representation of the dataset. The majority of them were used to figure out how the participants in the study were dealing with sun exposure. For example the frequency of avoiding sun while at work. This variable was included to gather further knowledge on whether participants that worked outside had the intention of avoiding the sun when possible. Similarly, to understand participants' behaviour towards sun exposure we looked at whether or not participants attempted to avoid the sun at leisure, and if they were concerned about sun exposure. Additionally, we included variables such as country of birth, natural hair colour and natural skin colour of inner arm. This was done to assess differences between participants' physical demographics, in case there was a relationship between these variables and skin cancer. Two more variables that were used were if participants' relatives had ever been diagnosed with skin cancer or if the participants themselves had ever been diagnosed. These variables are important in order to expand our knowledge when looking at the heritability of skin cancer. Lastly, we looked at the frequency of sunscreen being applied and the SPF that the participants normally used. These variables were used to assess whether the participants had good habits with sunscreen use when being exposed to the sun, and if this correlated with the risk of skin cancer.

Statistical Analysis

The central tendency that was measured with the following dataset was frequency. In the SPSS data given regarding the research question there were only categorical variables. Therefore, no table of normality was assigned leading to the measurement of frequency. Data was summarized throughout our table 1 showing the comparison of frequencies of different variables between males and females. Frequency measured the amount of times individuals chose a certain answer for a particular variable. Spearman's *rho* was run on 5 categorical variables in the dataset. This was used to gather results on the correlation between the number of participants who answered the questions in the survey, and those participants' genetic history. This analysis was also used to gather results on the correlation between the diagnosis of skin cancer and participants genetic history. These analyses were run through SPSS and a significance level of <.01 was considered statistically significant.

Results

Prior to running the analyses, the data was reformed by deleting missing data. The data that was deleted either did not pertain to our research question or was because participants answered with ‘Not stated’, ‘Valid skip’ or ‘Do not know’. Specifically, we used our independent and dependent variables and filtered out the data based on the answers that were provided. There were 4023 participants included in the start of the study, after the missing data was deleted 146 participants remained; which included 20 variables in total, one being the participant ID number.

Table 1: Comparison of Demographics of Females and Males (n=146)

	Females (*n*= 43)	**Males** (*n*= 103)
Frequency of Age Group	Age 15-19 (*n=8*) Age 20-24 (*n=6*) Age 25-34 (*n=11*) Age 35-44 (*n=7*) Age 45-54 (*n=5*) Age 55-64 (*n=3*) Age 65 or more (*n=3*)	Age 15-19 (*n=6*) Age 20-24 (*n=9*) Age 25-34 (*n=28*) Age 35-44 (*n=27*) Age 45-54 (*n=22*) Age 55-64 (*n=10*) Age 65 or more (*n=1*)
Frequency of avoiding sun 11am-4pm at work	Always (*n=1*) Often (*n=9*) Sometimes (*n=13*) Rarely (*n=11*) Never (*n=9*)	Always (*n=4*) Often (*n=20*) Sometimes (*n=17*) Rarely (*n=28*) Never (*n=34*)
Frequency of avoiding sun 11am-4pm at leisure	Always (*n=1*) Often (*n=8*) Sometimes (*n=11*) Rarely (*n=6*) Never (*n=4*)	Always (*n=8*) Often (*n=22*) Sometimes (*n=31*) Rarely (*n=20*) Never (*n=15*)
Country of Birth	Canada (*n=40*) United States (*n=0*) United Kingdom (*n=2*) Other European (*n=0*) Asia-India (*n=1*) South America-Caribbean (*n=0*) Other (*n=0*)	Canada (*n=95*) United States (*n=1*) United Kingdom (*n=4*) Other European (*n=1*) Asia-India (*n=1*) South America-Caribbean (*n=0*) Other (*n=1*)
Frequency of sun exposure	Work sun 30min > day (*n=43*)	Work sun 30min > day (*n=103*)

at work	Work sun 30min< day (*n=0*) Did not work outdoor (*n=0*)	Work sun 30min< day (*n=0*) Did not work outdoor (*n=0*)
Frequency of sun exposure during leisure hours	Least 30min day, sun (*n=30*) Less 30min day, sun (*n=13*)	Least 30min day, sun (*n=96*) Less 30min day, sun (*n=7*)
Frequency of not being concerned about sun exposure*	Agree (*n=8*) Disagree (*n=35*)	Agree (*n=29*) Disagree (*n=73*)
Frequency of natural skin colour of inner arm	Light skin (*n=24*) Medium (*n=17*) Dark (*n*=2)	Light skin (*n=37*) Medium (*n=51*) Dark (*n=15*)
Frequency of hair colour	Blonde (*n=11*) Red (*n=3*) Light brown (*n=14*) Dark brown (*n*=12) Black (*n=3*)	Blonde (*n=11*) Red (*n=4*) Light brown (*n=43*) Dark brown (*n=38*) Black (*n=7*)
Frequency of relatives ever having skin cancer	Yes (*n=21*) No (*n=22*)	Yes (*n=64*) No (*n=39*)
Frequency of ever being diagnosed with skin cancer	Yes (*n=3*) No (*n=40*)	Yes (*n=6*) No (*n=97*)
Frequency of sunscreen use on body	Always (*n=9*) Often (*n=13*) Sometimes (*n=5*) Rarely (*n=7*) Never (*n=9*)	Always (*n=11*) Often (*n=10*) Sometimes (*n=15*) Rarely (*n=10*) Never (*n=57*)
Frequency of SPF usually used on body*	Less than 15 (*n=4*) 15-25 (*n*=15) More than 25 (*n=9*)	Less than 15 (*n=7*) 15-25 (*n*=22) More than 25 (*n=18*)

Table 1 summarizes the comparison of demographics of both females and males. The comparison identified that females and males tend to have similar demographics but are different in terms of genetics, frequency of using sunscreen and avoidance of sun exposure. Males on average tend to have medium skin pigmentation compared to females who have light skin pigmentation. In addition, females generally always use sunscreen whereas males on average never use sunscreen. Another difference is during the highest peak of the sun (11am-4pm) females typically work indoors whereas males generally work outdoors.
*means that variable has missing data (valid skip, not stated or do not know)

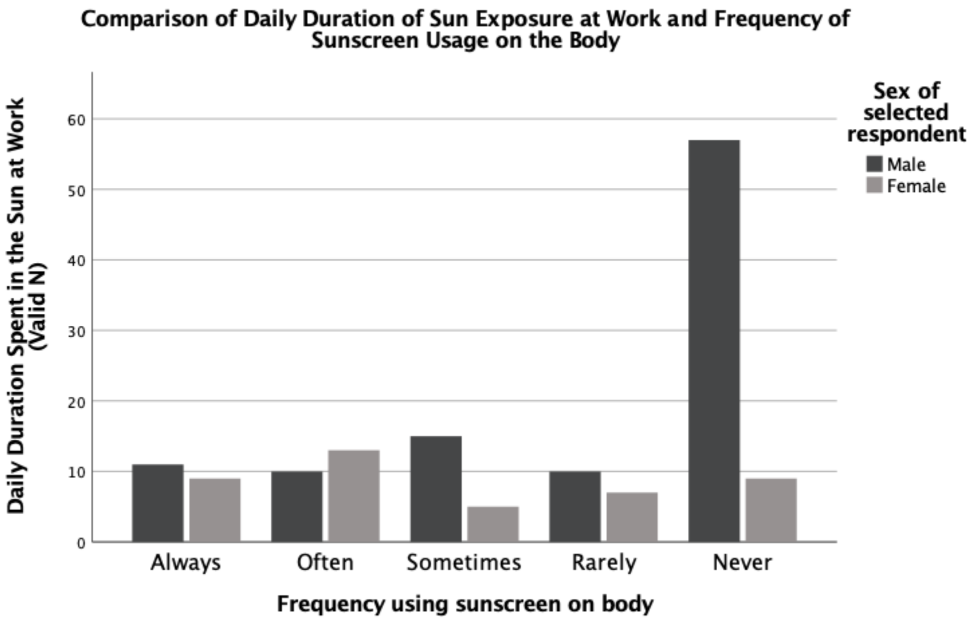

Figure 1. Clustered Bar Graph of Daily Duration of Sun Exposure at Work and Frequency of Sunscreen Usage on the Body Compared between Females and Males.
Participants were given five categories to choose from for the frequency of sunscreen used on the body based on the duration spent in the sun during work activities. A clustered bar graph was used to compare males and females while examining the comparison between the frequency of sunscreen usage on the body and the duration spent in the sun during work activities. The units on the y-axis represent the number of participants within each category.

The first part of the primary outcome to determine the frequency of sunscreen used on the body between males and females who were exposed to sun at work. A clustered bar graph was conducted to visualize the comparison between the frequency of sunscreen used on the body to the duration of time in the sun at work (Figure 1).

A significantly high proportion of males do not apply sunscreen when reporting to be spending the most amount of time in the sun working. In contrast, females tend to use sunscreen more frequently (“often”) when spending most of their time in the sun, working as well. There is an inverse proportional relationship between males applying sunscreen during the shorter hours outside working compared to females, who have a proportional relationship of applying sunscreen during the longer hour of working outside.

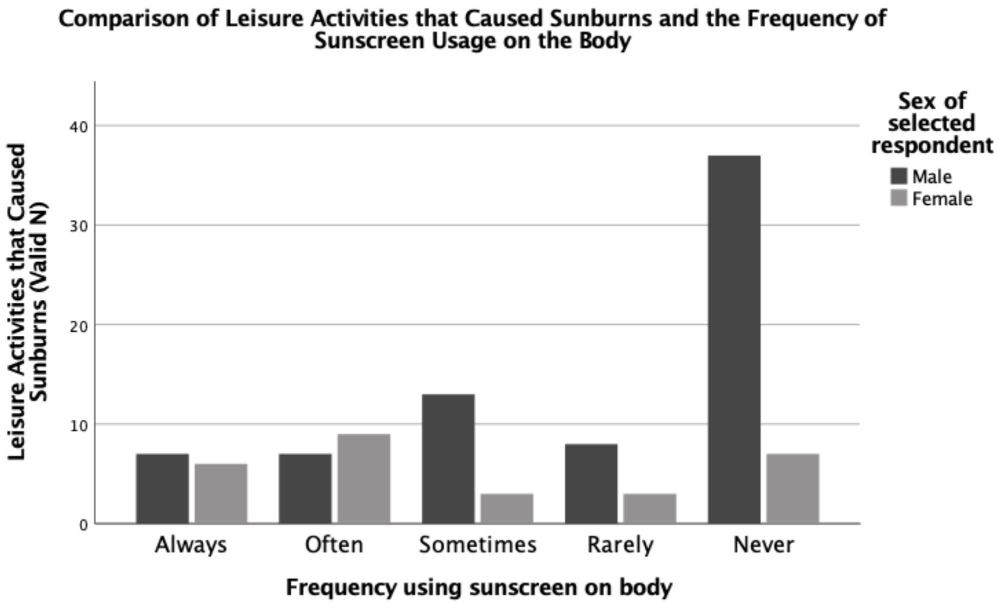

Figure 2. Clustered Bar Graph of Leisure Activities that Caused Sunburns and Frequency of Sunscreen Usage on the Body Compared between Females and Males.
Participants were given five categories to choose from for the frequency of sunscreen used on the body based on the leisure activities they performed in that caused sunburns. A clustered bar graph was conducted to compare males and females while examining the comparison between the frequency of sunscreen usage on the body and the duration spent in the sun during work activities. The units on the y-axis represent the number of participants within each category.

The first part of the primary outcome to determine the frequency of using sunscreen between males and females who were exposed to the sun during leisure activities that caused sunburns. A clustered bar graph was conducted to visualize the comparison between the frequency of sunscreen used on the body to the leisure activities that caused sunburns.

A major trend shown is that an extremely large amount of males never used sunscreen when it comes to leisure activities that caused sunburns. Majority of the male participants either sometimes, rarely or never used sunscreen compared to females who mainly always or often use sunscreen when partaking in leisure activities that caused sunsburns.

Table 2. Correlation of Participants asked Ever Diagnosed with Skin Cancer and their Genetic History

	Ever Diagnosed with Skin Cancer	
Genetic History with:	r	*p* value
Country of Birth	-0.153	0.066
Natural Hair Colour	0.222**	0.007
Natural Skin Colour of Inner Arm	0.029	0.725

Participants who answered yes and no to the ever diagnosed with skin cancer survey question were included. A Spearman Rho correlation was conducted between the number of participants who answered the question and those participants' genetic history; country of birth, natural hair colour, and natural skin colour of inner arm. ** means that the correlation is statistically significant at the 0.01 level (2-tailed)

To analyze the secondary outcome, a Spearman Rho correlation test was conducted between the survey question on diagnosis of skin cancer and the genetic history of the participants (Table 2). A weak negative correlation was found between the survey question and the birth country of those participants (r_s = -0.153, p = 0.066). A positive correlation was found between the survey question and the natural hair colour of the participants (r_s = 0.222, p = 0.007); the correlation is statistically significant.

Table 3. Comparison of the Prevalence of Males and Females Not concerned about Sun Exposure

	Prevalence n(%)	
	Female	Male
Concerned	35 (81.4%)	73 (71.6%)
Not Concerned	8 (18.6%)	29 (28.4%)

Note. Only 43 females and 102 males were included. One male participant was excluded since he answered with ‘do not know’. Values are reported as frequency (valid percent %).

The prevalence of females and males in regards to their concern about sun exposure to their skin was analyzed to answer the additional outcome. It was found that 81.4% of females and 71.6% of males were concerned about sun exposure.

Discussion

Our main findings suggest that for males and females aged 15-65 or older, participating in either work and leisure activities during the months of June to August do not show a strong correlation with a risk of causing skin cancer. In the population of males, for both work and leisure activities majority of them never use sunscreen. Finally, our study found that more than 70% of both males and females are concerned about sun exposure.

Our findings are supported by existing literature, 'Ultraviolet Exposure Patterns of Irish and Danish Gardeners during Work and Leisure' by Thieden et al. (2005). The literature suggested that being directly exposed to UV radiation has a higher risk for developing skin cancer compared to being indirectly exposed. The researchers furthered their findings by explaining that even the individuals who are indirectly exposed to UV radiation still have a chance of developing skin cancer. These individuals still have a slight risk however, it is not as prominent as being consistently exposed to the sun's UV rays directly (Thieden et al., 2005).

Another study conducted by Wickenheiser et al. (2013) showed that males have a lack of concern in applying sunscreen (SPF) when spending long durations in the sun. Their findings align with our study; showing how frequently sunscreen is applied in relation to the duration spent in the sun. A limitation within this study explains that more research needs to be done to show the effectiveness between different sunscreen products, such as sunscreen sprays with UV radiation (Wickenheiser et al., 2013). Both studies provide additional information about our knowledge gap and results of our study, within the field of research done on sun exposure. The public, specifically males, are not fully aware of the detrimental effects UV radiation has on their health, especially when individuals are not taking precautions when exposed to the sun.

Our findings report that individuals' natural hair colour has a statistically significant correlation with the survey question, ‘ever diagnosed with skin cancer’ compared to country of birth which had a negative correlation. This association may be a result of the genetic aspect of the individual and the factor that different hair colours are more sensitive towards the UV rays of the sun. The occurrence of the variable natural skin colour of the inner arm having a moderate correlation was not expected, since fair skin tones compared to darker ones burn easier. Looking further into the correlation of the participants inner arm colour, that area typically receives less sun exposure than other parts of the body. Therefore, it showed minimal correlation towards the risk of skin cancer. The association between country of birth and the survey question may be a result of different geographical locations when the survey was conducted. Most participants within the study could have moved from their country of birth, therefore that factor would have no correlation with the risk of skin cancer occurring. However, our study fails to differentiate whether or not the participants who had been diagnosed with skin cancer or not, have a stronger correlation to the genetic history variables.

Our study reports when looking at the gender separately, females have a higher concern towards sun exposure compared to males within the age range of 15-65 or older. This association may be a result of the unbalanced number of participants within each gender; 103 males and 43 females. When looking at males and females within the entire population, males would have a higher percentage of participants who are concerned about sun exposure compared to females; 73/146 (50%) and 35/146 (24%), respectively. By having a smaller population of females compared to males, it caused bias among the prevalence of participants not concerned and concerned about sun exposure. The difference in prevalence between genders in terms of their concern towards sun exposure due to the occurrence of bias, was viewed as an additional outcome to provide further understanding of the participant population instead of a main outcome.

The variables used in the current study were categorical variables therefore, there were little to no continuous variables available. Also the nominal categorical variables were unable to be transformed into scale variables, which limited our abilities to run certain analyzes and graphical representations. When analyzing the participant population there was a split of 70% males and 30% females, which altered the results. The results were biased in a sense that there were higher percentages and frequencies for females because they had a smaller total population compared to males. The participant population of our study after manipulating our data set only contained 146 subjects. Going further, a larger population size is needed to determine if the findings are accurate and not biased. Our study contained limitations that were due to the type of variables and the size of the population the database contained, which have the ability to be fixed within future studies.

In the future, studies that collect continuous ordinal data would be useful for the purpose of running a Spearman's Rho analysis. This could be used to determine the correlation between genetic history and individuals who have been or have not been diagnosed with skin cancer. Additionally, running a study with a larger population would be beneficial for the use of analyses like the Chi-Squared test, to ensure each category contains enough participants. A larger population would also help with looking at individual age groups like children or elderly for example; to draw correlation between age groups and their sun exposure habits. As of now, the results obtained from our study can be used to further educate people that are outside often for work or leisure, on the risks that can cause skin cancer and the importance of sunscreen use.

References

Autier, P., Boniol, M., and Doré, JF. (2007, July) Sunscreen use and increased duration of intentional sun exposure: still a burning issue. *Int J Cancer. 121*(1), 1-5. DOI:https://doi.org/10.1002/ijc.22745

Idowu, O., Markiewicz, E. (2020). Melanogenic difference consideration in ethnic skin type: a balance approach between skin brightening applications and beneficial sun exposure. *Clinical, cosmetic and investigational dermatology*. *2020*(13), 215–232. DOI: https://doi.org/10.2147/CCID.S245043

Liu-Smith, F., Farhat, A., Arce, A., Ziogas, A., Taylor, T., Wang, Z., York, V., Liu, J., Wu, J., McEligot, A., Anton-Culver, H., & Meyskens, F. (2016, October). Gender differences in the association between the incidence of cutaneous melanoma and geographic UV exposure. *US National Library of Medicine National Institutes of Health. 76*(3)*,* 499-505. DOI: https://dx.doi.org/10.1016%2Fj.jaad.2016.08.027

Nahar, V. (2016, August). Utility of the information-motivation-behavioral skills model in measuring and predicting protection behaviors among skin cancer patients. *eGROVE*. 613. https://egrove.olemiss.edu/etd/613

Ransohoff, K., Jaju, Prajaka., Tang, J., Carbone, M., Leachman, S., Sarin, K. (2016, March). Familial skin cancer syndromes: increased melanoma risk. *Journal of the American Academy of Dermatology. 74*(3), 423-434. DOI: https://doi.org/10.1016/j.jaad.2015.09.07

Statistics Canada. (1996). Sun Exposure Survey, 1996 [Canada]: Study Documentation. *Statistics Canada*. http://odesi2.scholarsportal.info.libaccess.lib.mcmaster.ca/webview/

Thieden, E., Collins, S. M., Philipsen, P. A., Murphy, G. M., & Wulf, H. C. (2005). Ultraviolet exposure patterns of Irish and Danish gardeners during work and leisure. *The British journal of dermatology*, *153*(4), 795–801. https://doi.org/10.1111/j.1365-2133.2005.06797.x

Watts, C., Drummond, M., Goumas, C., Schmin, H., Armstrong, B., Aitken, J., Jenkins, M., Giles, G., Hopper, J., Mann, G., Cust, A. (2018, September). Sunscreen use and melanoma risk among young Australian adults. *JAMA Dermatology.. 154*(9), 1001-1009. DOI: 10.1001/jamadermatol.2018.1774

Wickenheiser, M., Baker, M. K., Gaber, R., Blatt, H., & Robinson, J. K. (2013). Sun protection preferences and behaviors among young adult males during maximum ultraviolet radiation exposure activities. *International journal of environmental research and public health*, *10*(8), 3203–3216. https://doi.org/10.3390/ijerph10083203

Examining the correlation between the prevalence of CVD, risk factors and marital status amongst Canadian men: A cross-sectional cohort study

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1. Introduction

Cardiovascular diseases (CVD) are a group of diseases that affect both the heart and blood vessels. CVDs include but are not limited to strokes, arrhythmias, heart attacks and myocardial infarctions. The prevalence of CVD amongst a population can be greatly attributed to specific sociodemographic factors such as age, sex, marital status, lifestyle choices such as tobacco use and income (Wang et al., 2020).

According to a study completed by Wang et al. (2020), marriage has been found to reduce unhealthy behaviors such as substance abuse and increased stress. They studied the relationship between marital status and CVD prevalence amongst both men and women. The results stated that marital status is associated with an increase in CVD mortality (Wang et al., 2020). Particularly, evidence suggested that men have a greater CVD prevalence and mortality when compared to women (Wang et al., 2020). This can be linked with the finding that marital status, in specific, being married, had a greater positive correlation with men’s overall health when compared to women (Wang et al., 2020). Unmarried, divorced, or widowed men had a greater susceptibility to CVD (Wang et al., 2020). The increase in CVD amongst men can be explained by its underlying association with marital status and changes in societal attitude towards marriage which were considered by Wang et al., (2020).

The impact of smoking on the human body has been associated with several mechanisms that potentially increase the risk of CVD, including vascular dysfunction, progression of atherosclerosis, and the development of thrombi (Erhardt, 2009). The level of exposure and duration of smoking is also a crucial factor to consider when determining the effect smoking has on the prevalence of CVD. Smoking has been associated with increasing the risk of myocardial infarction by 5.6% for every additional cigarette smoked per day (Erhardt, 2009). Exposure to environmental tobacco in non-smokers is also a risk factor of CVD. Smoking has been identified as one of six major modifiable risk factors of CVD that have resulted in twice as many deaths when compared to lung cancer and respiratory diseases (Erhardt, 2009). While it has been observed that CVD became more prevalent with age, the risk of a heart attack in smokers younger than 50 years old is at least five times greater than smokers above 60 years old (Erhardt, 2009)..

Additionally, a study conducted by Dhindsa et al. (2020), found that stronger financial support can play a crucial role in the CVD prevalence and mortality rates amongst men. Dhindsa et al. (2020), argued that men had a greater risk of CVD when widowed as they are less likely to benefit from government resources when compared to widowed women. Additionally, researchers at the University of Saskatchewan determined why income amongst unmarried men caused worse outcomes upon CVD prognosis (Lemstra et al., 2015). They determined the rates of heart disease amongst Canadians to be 17.9% of lower and lower-middle-income residents, 5.2% of upper-middle-income and 2.9% of high-income residents (Lemstra et al., 2015). Evidence suggests that these rates are caused by financial stress that is prevalent amongst those living in lower-income households (Lemstra et al., 2015).

Through our research, we found that current publications on the prevalence of CVD report that men have a greater susceptibility to CVD when compared to women. However, there is little known about the impact of these risk factors amongst different age groups of men. In particular, the studies we analyzed recruited a general population that included men and women of all age groups. In our study, we aimed to investigate the association of CVD risk factors and the prevalence of CVD amongst specific age groups of men. We targeted married and unmarried men who are 35 to 64 years of age, inclusive, in order to determine how risk factors can play a crucial role in the onset of CVD amongst the age groups of interest. Particularly, within our literature review, we found that current publications did not analyze the correlation between marital status amongst target age groups of men and smoking paraphernalia. While there are studies that explore the mechanisms behind this, little is known about the varying effects that different smoking paraphernalia can have on CVD. Our study aims to analyze the varying effects of cigarettes, cigars, and pipes on the risk of developing CVD. Furthermore, the prevalence of CVD has been associated with several demographic factors including income. The information obtained from our research will be beneficial to healthcare professionals when developing treatment plans or diagnosing a CVD based on the patient's age. Our study primarily focuses on if the type of smoking paraphernalia used (cigarettes, cigars, pipes) affects the prevalence of CVD in married Canadian men aged 35-64 years old, inclusive, compared to unmarried Canadian men aged 35-64 years old. Additionally, this research will also evaluate whether income (low, medium, and high levels of income) among married Canadian men aged 35-64 years old compared to unmarried Canadian men aged 35-64 years old affect the prevalence of CVD.

2. Method

This cross-sectional cohort study was conducted to analyze the relationship between Canadian men and the prevalence of CVD as a part of the LIFESCI 3LL3 assignment. To begin the study, we accessed the data portal via the Odesi database to collect the appropriate data required for our analysis. Then, we selected Health > CANADA > Canadian Heart Health Database and downloaded the data using SPSS format. We then used the IBM SPSS Statistics program (version 28.0.0.0) to sort appropriate data by filtering out unrelated data for this study such as diet or physical activity.

After analyzing the raw data from Odesi, we included only Canadian males between the age of 35 to 64 years old (n = 2783) who provided their marital status, information regarding smoking and income. The sample participants were then divided into two groups based on their marital status including the married group (2412 men) and the unmarried group (371 men). In addition, we restricted our database to males who provided information regarding their previous medical history, including whether they have had a stroke, heart attack or other heart diseases. We chose to exclude women from our study as they have lower smoking rates and benefit less from being married (Wang et al., 2020).

Within the Canadian Heart Health Database, data from ten Provincial Heart Health Surveys conducted from 1986 to 1992 were primarily assessed to analyze the prevalence of CVD risk factors amongst Canadians. Surveys are an effective method that allow for the collection of descriptive variables of a large population. Through this method, we were able to analyze specific data regarding variables to address the research question. The data from the Canadian Heart Health Database consisted of 16 individual sections which aimed to determine if demographics or specific lifestyle factors play a role in the diagnosis of CVD. Within our study, we chose to analyze whether different types of smoking paraphernalia (cigar, pipes, cigarettes) and income influence the prevalence of CVD amongst Canadian men from the age of 35 to 64.

Our primary research assessed correlation between smoking status amongst married and unmarried men, and the prevalence of CVD, by obtaining information regarding the smoking paraphernalia (cigars, pipes, cigarettes) that the participants used. Research conducted by Diez-Roux et al. (2000) mentioned a positive correlation between low income (annual household income is less than $25,000) and smoking, which is positively associated with an increased risk factor of CVD. In this large pool of data, we chose to look at gender (male only), age (35-64 years), level of income (low, middle, high), marital status (married or unmarried), pipe use (yes or no), cigar use (yes or no), cigarette use (yes or no), and the incidence of CVD (yes or no). Our primary outcome was the type of smoking paraphernalia and their prevalence on CVD and our secondary outcome was level of income. In addition, to determine the correlation between income and marital status, the participants were asked to indicate their current marital status (never married, married, widowed, separated, not stated) and income adequacy level which was categorized into low income, middle income and high income. Average household income was retrieved from the participants as they selected the range of their total gross household income (under $12000, $12000 - $24999, $25000 - $49999, $50000 and over, prefer not to answer). Smoking and income are important risk factors when considering one's susceptibility to CVD.

To study the relationship between the marital status of Canadian men types of smoking, level of income and the prevalence of CVD, we ran a Chi-squared test on the IBM Statistical Package for the Social Sciences (SPSS) statistics program. A Chi-squared test was used to analyze the relationship between the marital status of Canadian men aged 36-64 years old and the type of smoking paraphernalia used (cigarette, cigars, pipes). A chi-square test is used to determine the presence of an association among variables in the rows and columns of a contingency table (Singhal & Rana, 2015). The study used the chi-square test to evaluate whether there was a difference between the study groups in relation to the prevalence of CVD among the risk factors of interest (Singhal & Rana, 2015). The p-value for significance used for the Chi-square tests conducted in our study was 0.05, values below 0.05 were considered to be significant. Table 1 indicates the values that were depicted for each of the categorical variables, as well as the number of participants that provided valid data during the survey for the given variables.

3. Results

3.1 Marital Status and Prevalence of CVD

The Canadian Heart Health Database presented on Odesi Data Portal consisted of an original sample size of male and female respondents from the ages of 18 to 74, n = 23,129 (male, n= 11,376 and female, n=11,753). The participants of our study were males from the ages of 35 to 64 who provided information regarding age, income, marital status, type of smoking paraphernalia and cardiovascular health history (n= 2783) as shown in Table 1.

Descriptive variable	Value	Participant Count
SEX	1. Male	2783
AGE	Number	Minimum: 35 Median: 48 Maximum: 64 Range: 30 IQR: 17
INCOME	1. under $12,000	205
	2. $12,000 - $24,999	583
	3. $25,000 – 49,999	1108
	4. above $50,000	887
INCADEQ	1. Low	547
	2. Middle	1274
	3. High	962
MARRIAGE	0. Not currently married and/or no current common-law partner (e.g., never married, divorced, separated, widowed/widower)	371
	1. Currently married and/or current common-law partner	2412
PIPE	0. No	2665
	1. Yes	118
CIGAR	0. No	2635
	1. Yes	148
CIGET	0. No	1687
	1. Yes	1096
EVERCVD	0. No	2410
	1. Yes	373

Table 1. Descriptive Characteristics (Sex, Age, Income, Employment Status, Marital Status, Height & Weight) of Canadian Male Participants Between the age of 35-64 Years (n

= 2783). The data was obtained from the Canadian Heart Health Database on the Odesi Data Portal and analyzed on IBM SPSS Software.

3.2 Marital status and smoking

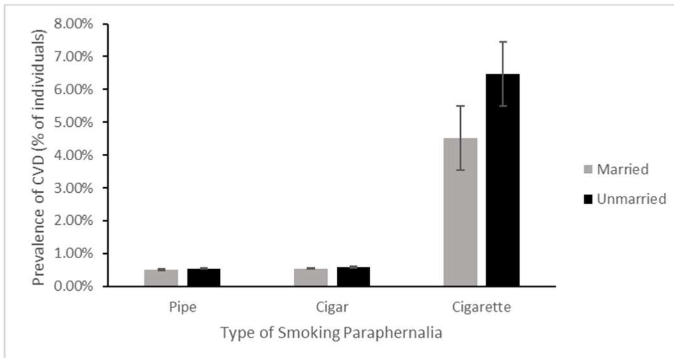

Figure 1. Analysis of the distribution of CVDs amongst Canadian men who smoke pipe, cigars, and/or cigarettes. The data for the graphs were retrieved from the Canadian Heart Health Database and analyzed on IBM SPSS (n=2873).

Figure 1 showed the percentage differences between the prevalence of CVD and different types of smoking. Those percentages were calculated the same way it was done for Figure 2. For Canadian men who smoke pipe, the married group showed 0.50%, whereas the unmarried group showed 0.54% with a standard deviation of 0.02%. For Canadian men who smoke cigars, the married group showed 0.54%, whereas the unmarried group shows 0.58% with a standard deviation of 0.02%. For Canadian men who smoke cigarettes, the married group showed 4.52%, whereas the unmarried group showed 6.47% with a standard deviation of 0.97%.

Chi-Square Tests

CURRENT MARRIAGE		Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
UNMARRIED	Pearson Chi-Square	.190[c]	1	.663		
	Fisher's Exact Test				1.000	.493
	N of Valid Cases	371				
MARRIED	Pearson Chi-Square	.124[d]	1	.725		
	Fisher's Exact Test				.880	.433
	N of Valid Cases	2412				
Total	Pearson Chi-Square	.251[a]	1	.616		
	Fisher's Exact Test				.782	.369
	N of Valid Cases	2783				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 15.82.
c. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.64.
d. 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.16.

Table 2. Chi-Square Analysis for the Relationship between Pipe Use and CVD Prevalence Amongst Married and Unmarried Canadian Men. This table reports the Pearson Chi-Square value of the 2- sided Asymptotic Significance (p-value) of the relationship between CVD prevalence and the use of pipes for smoking amongst married and unmarried men. The data was obtained from the Canadian Heart Health Database and analyzed on IBM SPSS (n=2873).

A 2×2 chi-square test was performed to examine the relationship between the marital status of Canadian men, the incidence of CVD, and the use of pipe in Table 2. The relationship between these variables for the married group was insignificant, X^2 (N = 2412) = 0.124, p = 0.725. Similarly, the relationship between these variables for the unmarried group was insignificant, X^2 (N = 371) = 0.190, p = 0.663.

Chi-Square Tests

CURRENT MARRIAGE		Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
UNMARRIED	Pearson Chi-Square	.855[c]	1	.355		
	Fisher's Exact Test				.555	.279
	N of Valid Cases	371				
MARRIED	Pearson Chi-Square	.380[d]	1	.538		
	Fisher's Exact Test				.681	.324
	N of Valid Cases	2412				
Total	Pearson Chi-Square	.905[a]	1	.341		
	Fisher's Exact Test				.387	.206
	N of Valid Cases	2783				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 19.84.
c. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.57.
d. 0 cells (.0%) have expected count less than 5. The minimum expected count is 16.25.

Table 3: **Chi-Square Analysis for the Relationship between Cigar Use and CVD Prevalence Amongst Married and Unmarried Canadian Men.** This table reports the Pearson Chi-Square value of the 2- sided Asymptotic Significance (p-value) of the relationship between CVD prevalence and the use of cigars for smoking amongst married and unmarried men. The data was obtained from the Canadian Heart Health Database and analyzed on IBM SPSS (n=2873).

A 2×2 chi-square test was performed to examine the relationship between the marital status of Canadian men, the incidence of CVD, and the use of cigars in Table 3. The relationship between these variables for the married group was insignificant, X^2 (N = 2412) = 0.380, p = 0.538. Similarly, the relationship between these variables for the unmarried group was insignificant, X^2 (N = 371) = 0.855, p = 0.355.

Chi-Square Tests

CURRENT MARRIAGE		Value	df	Asymptotic Significance (2-sided)
UNMARRIED	Pearson Chi-Square	.248[c]	1	.618
	N of Valid Cases	371		
MARRIED	Pearson Chi-Square	2.253[d]	1	.133
	N of Valid Cases	2412		
Total	Pearson Chi-Square	2.504[a]	1	.114
	N of Valid Cases	2783		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 146.89.

c. 0 cells (.0%) have expected count less than 5. The minimum expected count is 23.38.

d. 0 cells (.0%) have expected count less than 5. The minimum expected count is 121.16.

Table 4: **Chi-Square Analysis for the Relationship between Cigarette Use and CVD Prevalence Amongst Married and Unmarried Canadian Men.** This table reports the Pearson Chi-Square value of the 2- sided Asymptotic Significance (p-value) of the relationship between CVD prevalence and the use of cigarettes for smoking amongst married and unmarried men. The data was obtained from the Canadian Heart Health Database and analyzed on IBM SPSS (n=2873).

A 2×2 chi-square test was performed to examine the relationship between the marital status of Canadian men, the incidence of CVD, and the use of cigarettes in Table 4. The relationship between these variables for the married group was insignificant, X^2 (N = 2412) = 2.253, p = 0.133. Similarly, the relationship between these variables for the unmarried group was insignificant, X^2 (N = 371) = 0.248, p = 0.618.

3.3 Marital status and income

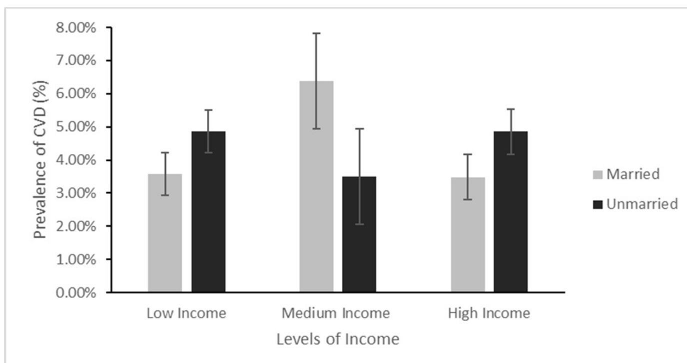

Figure 2. Analyzes the distribution of CVDs among Canadian men from low, medium high-income households. The bar graph created on MS Excel displays the distribution of CVDs among married and unmarried Canadian males from different levels of income.

Figure 2 showed the percentage differences between the prevalence of CVD and the level of income. Those percentages were calculated by dividing the number of positive cases by the total number of the population in that specific group and multiplying the result by one hundred percent (e.g. (86÷2412) × 100% = 3.57% for the married group with low income). For Canadian men with low income, the married group showed 3.57%, whereas the unmarried group showed 4.85% with a standard deviation of 0.64%. For Canadian men with medium income, the married group showed 6.38%, whereas the unmarried group showed 3.50% with a standard deviation of

1.44%. For Canadian men with high income, the married group showed 3.48%, whereas the unmarried group showed 4.85% with a standard deviation of 0.68%.

A 3×2 chi-square test was performed to examine the relationship between the marital status of Canadian men, the incidence of CVD, and the level of income. The relationship between these variables for the married group was significant, X^2 (N = 2412) = 19.297, p = <0.001. On the other hand, the relationship between these variables for the unmarried group was insignificant, X^2 (N = 371) = 5.358, p = 0.069.

Discussion

Our findings suggest that there is not adequate evidence to suggest a correlation between smoking paraphernalia, marital status, and the prevalence of CVD among our sample participants. Additionally, there is no correlation between the level of income, and the prevalence of CVDs for unmarried Canadian men aged 35 to 64 years. However, a significance was found between the level of income, and the prevalence of CVDs for married Canadian men aged 35 to 64 years.

A large prospective study conducted by Banks et al., (2019) concluded that there is a correlation between smoking and the risk of developing CVDs. Through this study, the researchers were able to identify that the risk of specific CVDs were doubled in participants with a history of smoking. The findings of our study differed from the findings of the study by Banks et al (2019) as it did not analyze the effect of varying types of smoking paraphernalia. The study by Banks et al., grouped the different types of smoking into one category because of the inadequate sample portion of participants that used pipes and cigars. Furthermore, the study by Banks et al (2019) population characteristics differed from our study as they analyzed males and females above the age of 45. The study specifically focused on 36 CVD subtypes whereas our study analyzed occurrences of any CVDs among our participants. Both studies were limited by the potential information bias of data collection as the methods were survey-based. Smoking has been identified as a known lifestyle risk factor for CVDs, however existing studies do not analyze the varying impacts of types of smoking paraphernalia on males aged 35 to 64. Through our data analysis we were able to provide evidence that there is not a significant association between smoking paraphernalia, marital status and the prevalence of CVDs.

According to a study conducted by Dhindsa et al. (2019), an association was identified between marital status and the risk of CVD. They indicated that men benefited greatly from being married as it decreased their susceptibility to CVD and improved their outcomes upon diagnosis (Dhindsa et al., 2019). The findings of our study differed from the study conducted by Dhindsa et al. (2019) as the researchers did not assess the effect of household income on the prevalence of CVD amongst married and unmarried men that are 35 to 64. The study reported the relationship between marital status and CVD prevalence that was found for both male and female participants while our study focused our research on men, who have a greater risk for CVD. In addition, Dhindsa et al. (2019), used different categories for marital status including married, divorced, widowed, separated, and never married, whereas our study combined the widowed, divorced, separated and never married into one category, unmarried. This created heterogeneity between our respective analyses, however, both studies analyzed the role of demographic factors and the risk of CVD but were limited as they were cross-sectional studies.

Another study by researchers at the University of Saskatchewan, analyzed demographic variables such as income, in relation to their effect on heart disease amongst Canadians. They determined that heart disease is increasingly prevalent amongst lower-income residents, whereas the evidence from our study was not adequate to suggest this relationship (Lemstra et al., 2015). The researchers from the University of Saskatchewan study obtained their information from participants through the same survey that was used in this study, the Canadian Community Health Survey (CCHS). Questions were asked in a similar manner, however there were additional variables that were included within this survey.

The first limitation of our research was a large gap between our group samples. After applying the inclusion and exclusion criteria, our sample population was reduced from 23,129 people to 2,783 people. The reduced sample population was then divided into two groups, which were the married Canadian men (n = 2412) and the unmarried Canadian men (n = 371). The population size of the married Canadian men group was over 6-fold greater than the comparison group, which made the statistical analysis more challenging to conduct with limited options. The second limitation of our research was a small age range and gender restriction in our sample participants (Canadian males aged 35 to 64 years). As a result, it made our research findings less generalizable to all Canadian populations and provide no indication of whether the level of income and different types of smoke influence Canadian men aged below 35 or above 64 as well as Canadian women. The study is limited by the use of surveys for data collection as it is self-reported (Ponto et al, 2015). Surveys can produce inaccurate results that do not represent the characteristics of the population studied as the responses are objective (Ponto et al, 2015). The results of the study are limited as it may not apply to the present general population as the data was collected in 1986-1992.

Researching the risk factors associated with CVD is significant as it allows us to consider the implications of income and preferred smoking paraphernalia that must be accounted for when providing primary care for patients who are susceptible to CVD. Further research is needed in this area as the results from our study suggested that there is not enough evidence to confirm a relationship between these variables. However, this result is due to limitations from the sample size of men in our study. In order to obtain further data and assess the relationship between income and preferred smoking paraphernalia amongst unmarried and married men, future studies should be observational and include a larger population of both unmarried and married men. The results from future studies can be analyzed through the use of the Chi-square test to determine if there is a statistically significant difference amongst the observed and expected values of these categorical groups.

Our research findings may be useful for family doctors, CVD specialists, and other healthcare providers to pay closer attention to married Canadian men between the age of 35 to 64 years who earn medium income for any early signs of CVD. However, our research findings did not provide enough evidence to conclude an association between marital status, the level of income, different types of smoking paraphernalia, and the prevalence of CVD. Therefore, additional research on this topic is needed to see the true correlation between those variables and other factors that contribute to an increase in the prevalence of CVD. Future researchers may use this study as a guideline or a starting point to further study different factors that contribute to CVD. It is essential for practitioners to detect and diagnose the early-onset cardiovascular vascular disease as it can lower the chance of developing further health complications and improve the quality of life for all patients.

References

Banks, E., Joshy, G., Korda, R. J., Stavreski, B., Soga, K., Egger, S., Day, C., Clarke, N. E., Lewington, S., & Lopez, A. D. (2019). Tobacco smoking and risk of 36 CVD subtypes: Fatal and non-fatal outcomes in a large prospective Australian study. *BMC Medicine*, *17*(1). https://doi.org/10.1186/s12916-019-1351-4

Canadian Heart Health Database Centre. (1992). Canadian Heart Health Database [ODESI].

Retrieved from http://odesi2.scholarsportal.info.libaccess.lib.mcmaster.ca/webview/

Dhindsa, D. S., Khambhati, J., Schultz, W. M., Tahhan, A. S., & Quyyumi, A. A. (2020). Marital status and outcomes in patients with CVD. *Trends in Cardiovascular Medicine*, *30*(4), 215–220. https://doi.org/10.1016/j.tcm.2019.05.012

Diez-Roux, A. V., Link, B. G., & Northridge, M. E. (2000). A multilevel analysis of income inequality and CVD risk factors. *Social Science & Medicine*, *50*(5), 673–687. https://doi.org/10.1016/s0277-9536(99)00320-2

Erhardt, L. (2009). Cigarette smoking: An undertreated risk factor for CVD. *Atherosclerosis*, *205*(1), 23–32. https://doi.org/10.1016/j.atherosclerosis.2009.01.007

Lemstra, M., Rogers, M., & Moraros, J. (2015). Income and heart disease: Neglected risk factor. *Canadian family physician Medecin de famille canadien*, *61*(8), 698–704. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4541436/

Ponto, PhD, APRN, AGCNS-BC, AOCNS®, J. (2015). Understanding and evaluating survey research. *Journal of the Advanced Practitioner in Oncology*, *6*(2). https://doi.org/10.6004/jadpro.2015.6.2.9

Singhal, R., & Rana, R. (2015). Chi-square test and its application in hypothesis testing. *Journal of the Practice of Cardiovascular Sciences*, *1*(1), 69. https://doi.org/10.4103/2395-5414.157577

Wang, Y., Jiao, Y., Nie, J., O'Neil, A., Huang, W., Zhang, L., Han, J., Liu, H., Zhu, Y., Yu, C., & Woodward, M. (2020). Sex differences in the association between marital status and the risk of cardiovascular, cancer, and all-cause mortality: A systematic review and meta-analysis of 7,881,040 individuals. *Global Health Research and Policy*, *5*(1). https://doi.org/10.1186/s41256-020-00133-8

No Evidence to Support the Relationship Between Pain Reliever Use and Alcohol Binge Drinking Habits: A Cross-sectional Study

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Introduction

Alcohol misuse includes a wide range of unhealthy alcohol use beginning from at-risk drinking to alcohol use disorders (Hawkins et al., 2010). There are numerous variables that can be taken into account when defining alcohol misuse, such as, quantity of drinking, frequency (Bradizza et al., 2015). There are many forms of alcohol misuse such as heavy drinking and binge drinking, both of which can cause extreme harm to health and result in an alcohol dependency (Bradizza et al., 2015). Binge drinking is classified when women consume 4 or more drinks in about 2 hours and men consume 5 or more drinks in about 2 hours (Hoke & Cotti, 2015). Despite the well-known effects of alcohol misuse, alcohol consumption is a serious issue. Unfortunately, many individuals who struggle with alcohol consumption may experience other forms of substance misuse, such as opioids. Opioids are pain-relieving drugs that work by interacting with opioid receptors in your cells (Weiss & Rao, 2017). The National Institute on Drug Abuse categorizes opioids into three classes: heroin, synthetic opioids, and pain relievers (Weiss & Rao, 2017.). Any form of opioid when consumed in excess can create an addiction, which can then take individuals down a very dangerous path, one that can ultimately result in death. Unlike alcohol use disorder (AUD), which has been steadily increasing over the past years, the causes of opioid use disorder (OUD) has increased drastically over the past couple of years (Hood et al., 2020). The opioid crisis is currently a major problem and seeking to better understand this drug and the factors that contribute to its use is extremely important. However, as the incidences of OUD begin to increase, the co-use of alcohol and opioid is becoming fairly popular (Hood et al., 2020). The effects of AUD and OUD together can be considered very dangerous, as researchers in the past have struggled to treat both substance abuse disorders together (Hood et al., 2020).

In recent years, a fair bit of literature has suggested that a potential link may exist between consumption of opioids and alcohol intake. Researchers believe that the endogenous opioid system plays an important role in controlling alcohol-seeking behavior (Gianoulakis, 2001). Consumption of alcohol may trigger the release of specific opioid peptides which are believed to interact with reward and positive reinforcement centers of the brain that in turn lead to more alcohol consumption (Gianoulakis, 2001). Previous studies have attempted to solidify this mechanism responsible for the potential relationship between opioids and alcohol by establishing binge-drinking behavior in female and male models (Haun et al., 2020). Researchers were then able to block a kappa opioid receptor (KOR) in the extended amygdala using a KOR antagonist. This direct injection of the KOR antagonist resulted in a significant decrease in binge-like alcohol consumption (Haun et al., 2020). A study by Witkiewitz et al., conducted secondary analyses where they looked at if opioid misuse was related to outcomes of alcohol treatment for those with AUD (Witkiewitz et al., 2018). Their analysis revealed that baseline opioid misuse predicted higher probability of being a heavier and more frequent drinker by the end of the treatment and at one-year follow up (Witkiewitz et al., 2018). In addition, participants with opioid use had significantly higher alcohol dependence levels than other participants (Witkiewitz et al., 2018). When examining the relationship between opioid use and alcohol use, not many studies factor in the potential sex differences (Haun et al., 2020). However, a self-report study did look into the link between opioid use and alcohol use in prenatal females (Bakhireva et al., 2018). Researchers compared prenatal females with an OUD and those without an OUD, and found that they reveal similar results as previous studies (Bakhireva et al., 2018). There appeared to be a higher rate of alcohol use in the women with OUD than those without it (Bakhireva et al., 2018).

Unfortunately not much research exists regarding the mechanism between alcohol use and opioid use. Although there have been quite a few studies attempting to identify an association between alcohol use and opioid use by looking into self-reported data, researchers are unable to develop a concrete link between the two substances. This could be due to the potential influence of lifestyle factors such as personal income, education, presence of a support system. This study will explore the primary question which is if individuals (female and male) above the age of 15 who use pain relievers are more likely to binge drink alcohol (for females 4 or more and males 5 or more in a single occasion) when compared to individuals (female and male) above the age of 15 who do not use pain relievers. The secondary question that we will explore is if people over the age of 15 (male and female) with lower income level or lower education level will have a higher risk of binge drinking alcohol (for females 4 drinks and more on a single occasion and males 5 drinks or more on a single occasion) as compared to people of the same age who has a higher income level or higher education level. This will help further support whether or not the link between opioid use and binge drinking alcohol exists.

Methods

Part A

This is a cross-sectional study that used the Canadian Alcohol and Drug Use Monitoring Survey 2012 to address three exposure variables - opioid uses, education level, and income level, that may affect binge drinking alcohol. Other studies used this database to investigate risk factors associated with marijuana use and prevalence of tobacco co-morbidities (Bonner et al., 2017; Krist et al., 2013). This database was designed to provide detailed national and provincial estimates of alcohol- and drug-related behaviors and outcomes. Data was collected through telephone interviews.

Part B

The inclusion criteria included: (a) no restriction on sex, (b) individuals above the age of 15, (c) individuals residing in Canada, (d) individuals who reported binge drinking alcohol behaviour and those that reported non-drinking behaviour, and (e) individuals who live in a household with an operating telephone. The exclusion criteria excluded missing data which included individuals who did not provide an answer for the questions regarding pain reliever consumption in the past year, monthly alcohol use in the past year, highest education level completed and personal income before taxes in the past year, as this was irrelevant for our study.

Part C

For the primary outcome, binge drinking alcohol levels, participants were asked if in the past 12 months they had 4 or more drinks (for female) or 5 or more drinks (for male) in a single sitting once a month or more often. Participants had two categories to choose from – never/non-drinker and binge drinking alcohol (4 or more drinks (for female) or 5 or more drinks (for male)). With education level, participants were asked what their highest level of completed education was. There were a total of 14 categories, which was collapsed into 2 categories: completed highschool or less or post-secondary or higher. The completed highschool or less category consisted of 5 of the 14 original categories. The post-secondary or higher category consisted of the remaining 9 original categories. Participants were asked to choose a category that best fit their personal income before tax in the past year. Initially there were 11 categories to choose from with the first category being less than $20,000 and the last category with a significant value for our analysis being more than $100,000. In between, there were 8 categories with a $9,999 interval. These categories were then collapsed into 2 new categories appropriate for our study which were classified as low income ($49,999 or less) and high income ($50,000 or more). The average annual income for Canadians was reported to be $49,738 so we decided to use $50,000 as the benchmark to categorize participants as high income or low income (Kuenzig et al., 2019). For our analysis, individuals who earn more than the average Canadian are considered to have a high income and individuals who earn less than the average Canadian are considered to have a low income.

Opioid use is believed to play a role in alcohol addiction behavior (Gianoulakis, 2001). Pain relievers were used as the primary outcome to represent opioid misuse since the misuse of opioid analgesics appears to be of growing health concern (Ives et al., 2006). Binge drinking alcohol level is a type of alcohol misuse hence making it an appropriate illustrative of alcohol misuse (Bradizza et al., 2015). Previous literature has shown that personal income and education level do affect alcohol consumption behavior (Assari & Lankarani, 2016; Cerdá et al., 2011). We included individuals above the age of 15 years because even though substance misuse is fairly discussed for the adult population, there is not much emphasis on adolescents, despite the increasing substance misuse across the adolescent population (Kilpatrick et al., 2000). The data collected was self-reported which may result in individuals reporting a more socially acceptable answer (Brenner & DeLamate 2016). However, this effect may have been minimized with the choice to use telephone interviews to collect the self-reported data. When collecting data regarding sensitive information, such as substance use, telephone interviews allow for a more open environment and anonymity (Carr, 1999). We ran statistical tests using SPSS to analyze the collected data which ensures a high reproducibility for analysis by other researchers.

Part D

In addition to our study outcomes - monthly alcohol use, personal income and education level, we used additional variables such as age and sex to help understand the characteristics of our population and will be used to describe the population. These variables, along with our study outcomes, were separated into two groups in table 1 based on pain reliever use: participants who use pain relievers and participants who do not use pain relievers. Missing data was eliminated.

Part E

The data was analyzed using the statistical software, SPSS. The database was selected from odesi. The variables were mainly categorical, so frequency and percent were measured for these variables. We used a chi-square statistical test to identify whether a difference exists between pain reliever use and binge drinking alcohol, and our secondary outcomes, education level and personal income, and binge drinking alcohol. If there is a difference, the asymptotic significance (p-value) tells us if this difference is significant ($p\text{-value} < 0.05$) or not significant ($p\text{-value} > 0.05$).

Results

The database consisted of 11,090 participants which we narrowed down to 8,451 participants in our study. First, we excluded cases that did not report their heavy monthly alcohol use (n = 105). After we excluded cases who did not report their past years personal income before taxes, we had 8,579 participants remaining. We also excluded cases who did not report their highest level of education completed which gave us 8,550 participants. We arrived at our final participant population of 8,451 after we excluded cases who did not report their past years pain reliever use (n = 99).

Table 1. Sociodemographic Characteristics for Pain Reliever Users and Non-Pain Reliever Users

Variables	People who do not use pain reliever (N = 6930)	People who do use pain reliever (N = 1521)
Age (years)		
15-17	154 (2.2)	31 (2.0)
18-24	311 (4.5)	88 (5.8)
25-34	781 (11.3)	209 (13.7)
35-44	1207 (17.4)	225 (14.8)
45-54	1324 (19.1)	345 (22.7)
55-64	1507 (21.7)	329 (21.6)
65+	1646 (23.8)	294 (19.3)
Sex		
Male	2941 (42.4)	595 (39.1)
Female	3989 (57.6)	926 (60.9)
Education level		

Completed high school or less	2534 (36.7)	595 (39.1)
Post-secondary school or higher	3989 (57.6)	926 (60.9)
Personal Income		
Low income ($49,999 or less)	4522 (65.3)	1032 (67.9)
High income ($50,000 or more)	2408 (34.7)	489 (32.1)
Monthly Alcohol Use		
Non-drinker	5675 (81.9)	1232 (81.0)
Binge Alcohol Drinkers (5 or more drinks for male, 4 or more drinks for female)	1255 (18.1)	289 (19.0)

Note: Data are presented as frequency (%) unless otherwise specified. N represents the number of participants that provided answers and this excludes the number of people who refused to answer and people who answered "don't know"

The final sample (N = 8,451) consisted of 4915 females and 3536 males of those 15 years and older. As indicated in table 1, individuals in the 45-54 age category appear to use pain relievers the most, 22.7% (n = 345). Females use pain relievers the most, 60.9% (n = 926) in comparison to males, 39.1% (n = 595) (table 1). Individuals in the low-income category ($49,999 or less) appear to use pain relievers the most at 67.9% of the entire population (table 1). Non-drinkers make up 81.0% of pain reliever consumers and those considered binge drinkers make up 19.0% of those who consume pain relievers (table 1).

Table 2. Results of Chi-Square Analysis of the Relationship Between Pain Reliever Use and Monthly Alcohol Use

Monthly Alcohol Use	People who do not use pain relievers (N = 6930) N	People who do use pain relievers (N = 1521) N	χ^2 (df)	*p* value
Non-Drinker	5675	1232	.663 (1)	.437
Binge Alcohol Drinkers (5 or more drinks for male, 4 or more drinks for female)	1255	289		

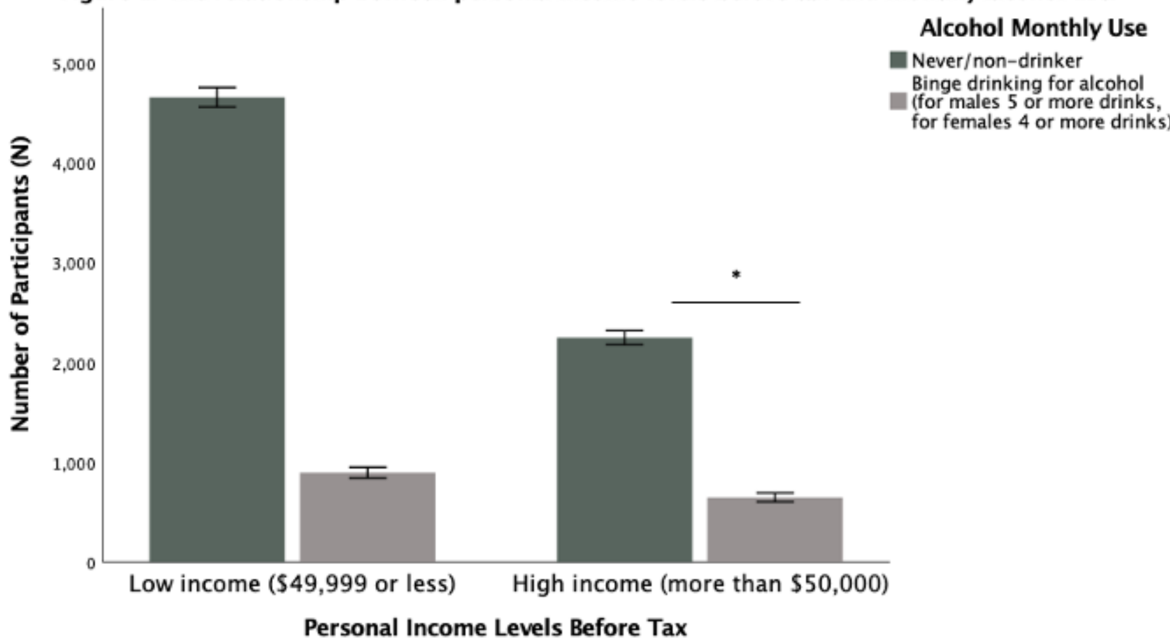
A chi-square test of independence was utilized for all statistical analyses conducted. We used an alpha level of 0.05 for all statistical tests. In table 2, a chi-square test was used to determine if significant differences exist between the use of pain relievers and monthly alcohol use. A total of 289/1521 (19%) participants use pain relievers and binge drink alcohol (table 2). The number of participants who used pain relievers did not differ by whether they were a binge alcohol drinker or not, X2 (1) = 0.663, p = 0.437 (table 2).

Table 3. Results of Chi-Square Analysis of the Relationship Between Highest Education Completed and Monthly Alcohol Use

Highest Education Completed	People who are non-drinkers (N = 6907) N	People who binge drink alcohol (5 or more drink for male, 4 or more drinks for female) (N = 1544) N	χ^2 (df)	*p* value
Completed Highschool or Less	2502	593	2.590 (1)	.114
Completed Post-Secondary or Higher	4405	951		

A chi-square test of independence was performed to examine the relationship between highest education completed and monthly alcohol use. 593/1544 (38.41%) participants who completed a high school or less and 951/1544 (61.59%) participants who completed post-secondary or higher were binge alcohol drinkers (table 3). Monthly alcohol use did not differ between the highest education level completed, X2 (1) = 2.590, p = 0.114 (table 3).

Figure 1. The relationship between personal income levels before tax and monthly alcohol use.



A chi-square test of independence was used to identify the relationship between personal income levels before taxes in the past year and monthly alcohol use. The proportions did not differ between low income and monthly alcohol use, X2 (3) = 7.198, p = 0.066. A total of 2249/6907 (32.56%) participants who classified as non-drinkers and 648/1544 (41.97%) participants who classified as binge alcohol drinkers had high income levels. As indicated by the asterisk in figure 1, the relationship between high income and monthly alcohol use was significant, X2 (5) = 17.068, p < 0.001.

Discussion

The primary aim of this study was to examine the association between opioid use and alcohol consumption among individuals 15 years of age and older. The secondary objective was to assess whether education level and income level had an effect on binge drinking. The present study showed no significant difference of binge drinking alcohol between people who consume pain relievers and those who did not consume pain relievers. Many studies have shown a high comorbidity between opioid use and alcohol consumption. Frank et al. found when combined with alcohol, opioid overdoses were more likely to occur (Frank et al,. 2015). Another study found that opioid use disorder medication is associated with lower incidence of alcohol-related acute events (Xu et al., 2021). In previous experimental research, the binding of naltrexone, which is an opioid antagonist that binds to opioid receptors, has resulted in a decrease of alcohol consumption (de Laat et al., 2019). A possible explanation is that alcohol properties are able to bind to opioid receptors which in turn increases alcohol craving (White and Irvine, 1999).

Education level did not differ with drinking status. Our results differ from the findings of Murakami and Hashimoto as they found individuals with lower levels of education were more likely to engage in heavy drinking in a Japanese population based study (Murakami & Hashimoto 2019). They classify the drinking pattern that is greater than 46 g/day of ethanol intake as heavy drinking (Murakami and Hashimoto, 2019). Another study found that excessive drinking is more prevalent in male with lower education levels. They found that there is no significant relationship between excessive drinking and education levels among females (van Oers et al,. 1999).

There is a significant difference in income level and drinking status, particularly, there is a significant association between individuals with a high income and monthly alcohol use. These results support the findings from a study by Peacock et al., which also found that the region of high-income North America has some of the highest rates of cannabis, opioid, and cocaine addiction (2018). A study done by Cerdá et al., compared the effect of life-time income and past year short-term income on drinking pattern (2011). They found that a history of low or middling lifetime income from childhood to adulthood was linked to increased probabilities of abstinence and excessive drinking (Cerdá et. al,. 2011).

One limitation was the statistical analysis methods used. Since our variables are categorical, there are a limited number of analyses that can be used for our data. After running the Shapiro-Wilk test and Mann-Whitney U test, we found that our data is not normally distributed. The Pearson correlation analysis is for variables that are continuous and normally distributed. Biserial correlation analysis can only be used for one continuous variable and one categorical variable. Spearman's Rho test is used for continuous variables that are not normally distributed. ANCOVA requires the data to have at least one continuous variable. We were unable to use logistic regression because our predictor variables for Spearman Rho was less than 0.3 which violates the assumption of linear regression. The data was collected from a self-reported study which impacted validity. Self-reported studies could have individuals who overstate symptoms to fit them in the scenario that they believe they are in. There was also an opportunity for individuals to understate their symptoms to minimize their problems.

The self-reported study has individuals who simply don't feel like answering specific questions, so they tend to answer, "I don't know" or simply refuse to answer, which then affects our sample size. When individuals were asked about whether they used pain relievers in the past year, there were about 0.3% and 0.1% of the total number of participants who answered "don't know" and "refused" respectively. Some individuals might provide false answers due to recall bias. The questions about alcohol consumption were mostly over the past year, month, or week therefore, some participants might not remember the number of times they used alcohol over that period of time. This will cause some participants to subconsciously base their answers on recent consumptions. Some individuals may provide a more socially acceptable answer rather than an honest answer. If the nature of the question had the potential to impact an individual's self image, then some individuals may choose not to answer or to provide an incorrect answer. Additionally, if the nature of the question involves legal aspects like asking about opioid use and pain relievers where people are more likely to lie then people are more likely to provide false answers. When questions are related to normative behaviors, people tend to answer the question in a way that allows them to look collaborative with the examiner and at the same time place them in their perfect self image that they have for themselves (Brenner & DeLamate 2016).

Another limitation is the fact that the questionnaire was only collected in Canada. This indicates that there is a lack of globalization. The research is preferred to be approachable around the globe. If the research was localized then a bias is expected. For example Denmark is considered the top 10 countries to consume alcohol so they are more likely to drink more than Canadians because it is embedded in their culture **(**Grønkjær et.al 2011**)**. The survey did not include the whole population in Canada. Individuals who were homeless and households that lacked a telephone were not surveyed. Further research should look at potential sex differences when examing opioid users likelihood of devloping binge drinking habits. Longitudinal studies can also assist with understanding these associations because people change their habits and norms constantly and as a result their answers might change with time. Another suggestion is to understand the role of genes and environment when looking at the likelihood of pain reliever users to develop binge drinking habits. According to the famous psychologist Francis Galton, the concept of genes and environment are the main reasons why humans behave the way they do (Galton, 1876). For example, if a pain reliever user is living in an environment where the mother tends to binge drink, then the likelihood of this individual developing a binge drinking habit is high because of the environment and may not be because of the use of pain reliever. Furthermore, research found that CHRM2 genotype is associated with binge drinking habits (Bauer & Ceballos, 2014). So if the same individual has CHRM2 genotype then the individual is more likely to develop binge drinking habits because of genotype and not because of the pain reliever itself.

There is limited research currently being done on the association between pain relievers and binge drinking habits. Most research looks at substance use disorder and other variables like mental health and alcohol use disorder and other variables. Yet little cross-sectional research is done on whether there is an association between pain relievers and binge drinking habits. Further investigation of this topic will allow for the prevention and management of substance misuse. If a biological mechanism between pain reliever use and alcohol misuse does exist, then healthcare professionals can find ways to implement prevention strategies for those struggling with substance abuse. The hope is that this article will be an introduction to further research on this topic, in order to help individuals with substance addictions.

References

Assari, S., & Lankarani, M. M. (2016). Education and Alcohol Consumption among Older Americans; Black–White Differences. *Frontiers in Public Health*, *4*, 67. https://doi.org/10.3389/fpubh.2016.00067

Bakhireva, L. N., Shrestha, S., Garrison, L., Leeman, L., Rayburn, W. F., & Stephen, J. M. (2018). Prevalence of alcohol use in pregnant women with substance use disorder. *Drug and Alcohol Dependence*, *187*, 305–310. https://doi.org/10.1016/j.drugalcdep.2018.02.025

Bauer, L. O., & Ceballos, N. A. (2014). Neural and Genetic Correlates of Binge Drinking Among College Women. *Biological Psychology*, *97*, 43–48. https://doi.org/10.1016/j.biopsycho.2014.01.005

Bradizza, C. M., Reifman, A., & Barnes, G. M. (2015). Social and coping reasons for drinking: Predicting alcohol misuse in adolescents. *Journal of Studies on Alcohol*. https://doi.org/10.15288/jsa.1999.60.491

Brenner, P. S., & DeLamater, J. (2016). Lies, Damned Lies, and Survey Self-Reports? Identity as a Cause of Measurement Bias. *Social Psychology Quarterly*, *79*(4), 333–354. https://doi.org/10.1177/0190272516628298

Bonner, W., Andkhoie, M., Thompson, C., Farag, M., & Szafron, M. (2017). Patterns and factors of problematic marijuana use in the Canadian population: Evidence from three cross-sectional surveys. *Canadian journal of public health = Revue canadienne de sante publique*, *108*(2), e110–e116. https://doi.org/10.17269/cjph.108.5926

Carr, E. C. J. (1999). Talking on the telephone with people who have experienced pain in hospital: Clinical audit or research? *Journal of Advanced Nursing*, *29*(1), 194–200.

https://doi.org/10.1046/j.1365-2648.1999.00875.x

Cerdá, M., Johnson-Lawrence, V. D., & Galea, S. (2011). Lifetime income patterns and alcohol consumption: investigating the association between long- and short-term income trajectories and drinking. *Social science & medicine (1982)*, *73*(8), 1178–1185. https://doi.org/10.1016/j.socscimed.2011.07.025

Controlled Substances and Tobacco Directorate. 2012. Canadian Alcohol and Drug Use Monitoring Survey [public-use microdata file]. Ottawa, Ontario: Health Canada.

de Laat, B., Goldberg, A., Shi, J., Tetrault, J. M., Nabulsi, N., Zheng, M.-Q., Najafzadeh, S., Gao, H., Kapinos, M., Ropchan, J., O'Malley, S. S., Huang, Y., Morris, E. D., & Krishnan-Sarin, S. (2019). The Kappa Opioid Receptor Is Associated With Naltrexone-Induced Reduction of Drinking and Craving. *Biological Psychiatry*, *86*(11), 864–871. https://doi.org/10.1016/j.biopsych.2019.05.021

Frank, D., Mateu-Gelabert, P., Guarino, H., Bennett, A., Wendel, T., Jessell, L., & Teper, A. (2015). High risk and little knowledge: overdose experiences and knowledge among young adult nonmedical prescription opioid users. *The International journal on drug policy*, *26*(1), 84–91. https://doi.org/10.1016/j.drugpo.2014.07.013

Galton, F. (1876). The History of Twins, as a Criterion of the Relative Powers of Nature and Nurture. *The Journal of the Anthropological Institute of Great Britain and Ireland*, *5*, 391–406. https://doi.org/10.2307/2840900

Gianoulakis, C. (2001). Influence of the endogenous opioid system on high alcohol consumption and genetic predisposition to alcoholism. *Journal of Psychiatry &*

Neuroscience : JPN, *26*(4), 304–318.

Grønkjær, M., Curtis, T., Crespigny, C. D., & Delmar, C. (2011). *Acceptance and expectance: Cultural norms for alcohol use in Denmark*. International journal of qualitative studies on health and well-being. Retrieved December 7, 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3208969/.

Haun, H. L., Griffin, W. C., Lopez, M. F., & Becker, H. C. (2020). Kappa opioid receptors in the bed nucleus of the stria terminalis regulate binge-like alcohol consumption in male and female mice. *Neuropharmacology*, *167*, 107984. https://doi.org/10.1016/j.neuropharm.2020.107984.

Hawkins, E. J., Lapham, G. T., Kivlahan, D. R., & Bradley, K. A. (2010). Recognition and management of alcohol misuse in OEF/OIF and other veterans in the VA: A cross-sectional study. *Drug and Alcohol Dependence*, *109*(1), 147–153. https://doi.org/10.1016/j.drugalcdep.2009.12.025

Hoke, O., & Cotti, C. (2015). Minimum wages and youth binge drinking. *Empirical Economics, 51,* 363-381. https://doi.org/10.1007/s00181-015-0998-8

Hood, L. E., Leyrer-Jackson, J. M., & Olive, M. F. (2020). Pharmacotherapeutic management of co-morbid alcohol and opioid use. *Expert Opinion on Pharmacotherapy*, *21*(7), 823–839. https://doi.org/10.1080/14656566.2020.1732349

Ives, T. J., Chelminski, P. R., Hammett-Stabler, C. A., Malone, R. M., Perhac, J. S., Potisek, N. M., Shilliday, B. B., DeWalt, D. A., & Pignone, M. P. (2006). Predictors of opioid misuse in patients with chronic pain: A prospective cohort study. *BMC Health Services Research*, *6*(1), 46. https://doi.org/10.1186/1472-6963-6-46

Kilpatrick, D. G., Acierno, R., Saunders, B., Resnick, H. S., Best, C. L., & Schnurr, P. P. (2000). Risk Factors for Adolescent Substance Abuse and Dependence: Data From a National Sample. *Journal of Consulting and Clinical Psychology*, *68*(1), 19–30. https://doi.org/10.1037//0022-006X.68.1.19

Kirst, M., Mecredy, G., & Chaiton, M. (2013). The prevalence of tobacco use co-morbidities in Canada. *Canadian journal of public health = Revue canadienne de sante publique*, *104*(3), e210–e215. https://doi.org/10.17269/cjph.104.3770

Kuenzig, M. E., Lee, L., El-Matary, W., Weizman, A. V., Benchimol, E. I., Kaplan, G. G., Nguyen, G.C., Bernstein, C. N., Bitton, A., Lee, K., Cooke-Lauder, J., & Murthy, S. K. (2019). The Impact of Inflammatory Bowel Disease in Canada 2018: Indirect Costs of IBD Care. *Journal of the Canadian Association of Gastroenterology*, *2*(Supplement_1), S34–S41. https://doi.org/10.1093/jcag/gwy050

Murakami, K., & Hashimoto, H. (2019). Associations of education and income with heavy drinking and problem drinking among men: evidence from a population-based study in Japan. *BMC public health*, *19*(1), 420. https://doi.org/10.1186/s12889-019-6790-5

Peacock, A., Leung, J., Larney, S., Colledge, S., Hickman, M., Rehm, J., Giovino, G. A., West, R., Hall, W., Griffiths, P., Ali, R., Gowing, L., Marsden, J., Ferrari, A. J., Grebely, J., Farrell, M., & Degenhardt, L. (2018). Global statistics on alcohol, tobacco and illicit drug use: 2017 status report. *Addiction (Abingdon, England)*, *113*(10), 1905–1926. https://doi.org/10.1111/add.14234

Turton, S., Myers, J. F., Mick, I., Colasanti, A., Venkataraman, A., Durant, C., Waldman, A., Brailsford, A., Parkin, M. C., Dawe, G., Rabiner, E. A., Gunn, R. N., Lightman, S. L., Nutt, D. J., & Lingford-Hughes, A. (2020). Blunted endogenous opioid release following an oral dexamphetamine challenge in abstinent alcohol-dependent individuals. *Molecular Psychiatry*, *25*(8), 1749–1758. https://doi.org/10.1038/s41380-018-0107-4

Van Oers, J. A., Bongers, I. M., van de Goor, L. A., & Garretsen, H. F. (1999). Alcohol consumption, alcohol-related problems, problem drinking, and socioeconomic status. *Alcohol and alcoholism (Oxford, Oxfordshire)*, *34*(1), 78–88. https://doi.org/10.1093/alcalc/34.1.78

Weiss, R. D., & Rao, V. (2017). The Prescription Opioid Addiction Treatment Study: What have we learned. *Drug and Alcohol Dependence*, *173 Suppl 1*, S48–S54. https://doi.org/10.1016/j.drugalcdep.2016.12.001.

Witkiewitz, K., & Vowles, K. E. (2018). Alcohol and Opioid Use, Co-Use, and Chronic Pain in the Context of the Opioid Epidemic: A Critical Review. *Alcoholism, clinical and experimental research*, *42*(3), 478–488. https://doi.org/10.1111/acer.13594

Xu, K. Y., Presnall, N., Mintz, C. M., Borodovsky, J. T., Bhat, N. R., Bierut, L. J., & Grucza, R. A. (2021). Association of Opioid Use Disorder Treatment With Alcohol-Related Acute Events. *JAMA network open*, *4*(2), e210061. https://doi.org/10.1001/jamanetworkopen.2021.0061

The Effect of Exercise at Least Once a Week on LDL-C, HDL-C, Triglycerides, Average Systolic Blood Pressure, and Average Diastolic Blood Pressure in 18-34 Year Old Canadian Females: An Observational Cross-Sectional Study

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December 10th, 2021

Group 15

INTRODUCTION

Cholesterol can be a double-edged sword when it comes to heart health. Studies have shown across various populations that increased dietary cholesterol levels are associated with an increased risk of developing cardiovascular disease due to a buildup of plaque in the arteries (Jeong et al., 2018; Berger et al., 2015; Toth, 2005). Low-density lipoprotein cholesterol (LDL-C) and triglycerides, have been identified to be the primary risk markers of cardiovascular disease and are targets for risk mitigation (Wadhera et al., 2016). However, there is a subset of total dietary cholesterol, high-density lipoprotein cholesterol (HDL-C), which has been suggested to be advantageous due to its therapeutic effects on cardiovascular disease risk (Bhatt & Rohatgi, 2016; Toth, 2005). LDL-C buildup can block the arteries and vital organs, such as the brain and heart, which reduces blood flow and may result in heart attacks or strokes (Toth, 2005). High systolic and diastolic blood pressures (BP) have been found to lead to a 1.18 increase in the hazard ratio for heart disease (Stevens et al., 2016). Intervention studies have found that administering medications to lower LDL-C levels have been associated with reductions in the incidence of cardiovascular events (Jeong et al., 2018). HDL-C on the other hand, is correlated with lowering of LDL-C levels as well as regression of coronary atherosclerosis (De Vries et al., 2014). High triglyceride levels are the main lipid component of dietary fat, which is composed of very low-density lipoprotein cholesterol (Sandesara, 2019; Cox & García-Palmieri, 1990). A study by Morrison & Hokanson (2009) found that higher levels of nonfasting triglycerides is a predictor of coronary heart disease. Exercise is one of many ways to help in reducing LDL-C and triglyceride levels (Mann et al., 2014). The literature suggests that exercise in school aged children can help in increasing HDL-C levels as well as decreasing triglyceride levels (Janssen & LeBlanc, 2010). A meta-analysis showed that aerobic exercise interventions increased HDL-C by a factor of 0.26 and decreased triglycerides by a factor of 3.03 (Janssen & LeBlanc, 2010). This study demonstrated that children who were 20% fit, were two to three times more likely to have low HDL-C and develop hypercholesterolemia in the future than fit children (Janssen & LeBlanc, 2010). Since this study did not analyze LDL-C, or how this would affect individuals who are aged 18-34, we will be addressing this knowledge gap. We decided to observe LDL-C and triglyceride levels in this age group to determine if an excess of these lipoproteins could negatively impact cardiovascular health in the future. Triglyceride and LDL-C levels were included in our data because it provides an indication for the risk range. LDL-C levels above 3.5 mmol/L are considered high (unhealthy), and triglyceride levels above 2.2 mmol/L are considered high (unhealthy) (Pike et al., 2017). HDL-C levels were included in order to observe the abundance of healthy cholesterol in the participants studied. HDL-C levels below 1.3 mmol/L are considered very low (unhealthy) (Arsenault et al., 2009). Systolic BP above 130 mm Hg, and diastolic BP above 80 mm Hg, are direct indicators for poor heart health (Smitson et al., 2017; Whelton et al., 2018). Many other studies have attempted to analyze how exercise affects cholesterol levels in middle aged to older adults as well as children. Limited studies have analyzed how exercise affects BP and cholesterol levels in females who are in the age range of 18-34. For example, a study that observed men and women in their 60's and 70's discovered that fat was reduced in central regions of the body after exercise training (Kohrt et al., 1992). A separate study looked at how there is a gender difference between profiles in healthcare research in students aged 17-25 (Anish et al., 2013). They found that physical exertion is less pronounced in the female population (Anish et al., 2013). This study failed to analyze the triglyceride levels of the participants, which is where our research comes in. The literature suggests that cardiovascular diseases are considered to be more alarming among the male population, yet, cardiovascular disease is the leading cause of death in women (Woodward, 2019). While this study analyzed LDL-C levels in women, they neglected to observe the effect of exercise for 18-34 year olds. Nybo et al. (2012) found that prolonged exercise for two hours per week resulted in a significant 8 mm Hg decrease in systolic BP in 20–43 year old men. This was limited to men. Studies have also looked at household income and exercise frequency of school aged children (Assari et al., 2021). Researchers found a significant positive correlation between household income and physical activity (Assari et al., 2021). However, they did not address the age range of 18-34 or the subsequent effects on cholesterol. It is of utmost importance to focus on young adult women because there is limited research on the effects of exercise for their cholesterol levels. There is minimal research on cardiovascular disease risk in 18-34 year olds since 78% of research conducted on heart disease is on adults over the age of 60. (Rodgers et al., 2019). This may be the case because youth are physiologically healthier and more active (Tsai et al., 2020). However, youth also tend to have unhealthy lifestyles and eating habits which is why it is important to study this age range (Andersson & Vasan, 2018). We also sought to take a closer look at income levels and how it impacts exercise frequency due to gym memberships and equipment costs. Our research aims to fill the aforementioned knowledge gaps and will help address the following question: is there a difference in the proportion of individuals with healthy LDL-C levels, triglyceride levels, HDL-C levels, average systolic BP, and average diastolic BP in Canadian females who exercise for a minimum of once a week and for at least 30 minutes per session compared to Canadian females of the same age group who do not exercise on a weekly basis? The primary outcome of this study is LDL-C levels, the secondary is triglyceride levels, the tertiary is HDL-C levels, the quaternary is average systolic BP, and the quinary is average diastolic BP.

METHODS

Study Design and Database. This study has an observational, cross-sectional design. Data was obtained from the Canadian Heart Health Database (1986-1992) and it was designed to estimate the awareness levels and prevalence of cardiovascular disease risk factors among Canadians. A nurse conducted a home interview to collect demographic and lifestyle data, whereas cholesterol and BP data were collected in a clinic. Participants fasted for 8 hours or longer before their cholesterol blood tests and for at least 30 minutes before the BP readings were taken with a standard mercury-gravity manometer (Potvin et al. 2000). Four BP readings were taken at the beginning and end of two sessions; the mean of those measurements was used for analysis (Potvin et al., 2000).

Study Participants. Participants consisted of two groups: (1) those who regularly exercise for a minimum of 30 minutes, at least once a week (n = 1,929), and (2) those who do not exercise at all or those who do not exercise for a minimum of 30 minutes, at least once a week (n = 1,591). The inclusion criteria of the final database consisted of: (1) Canadian women, (2) participants aged 18-34, and (3) those who had data available for their exercise frequency. The exclusion criteria of the original database consisted of individuals: (1) on indigenous reserves, (2) in military camps, and (3) in institutions (Potvin et al., 2000).

Study Outcomes. The primary outcome is LDL-C, secondary is triglycerides, tertiary is HDL-C, quaternary is average systolic BP, and quinary is average diastolic BP. Outcomes were separated into healthy and unhealthy categories using the following critical values: (1) 3.5 mmol/L for LDL-C, (2) 2.2 mmol/L for triglycerides, (3) 1.3 mmol/L for HDL-C, (4) 130 mm Hg for average systolic BP, and (5) 80 mm Hg for average diastolic BP (Pike et al., 2017; Smitson et al., 2017; Whelton et al., 2018). These outcomes were selected due to the high volume of literature suggesting their association with cardiovascular disease risk (Jeong et al., 2018; Miller et al., 2011; Nordestgaard & Varbo, 2014; Whelton et al., 2018). Although these outcomes were continuous measurements, data collected on exercise and income were categorical. The following question was used to stratify the exercise groups: "do you regularly engage in physical activity during your leisure time? By regularly we mean at least once a week during the past month." Participants selected one of the following responses: yes, no, cannot remember, or not stated. The following question was used to identify income level: "could you please indicate from the list the income range for your household?" Participants identified their gross income by one of the following ranges: under $12,000, $12,000 - $24,999, $25,000 - $44,999, $50,000 and over, or not stated. In order to optimize validity and reproducibility, this study analyzed LDL-C, HDL-C, and triglyceride levels in participants who fasted for eight hours or longer. It has been suggested that raised triglyceride levels are associated with low HDL-C (Nordestgaard & Varbo, 2014). HDL-C was chosen to be observed since it has a sensitivity of 83.3% and a specificity of 96.3% in a blood test (Craig et al., 2000). This ensures that the HDL-C levels measured are true values. A standard mercury-gravity manometer was used to measure BP due to its high accuracy and because electronic instruments require more maintenance and have not been validated for a range of external factors (Jones et al., 2001). To minimize intrasubject variation as well as increase validity and reproducibility, participants were dressed in light, comfortable clothing (Jones et al., 2001).

Additional Data Collection. Aside from our outcomes, the proportions of individuals with high or low incomes were tested between the exercise groups to explore whether socioeconomic status played a role in participants' exercise regimens.

Statistical Analysis. Statistical analyses were performed using the IBM® SPSS® software to determine whether there was a difference in the proportions of healthy cholesterol and BP levels between participants that regularly exercised and those that did not. The Shapiro-Wilk normality test was performed on all outcomes. A Mann-Whitney U test was done to evaluate the differences in median cholesterol levels and BP measurements between the exercise groups. Chi-Square tests were also used to test for between group differences in proportions for each outcome as well as income level. For this purpose, all outcome variables were transformed from continuous variables into "healthy" and "unhealthy" categories as outlined in the study outcomes. This was carried out to gauge if regular exercise played a role in having healthy cholesterol and BP levels. An alpha value of 0.05 was used for significance. The original database (n = 4,370) was filtered in SPSS according to the inclusion criteria. Missing data was removed by sorting and deleting each case with missing information for each outcome in the following order: LDL-C, triglycerides, HDL-C, average systolic BP, and average diastolic BP. After missing data was removed, the final sample size was 3,520 participants.

RESULTS

At baseline, our database included 4,370 Canadian women aged 18 to 34 years old. Of that number, 850 (19.5%) were excluded because of missing LDL-C, triglyceride and HDL-C levels (n = 849) and missing average systolic and diastolic BP (n = 1). Complete baseline data for the sample population of Canadian women aged 18 to 34 years old was therefore available for 3,520 study participants. Data was found to be not normal for all variables. For income, data was available for n = 3,206 participants after missing data (n = 314) was removed.

Table 1. Descriptive Characteristics of Study Population of Canadian Women aged 18 to 34

Variables	*Regular Exercise* (*n* = 1,929)	*No Regular Exercise* (*n* = 1,591)
Income†		
\$24,999 and under	512 (29.025)	536 (37.171)
\$25,000 and over	1,252 (70.975)	906 (62.829)
LDL-C		
< 3.5 mmol/L	1,708 (88.543)	1,347 (84.664)
≥ 3.5 mmol/L	221 (11.457)	244 (15.336)
Triglyceride		
< 2.2 mmol/L	1,818 (94.246)	1,478 (92.898)
≥ 2.2 mmol/L	111 (5.754)	113 (7.102)
HDL-C		
< 1.3 mmol/L	780 (40.435)	752 (47.266)
≥ 1.3 mmol/L	1,149 (59.565)	839 (52.734)
Average Systolic BP		
< 120 mm Hg	1,619 (83.929)	1,335 (83.910)
≥ 120 mm Hg	310 (16.071)	256 (16.091)
Average Diastolic BP		
< 80 mm Hg	1,751 (90.772)	1,415 (88.938)
≥ 80 mm Hg	178 (9.228)	176 (11.062)

Values are presented as number (percent) of participants. LDL, Low-density lipoproteins; HDL, High-density lipoproteins. [N = 3,520]. †Income data was available for *n* = 3,206 participants. The research sample depicted more participants with higher income levels in both exercise groups, however, this disparity was more pronounced in the regular exercise group.

Table 2. Medians, IQR Values and Mann-Whitney U Test Values

Variables	*Regular Exercise* (*n* = 1,929)	*No Regular Exercise* (*n* = 1,591)	*Mann-Whitney U Test Value* (*n* = 3,520)
LDL-C, mmol/L	2.500 (0.840)	2.570 (0.950)	<0.001***
Triglyceride, mmol/L	0.970 (0.550)	0.980 (0.600)	<0.001***
HDL-C, mmol/L	1.390 (0.410)	1.370 (0.410)	<0.001***
Average Systolic BP, mm Hg	109.500 (11.500)	109.500 (12.000)	0.172
Average Diastolic BP, mm Hg	69.500 (9.500)	69.500 (10.000)	0.601

Values are presented as median (IQR). LDL-C, Low-density lipoproteins; HDL-C, High-density lipoproteins. Mann-Whitney U test values for LDL-C, triglyceride and HDL-C were significant (p-value <0.001). *** represents results with a p-value of <0.001.

Table 3. Chi-Square Test Values

Variables	*Continuity Correction Value*
Income†	<0.001***
LDL-C	<0.001***
Triglyceride	0.118
HDL-C	<0.001***
Average Systolic BP	1.000
Average Diastolic BP	0.081

LDL-C, Low-density lipoproteins; HDL-C, High-density lipoproteins. [N = 3,520]. †Income data was available for *n* = 3,206 participants. Income was also included in this analysis. LDL-C, HDL-C and income had significant continuity correction values. *** represents results with a p-value of <0.001.

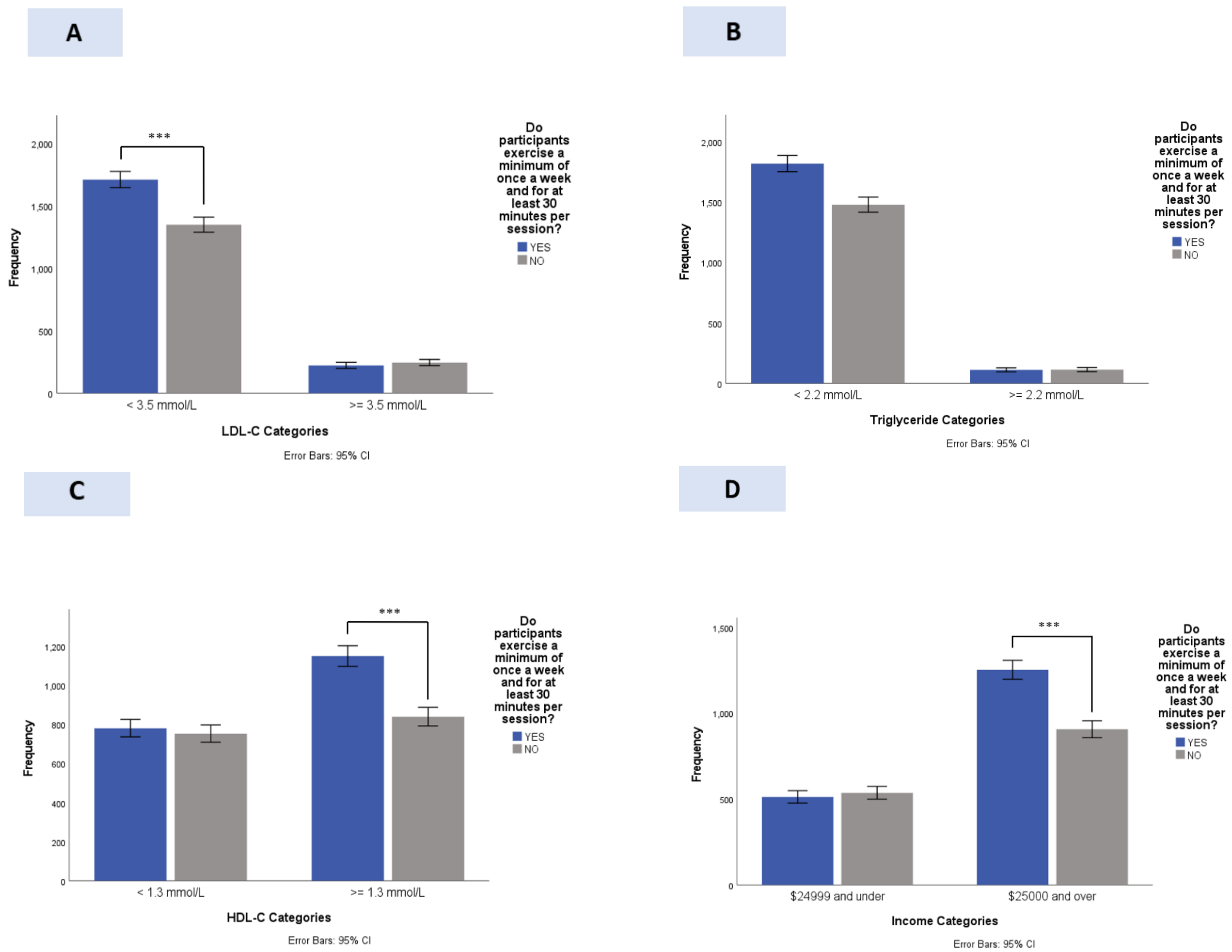

Figure 1. Frequency of unhealthy and healthy LDL-C (A), Triglyceride (B), HDL-C [N = 3,520] and Income (D) levels among participants that exercise regularly once a week for at least 30 minutes compared to those that do not [N = 3,206]. A - frequency of participants with LDL-C levels less than 3.5mmol/L, and greater than or equal to 3.5mmol/L. **B -** frequency of participants who have triglyceride levels less than 2.2 mmol/L, and greater than or equal to 2.2 mmol/L for those who exercise or not. **C -** frequency of participants who have HDL-C levels less than 1.3mmol/L, and greater than or equal to 1.3mmol/L. **D -** frequency of participants who have income levels of $24,999 and under, and $25,000 and over. Error bars represent standard errors of the means at a 95% confidence interval. *** represents results with a p-value of <0.001.

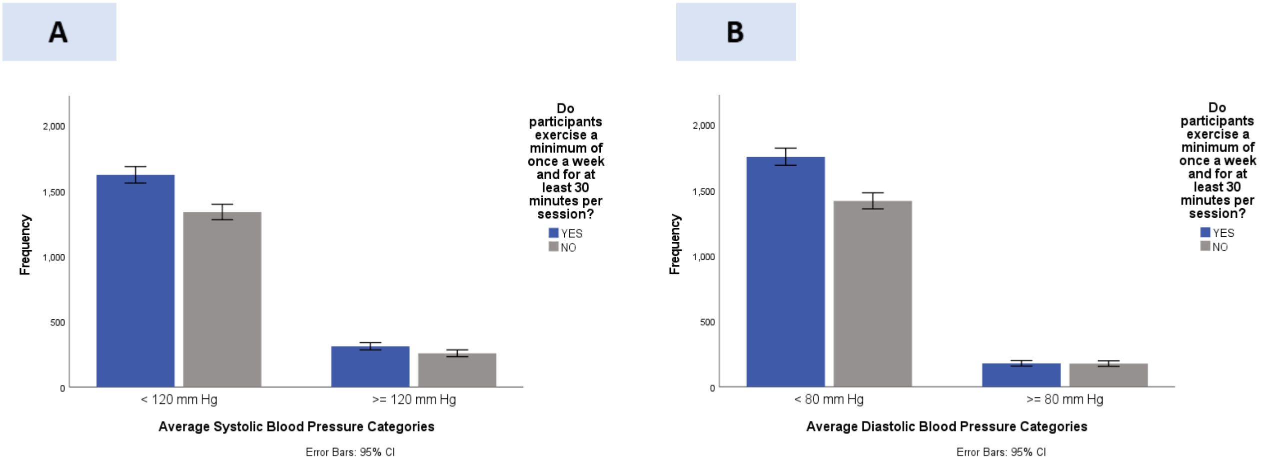

Figure 2. Frequency of unhealthy and healthy average systolic BP (A) and average diastolic BP (B) among participants that exercise regularly once a week for at least 30 minutes compared to those that do not [N = 3,520]. A - frequency of participants with average systolic BP of less than 120 mm Hg, and greater than or equal to 120 mm Hg. **B -** frequency of participants who have diastolic BP less than 80 mm Hg, and greater than or equal to 80 mm Hg. Error bars represent standard errors of the means at a 95% confidence interval. *** represents results with a p-value of <0.001.

Summary of Outcomes. For the primary outcome, the Mann-Whitney U test revealed a significant difference (p-value < 0.001) in the medians of LDL-C levels between the regular exercise and no regular exercise groups (Table 2). The Chi Square test found a significant difference (p-value < 0.001) in the proportions of LDL-C levels, less than 3.5 mmol/L, between exercise groups (Figure 1A). For the secondary outcome, a significant difference (p-value < 0.001) was found in the medians of triglyceride levels between exercise groups (Table 2). However, no significant difference (p-value = 0.118) was found in the proportions of triglyceride levels between exercise groups (Table 3). For the tertiary outcome, a significant difference (p-value < 0.001) was found in the medians of HDL-C levels between exercise groups (Table 2).

A significant difference (p-value < 0.001) was also found in the proportions of HDL-C levels, greater than or equal to 1.3 mmol/L, between exercise groups (Figure 1C). For the quaternary outcome, no significant differences were found in the medians of average systolic BP (p-value = 0.172) and in its proportions (p-value = 1.000) between exercise groups (Table 2 & 3). For the quinary outcome, no significant differences were found in the medians of average diastolic BP (p-value = 0.601) and in its proportions (p-value = 0.081) between exercise groups (Table 2 & 3).

DISCUSSION

Through our analysis, we found significant between group differences in healthy LDL-C levels and healthy HDL-C levels in 18-34 year old Canadian females who exercise at least once a week for a minimum of 30 minutes per session versus those who do not. Triglyceride and BP levels were not found to have significant differences in proportions between exercise groups. However, triglyceride levels had a significant difference in medians between groups. A significant difference in the proportions of income between groups was also found.

Health literature often suggests that individuals exercise to lower triglyceride and BP levels (Mann et al., 2014). There are some possible reasons why this was not observed in our study. Some studies observed reduced triglyceride levels with endurance and prolonged exercise (Henderson et al., 2010; Davitt et al., 2013). Since the intensity and span of the exercise regimen was not controlled in our study, it is possible that high intensity and long-term exercise may be needed to observe lower triglyceride levels in participants. The type of exercise is another important factor to consider. If participants engaged in exercise that specifically tested cardiopulmonary function, such as the master two-step test (Russek, 1957), it is possible that a significant difference would be found in BP levels between exercise groups.

There are similarities and differences when comparing this study's results with other scientific findings. One study found that after 9-12 months of endurance jogging in adults, aged 60-70, there were no significant changes in any cholesterol levels (Kohrt et al., 1992). In contrast, we found significant differences between exercise groups in healthy LDL-C and HDL-C levels (Figure 1A & 1C). A limitation of that study is that they did not account for the natural overestimation of LDL-C levels when triglyceride concentrations are over 400 mg/dL (Sundjaja & Pandey, 2021). Another study that analyzed 36 men who were between 20-43 years of age found that after 12 weeks of prolonged exercise for two hours per week, no significant changes in cholesterol levels were observed compared to those who didn't exercise at all (Nybo et al., 2010). However, they discovered that systolic BP was reduced by 8 mm Hg and diastolic BP was reduced by 5 mm Hg (Nybo et al., 2010). This is in contrast to our study which observed no significant differences in BP levels between exercise groups (Figure 2A & 2B). A limitation for this study is that there were inconsistencies with the prolonged exercise regime used between participants (Nybo et al., 2010). A different randomized control trial had college aged women go through aerobic exercise for 16 weeks at three 35-minute sessions per week (LeMura et al., 2000). These researchers did not measure average systolic and diastolic BP. They noticed a significant 0.4 mmol/L increase in HDL-C and a significant 0.2 mmol/L decrease in triglycerides, but no significant decreases in LDL-C (LeMura et al., 2000). Similarly, our study observed a significantly higher proportion of healthy HDL-C levels in the exercise group and a significant difference in the medians of healthy triglyceride levels between groups (Figure 1B & 1C). However, a point of difference was that we observed a significant difference in proportions of healthy LDL-C levels between groups (Figure 1A). A limitation to this study is that there was a small sample size of only 48 participants. In another randomized control trial by Prabhakaran et al., (1999), females aged 20-34 years old went through high resistance training for 14 weeks, three times per week for 45-50 minutes per session. A significant 0.42 mmol/L reduction in LDL-C was found, but there were no significant changes in HDL-C or triglyceride levels. Our study also observed a significantly higher proportion of LDL-C levels less than 3.5 mmol/L in the regular exercise group (Figure 1A & 1B). A limitation of that study includes its small sample size (n=24) and that the serum lipids they measured varied during the menstrual cycle, specifically in the late follicular phase, due to progesterone fluctuations (Prabhakaran et al., 1999). A study by Assari et al. (2021), looked at household income and exercise frequency of school aged children. Similar to our study, these researchers found significantly higher exercise frequencies among those with higher household income levels (Assari et al., 2021). A limitation of this study is that the availability of green space and physical activity was not measured (Assari et al., 2021). This suggests that those with higher income levels may have better access to exercise equipment leading to healthier habits than those with lower income levels.

The results from our study add to the current literature by filling in the existing knowledge gaps for cardiovascular disease risk in 18-34 year old Canadian females. It also fortifies findings from previous studies, such as that there are significantly higher proportions of healthy LDL-C and HDL-C levels in those who exercise regularly. This research provides insight into how LDL-C, triglyceride, HDL-C, and BP levels are affected when one exercises. The lack of significant differences in proportions of healthy triglyceride and BP levels could provide opportunities for more research to explore the meaning behind this.

Limitations of this study include the fact that since females were analyzed, the levels of cholesterol may have been skewed depending on if the female was menstruating or not. This is because progesterone fluctuations impact cholesterol levels (Prabhakaran et al., 1999). Also, the data in the database used for this study was conducted from 1986-1992, hence, the results gathered are outdated. Since the chi square test was used for variables with more than two categories, we weren't able to determine whether the unhealthy categories were significant between the exercise groups. This was the case for income and all outcomes. Finally, since the standard mercury-gravity manometer was used to measure BP, the measurements may have been subject to observer bias. This may have skewed the results when measuring BP. A major implication of this study is that it provides more knowledge on the topic of heart disease risk in young females in the field of preventive medicine. Having the knowledge of how exercise can minimize LDL-C, triglyceride, and BP levels in younger individuals can bring awareness in preventing the onset of heart attacks and strokes in the future. The results of this study may also be a pivoting point for youth, encouraging them to become more active and incorporate healthier habits into their daily routines. A future study could conduct a longitudinal, prospective cohort study design where participants' cholesterol levels and exercise frequencies are monitored starting from their 20's until their 40's. This will allow researchers to draw conclusions on how heart health is affected by lifestyle changes throughout their lives. Future studies could also analyze how the participants' level of knowledge on exercise, cholesterol, and heart health influence their eating and physical activity habits. In conclusion, this study observed that there was a significant difference in proportions of healthy LDL-C and HDL-C levels between participants that exercised regularly and those that did not. Healthy triglyceride, average systolic BP, and average diastolic BP levels did not have any significant differences in proportion between exercise groups in 18-34 year old Canadian females.

References

Andersson, C., & Vasan, R. S. (2018). Epidemiology of cardiovascular disease in young individuals. *Nature Reviews Cardiology*, 15(4), 230–240. https://doi.org/10.1038/nrcardio.2017.154

Anish, T. S., Shahulhameed, S., Vijayakumar, K., Joy, T. M., Sreelakshmi, P. R., & Kuriakose, A. (2013). Gender Difference in Blood Pressure, Blood Sugar, and Cholesterol in Young Adults with Comparable Routine Physical Exertion. *Journal of Family Medicine and Primary Care*, *2*(2), 200–203. https://doi.org/10.4103/2249-4863.117424

Arsenault, B. J., Rana, J. S., Stroes, E. S. G., Després, J.-P., Shah, P. K., Kastelein, J. J. P., Wareham, N. J., Boekholdt, S. M., & Khaw, K.-T. (2009). Beyond Low-Density Lipoprotein Cholesterol: Respective Contributions of Non–High-Density Lipoprotein Cholesterol Levels, Triglycerides, and the Total Cholesterol/High-Density Lipoprotein Cholesterol Ratio to Coronary Heart Disease Risk in Apparently Healthy Men and Women. *Journal of the American College of Cardiology*, *55*(1), 35–41. https://doi.org/10.1016/j.jacc.2009.07.057

Assari, S., Boyce, S., Bazargan, M., & Caldwell, C. (2021). *Household Income and Children Exercise Frequency: Blacks' Diminished Returns*. Retrieved September 30, 2021, from https://www.hilarispublisher.com/open-access/household-income-and-children-exercise-frequency-blacksrsquo-diminished-returns-68271.html

Berger, S., Raman, G., Vishwanathan, R., Jacques, P. F., & Johnson, E. J. (2015). Dietary cholesterol and cardiovascular disease: a systematic review and meta-analysis. *The*

American journal of clinical nutrition, 102(2), 276-294. https://doi.org/10.3945/ajcn.114.100305

Bhatt, A., & Rohatgi, A. (2016). HDL cholesterol efflux capacity: cardiovascular risk factor and potential therapeutic target. *Current atherosclerosis reports*, 18(1), 2. https://doi.org/10.1007/s11883-015-0554-1

Canadian Heart Health Database Centre. (1992). Canadian Heart Health Database, 1986-1992. <*odesi*>. http://odesi2.scholarsportal.info.libaccess.lib.mcmaster.ca/webview/index.jsp?v=2&analysismode=table&study=http%3A%2F%2F142.150.190.128%3A80%2Fobj%2FfStudy%2Fchhd-E-1986-1992&mode=download&top=yes

Cox, R. A., & García-Palmieri, M. R. (1990). Cholesterol, Triglycerides, and Associated Lipoproteins. In H. K. Walker, W. D. Hall, & J. W. Hurst (Eds.), *Clinical Methods: The History, Physical, and Laboratory Examinations* (3rd ed.). Butterworths. http://www.ncbi.nlm.nih.gov/books/NBK351/

Craig, S. R., Amin, R. V., Russell, D. W., & Paradise, N. F. (2000). Blood Cholesterol Screening. *Journal of General Internal Medicine*, *15*(6), 395–399. https://doi.org/10.1046/j.1525-1497.2000.03509.x

Davitt, P. M., Arent, S. M., Tuazon, M. A., Golem, D. L., & Henderson, G. C. (2013). Postprandial triglyceride and free fatty acid metabolism in obese women after either endurance or resistance exercise. *Journal of Applied Physiology*, *114*(12), 1743–1754.

https://doi.org/10.1152/japplphysiol.00095.2013

De Vries, F. M., Kolthof, J., Postma, M. J., Denig, P., & Hak, E. (2014). Efficacy of standard and intensive statin treatment for the secondary prevention of cardiovascular and cerebrovascular events in diabetes patients: a meta-analysis. *PLoS One*, 9(11), e111247. https://doi.org/10.1371/journal.pone.0111247

Hanai, T., Takada, H., Nagashima, M., & Iwata, Toshiko Kuwano2 and Hirotoshi. (1999). Effects of exercise for 1 month on serum lipids in adolescent females. *Pediatrics International*, *41*(3), 253–259. https://doi.org/10.1046/j.1442-200x.1999.01064.x

Henderson, G. C., Krauss, R. M., Fattor, J. A., Faghihnia, N., Luke-Zeitoun, M., & Brooks, G. A. (2010). Plasma triglyceride concentrations are rapidly reduced following individual bouts of endurance exercise in women. *European Journal of Applied Physiology*, *109*(4), 721–730. https://doi.org/10.1007/s00421-010-1409-7

Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 40. https://doi.org/10.1186/1479-5868-7-40

Jeong, S., Choi, S., Kim, K., Kim, S. M., Lee, G., Park, S. Y., Kim, Y., Son, J. S., Yun, J., & Park, S. M. (2018). Effect of Change in Total Cholesterol Levels on Cardiovascular Disease Among Young Adults. *Journal of the American Heart Association*, *7*(12), e008819. https://doi.org/10.1161/JAHA.118.008819

Jones, D. W., Frohlich, E. D., Grim, C. M., Grim, C. E., & Taubert, K. A. (2001). Mercury Sphygmomanometers Should Not be Abandoned: An Advisory Statement From the Council for High Blood Pressure Research, American Heart Association. *Hypertension*, *37*(2), 185–186. https://doi.org/10.1161/01.HYP.37.2.185

Kohrt, W. M., Obert, K. A., & Holloszy, J. O. (1992). Exercise Training Improves Fat Distribution Patterns in 60-to 70-year-old Men and Women. *Journal of Gerontology*, *47*(4), M99–M105. https://doi.org/10.1093/geronj/47.4.M99

LeMura, L. M., von Duvillard, S. P., Andreacci, J., Klebez, J. M., Chelland, S. A., & Russo, J. (2000). Lipid and lipoprotein profiles, cardiovascular fitness, body composition, and diet during and after resistance, aerobic and combination training in young women. *European Journal of Applied Physiology*, *82*(5), 451–458. https://doi.org/10.1007/s004210000234

Mann, S., Beedie, C., & Jimenez, A. (2014). Differential Effects of Aerobic Exercise, Resistance Training and Combined Exercise Modalities on Cholesterol and the Lipid Profile: Review, Synthesis and Recommendations. *Sports Medicine (Auckland, N.z.)*, *44*(2), 211–221. https://doi.org/10.1007/s40279-013-0110-5

Miller, M., Stone, N. J., Ballantyne, C., Bittner, V., Criqui, M. H., Ginsberg, H. N., Goldberg, A. C., Howard, W. J., Jacobson, M. S., Kris-Etherton, P. M., Lennie, T. A., Levi, M., Mazzone, T., & Pennathur, S. (2011). Triglycerides and Cardiovascular Disease. *Circulation*, *123*(20), 2292–2333. https://doi.org/10.1161/CIR.0b013e3182160726

Morrison, A., & Hokanson, J. E. (2009). The independent relationship between triglycerides and coronary heart disease. *Vascular health and risk management*, 5, 89.

Nordestgaard, B. G., & Varbo, A. (2014). Triglycerides and cardiovascular disease. *The Lancet*, *384*(9943), 626–635. https://doi.org/10.1016/S0140-6736(14)61177-6

Nybo, L., Sundstrup, E., Jakobsen, M. D., Mohr, M., Hornstrup, T., Simonsen, L., Bülow, J., Randers, M. B., Nielsen, J. J., Aagaard, P., & Krustrup, P. (2010). High-intensity training versus traditional exercise interventions for promoting health. *Medicine and Science in Sports and Exercise*, *42*(10), 1951–1958. https://doi.org/10.1249/MSS.0b013e3181d99203

Pike, U. S. N. L. of M. 8600 R., MD, B., & Usa, 20894. (2017). High cholesterol: Overview. In *InformedHealth.org [Internet]*. Institute for Quality and Efficiency in Health Care (IQWiG). https://www.ncbi.nlm.nih.gov/books/NBK279318/

Potvin, L., Richard, L., & Edwards, A. C. (2000). Knowledge of cardiovascular disease risk factors among the Canadian population: relationships with indicators of socioeconomic status. *Cmaj*, 162(9 suppl), S5-S11.

Prabhakaran, B., Dowling, E. A., Branch, J. D., Swain, D. P., & Leutholtz, B. C. (1999). Effect of 14 weeks of resistance training on lipid profile and body fat percentage in premenopausal women. *British Journal of Sports Medicine*, *33*(3), 190–195. https://doi.org/10.1136/bjsm.33.3.190

Rodgers, J. L., Jones, J., Bolleddu, S. I., Vanthenapalli, S., Rodgers, L. E., Shah, K., Karia, K., & Panguluri, S. K. (2019). Cardiovascular Risks Associated with Gender and Aging. *Journal of Cardiovascular Development and Disease*, *6*(2), 19. https://doi.org/10.3390/jcdd6020019

Russek, H. I. (1957). MASTER TWO-STEP TEST IN CORONARY ARTERY DISEASE.

Journal of the American Medical Association, *165*(14), 1772–1775. https://doi.org/10.1001/jama.1957.02980320002002

Sandesara, P. B., Virani, S. S., Fazio, S., & Shapiro, M. D. (2019). The forgotten lipids: triglycerides, remnant cholesterol, and atherosclerotic cardiovascular disease risk. *Endocrine reviews*, 40(2), 537-557. https://doi.org/10.1210/er.2018-00184

Smitson, C. C., Scherzer, R., Shlipak, M. G., Psaty, B. M., Newman, A. B., Sarnak, M. J., Odden, M. C., & Peralta, C. A. (2017). Association of Blood Pressure Trajectory With Mortality, Incident Cardiovascular Disease, and Heart Failure in the Cardiovascular Health Study. *American Journal of Hypertension*, *30*(6), 587–593. https://doi.org/10.1093/ajh/hpx028

Stevens, S. L., Wood, S., Koshiaris, C., Law, K., Glasziou, P., Stevens, R. J., & McManus, R. J. (2016). Blood pressure variability and cardiovascular disease: Systematic review and meta-analysis. *BMJ*, *354*, i4098. https://doi.org/10.1136/bmj.i4098

Sundjaja, J. H., & Pandey, S. (2021). Cholesterol Screening. In StatPearls. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK560894/

Toth, P. P. (2005). The "Good Cholesterol." *Circulation*, *111*(5), e89–e91. https://doi.org/10.1161/01.CIR.0000154555.07002.CA

Tsai, M.-C., Lee, C.-C., Liu, S.-C., Tseng, P.-J., & Chien, K.-L. (2020). Combined healthy lifestyle factors are more beneficial in reducing cardiovascular disease in younger adults:

A meta-analysis of prospective cohort studies. *Scientific Reports*, *10*(1), 18165. https://doi.org/10.1038/s41598-020-75314-z

Wadhera, R. K., Steen, D. L., Khan, I., Giugliano, R. P., & Foody, J. M. (2016). A review of low-density lipoprotein cholesterol, treatment strategies, and its impact on cardiovascular disease morbidity and mortality. *Journal of clinical lipidology*, 10(3), 472-489. https://doi.org/10.1016/j.jacl.2015.11.010

Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Dennison Himmelfarb, C., DePalma, S. M., Gidding, S., Jamerson, K. A., Jones, D. W., MacLaughlin, E. J., Muntner, P., Ovbiagele, B., Smith, S. C., Spencer, C. C., Stafford, R. S., Taler, S. J., Thomas, R. J., Williams, K. A., … Wright, J. T. (2018). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension (Dallas, Tex.: 1979)*, *71*(6), e13–e115. https://doi.org/10.1161/HYP.0000000000000065

Woodward, M. (2019). Cardiovascular Disease and the Female Disadvantage. *International Journal of Environmental Research and Public Health*, *16*(7). https://doi.org/10.3390/ijerph16071165

The Association Between Attending School in an Urban Versus Rural Community and the Consumption and Frequency of Cannabis Use in the Last 12 Months in Male and Female Grade 9-12 Students in Prince Edward Island

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Introduction

In 2018, the Canadian government made the decision to legalize and regulate recreational cannabis under the *Cannabis Act*, making it the second country to do so (Rotermann, 2019). The legal age to consume and purchase cannabis was set at 19 (Nguyen et al., 2020). Youth cannabis use in Canada has increased from 30.5% in 2016/17 to 32.4% in 2018/19 and is expected to continue rising (Zuckermann et al., 2021). Cannabis use among youth poses a serious concern regarding educational achievement. Higher use of cannabis is associated with lower educational attainment and a lower chance of obtaining a higher-level degree in adulthood (Maggs et al., 2015). There is also a relationship between marijuana use during adolescence and cognitive deficits like poor attention and verbal memory (Lisdahl et al., 2014). Following its legalization, seeking differences in marijuana use among various adolescent groups is important to determine which adolescents are at the highest risk to suffer these consequences.

The terms “cannabis” and “marijuana” are often used interchangeably. However, marijuana is a component of the cannabis plant (Kimura., et al 2018). Both marijuana and cannabis contain the active ingredient THC (Kimura et al., 2018; Chaves et al., 2020), and thus will be studied under the same group in this study. The terms will be used interchangeably.

The Canadian government defines an urban region as a region with a population of at least 1,000 people, and a population density of at least 400 people per square kilometre, while a rural region is defined as anything which is not an urban region (Statistics Canada, 2017). The database from which the information for this study was extracted, the Canadian Student Tobacco, Alcohol and Drugs Survey, 2018-2019, did not specify alternate definitions for these terms, therefore, it is assumed that the database followed national guidelines.

Youth cannabis consumption may be related to geographic location, however, it is unclear whether their region influences their use. Adolescents in urban communities may have easier access to the drug due to the greater availability of cannabis in metropolitan areas (Warren et al., 2015). Additionally, there may be a greater opportunity to make more social connections through which one may obtain marijuana due to the greater population density in urban areas (Warren et al., 2015). In contrast, there are unique aspects to rural living which may lead to greater substance use, such as lack of recreation opportunities, access to care, and loneliness (Warren et al., 2015). Rural populations have shown more relaxed attitudes toward youth substance use, and adults are more likely to offer substances to children (Warren et al., 2015).

Previous studies have shown variable results regarding the influence of an urban versus rural environment on youth cannabis use. A 2008 study by Martino et al. found that in South Dakota, young adults aged 13-19 started using marijuana at an earlier age in urban communities compared to rural. Their findings suggest that less populated rural areas are more protective against the usage of certain drugs (Martino et al., 2008). Another study in 2015 by McInnis et al. had inconclusive results. Roughly 38% of their surveys found that students in a rural region were more likely to have tried cannabis than urban students (McInnis et al., 2015). Other surveys indicated no differences between attending school in an urban or rural region and consumption of marijuana or cannabis (McInnis et al., 2015). Approximately 25% of their surveys showed that students in a rural setting had a higher likelihood of almost daily or daily cannabis or marijuana use (McInnis et al., 2015). The data for this study was collected from multiple province-wide surveys from British Columbia, Alberta, Manitoba, Québec, Newfoundland and Labrador, and New Brunswick; not all Canadian provinces were included in this study (McInnis et al., 2015).

Due to confounding evidence, a knowledge gap exists regarding the correlation between geographic location (urban versus rural) and youth marijuana use. Findings exist both in favour of and against this correlation, however, no studies have focused specifically on high school students in Prince Edward Island (P.E.I.), Canada. Our research aims to answer the primary question of "what association is there between attending school in an urban area as opposed to in a rural area and the consumption of cannabis in male and female high school students in P.E.I.?" and the secondary question of "what association is there between attending school in an urban area as opposed to in a rural area and the frequency of cannabis use in the last 12 months in female high school students in P.E.I.?"

Methods

Study Design and Database. The database followed a cross-sectional format, while the sample design was a stratified single-stage cluster, which involves choosing a random sample of clusters and gathering data from every single subject within that cluster. Information for this study was extracted from the Canadian Student Tobacco, Alcohol and Drugs Survey (CSTADS), 2018-2019. The CSTADS was conducted for Health Canada to provide data on student tobacco, alcohol and drug use. The full database included young Canadian residents in private, public, and Catholic schools from grades 7 through 12. Provinces included in the complete database were Newfoundland and Labrador, P.E.I., Nova Scotia, New Brunswick, Québec, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia. Excluded from this database were students enrolled in schools in Nunavut, the Yukon and Northwest Territories, as well as those who attended special schools (e.g. schools for visual or hearing impaired, First Nation reserve schools, etc). Also, students from schools with less than 20 students were excluded. A total of 442 schools participated in the study for the database, with a total of 62,850 participants.

Study Participants. Only data from students in grades 9 through 12 in P.E.I. was used for this study. Data from other provinces, as well as missing data, was removed. There were 58,096 participants removed from provinces outside of P.E.I., 1,929 students removed from P.E.I. who were not in grades 9-12, and 32 participants removed who answered “not stated” to the first question, “Have you ever tried cannabis?”. This resulted in a final study population of 2,793. Further refinement was made that investigates the frequency of cannabis consumption. All participants must have used cannabis at least once, so the 1,996 participants who answered “no” to the first question were removed. Lastly, there were 48 cases removed who answered “I don’t know” or “Not stated” to the second question, “In the last 12 months, how often did you use marijuana or cannabis?”. This resulted in a final study population of 749.

Study Outcomes. The participants who stated P.E.I. as their Province ID were studied due to the relatively equal participants in rural and urban regions, to allow for the best comparison. The primary outcome of this study was to determine if the respondents' schools are in an urban or rural region in P.E.I. and if they have ever used or tried marijuana or cannabis in the form of a joint, pot, weed, hash, or hash oil. Participants chose from categories of either “urban” or “rural” for school location, and either “Yes” or “No” for whether they have ever tried cannabis or marijuana. The secondary outcome of this study was to determine if there is an association between the respondents’ schools in an urban or rural region and how frequently they have used cannabis or marijuana in the last 12 months. Participants could choose from the categories “I have not done this in the last 12 months”, “less than once a month”, “once a month”, “2 or 3 times a month”, “once a week”, “2 or 3 times a week”, “4 to 6 times a week”, or “every day”. These variables were studied as cannabis consumption poses a serious risk to youth. For example, it has been found that cannabis use can cause attention and memory deficits, which may lead to lower educational attainment (Chang et al., 2006; Maggs et al., 2015). Thus, cannabis use during adolescence is an issue that should be targeted early on. Furthermore, reproducing this study in other provinces or countries to continually assess youth cannabis consumption is also important to understand what can be done to prevent adolescent use and consequences associated with that (Sampasa-Kanyinga et al., 2018).

Additional Data Collection. Additional variables included in the study were the participants' sex at birth, and what high school grade they are in. Respondents chose either "male" or "female" as their sex at birth and stated their year of study between grades 9-12. These descriptive variables were used to help illustrate the population characteristics.

Statistical Analysis. Statistical analyses for this study were run using version 28 of the SPSS Statistics software to create figures and determine results. Frequencies for each category were determined using SPSS and presented in a table. One bar graph was constructed using SPSS to illustrate the consumption of cannabis or marijuana users and the area of the respondent's school. Using Microsoft Excel, another bar graph was constructed to compare the frequency of cannabis consumption and the percentage of responses in urban or rural areas. The data set was limited to categorical variables, therefore, SPSS was used for both outcomes to perform a Spearman's *rho* test to assess the relationship between the two variables, and a chi-squared test to compare the proportion of responses between groups. P-values in both analyses of less than 0.05 are considered significant, and a Spearman's *rho* correlation coefficient between 0.3-0.8 is considered significant. SPSS was used to transform the variable, "In the last 12 months, how often did you use marijuana or cannabis" to perform a 2x2 chi-square analysis for each frequency of use, then each p-value was put into a table to compare between-group differences.

Results

Table 1 demonstrates the distribution of answers between the various participants based on their characteristics. Notably, 70.65% of high school students reported that they have never used or tried marijuana or cannabis (a joint, pot, weed, hash, or hash oil), while there were 28.21% of high school students that have tried marijuana or cannabis.

Table 1. Descriptive characteristics of high school students in P.E.I. [n=2,825].

Characteristics	Frequency when the respondent's school is in an urban region n (%)	Frequency when the respondent's school is in a rural region n (%)	Total Frequency n (%)
Has the respondent ever used or tried marijuana or cannabis (a joint, pot, weed, hash, or hash oil)?			
Yes	298 (10.55)	499 (17.66)	797 (28.21)
No	1042 (36.88)	954 (33.77)	1996 (70.65)
Not Stated	18 (0.64)	14 (0.50)	32 (1.13)
In the last 12 months, how often did you use marijuana or cannabis?			
I have not done this in last 12 months	49 (1.73)	67 (2.37)	116 (4.11)
Less than once a month	109 (3.86)	168 (5.95)	277 (9.81)
Once a month	20 (0.71)	29 (1.03)	49 (1.73)
2 or 3 times a month	25 (0.88)	51 (1.81)	76 (2.69)
Once a week	18 (0.64)	27 (0.96)	45 (1.59)
2 or 3 times a week	17 (0.60)	31 (1.10)	48 (1.73)
4 to 6 times a week	16 (0.57)	34 (1.20)	50 (1.77)
Everyday	26 (0.92)	62 (2.19)	88 (3.12)
I do not know	11 (0.39)	20 (0.71)	31 (1.10)
Valid skip	1060 (37.52)	968 (34.27)	2028 (71.79)
Not stated	7 (0.25)	10 (0.35)	17 (0.60)
What grade are you in?			
Grade 9	628 (22.23)	435 (15.40)	1063 (37.63)
Grade 10	254 (8.99)	374 (13.24)	628 (22.23)
Grade 11	264 (9.35)	351 (12.42)	615 (21.77)
Grade 12	212 (7.50)	307 (10.87)	519 (18.37)
What was your sex at birth?			
Female	718 (25.42)	736 (26.05)	1454 (51.47)
Male	640 (22.65)	731 (25.88)	1371 (48.53)

Each of the percentages is of the total population and was rounded to the nearest 2 decimal places. This table includes all missing cases.

In Figure 1, of those 797 who partook in marijuana or cannabis consumption, 298 attended school in an urban area, compared to 499 of them who attended school in a rural area. Comparing the two different regions, there were approximately 34.34% of the rural students who have tried it and about 22.24% of the students who attended school in the urban area who have used or tried it.

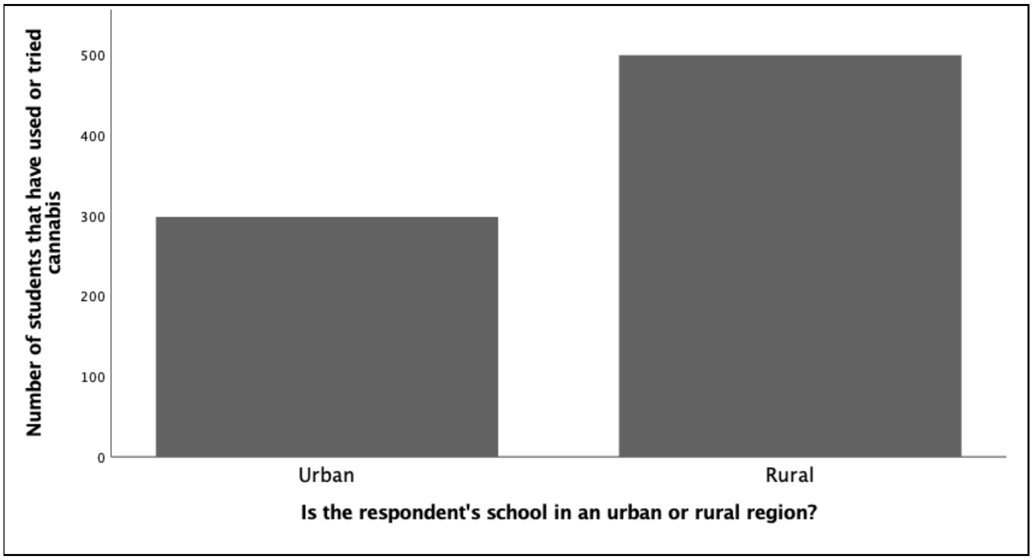

Figure 1. A bar graph presenting the consumption of cannabis or marijuana and the area of the respondent's school (urban versus rural) [n=797]. This figure represents the students who replied "yes" to the question of whether or not they have ever tried or used marijuana or cannabis. The 1,996 participants who replied "no" and the 32 who did not state an answer were excluded from this graph.

Table 2 presents a Spearman's *Rho* analysis for marijuana or cannabis (a joint, pot, weed, hash, or hash oil) consumption and the respondent's school in an urban versus rural area. SPPS produced a Spearman's *rho* correlation coefficient value of -0.134 and a p-value < 0.001, indicating that there is a weak, negative association between marijuana or cannabis consumption and the respondent's school.

Table 2. Spearman's *Rho* analysis for marijuana consumption and respondent's school in an urban versus rural area.

Correlations			Have you ever used or tried marijuana or cannabis (a joint, pot, weed, hash, or hash oil)?	Is the respondent's school in an urban or rural region?
Spearman's rho	Have you ever used or tried marijuana or cannabis (a joint, pot, weed, hash, or hash oil)?	Correlation Coefficient	1.000	-.134**
		Sig. (2-tailed)	.	* <.001
		N	2793	2793
	Is the respondent's school in an urban or rural region?	Correlation Coefficient	-.134**	1.000
		Sig. (2-tailed)	<.001	.
		N	2793	2793

**. Correlation is significant at the 0.01 level (2-tailed).

Participants who responded "yes" or "no" to have you ever tried it and "urban" or "rural" to the school region were included in this analysis. A total of 32 missing cases were excluded. A "*" indicates a significant value.

In Table 3, the Pearson chi-square significance was <0.001, indicating that the proportions are significantly different between all proportions of the variable groups.

Table 3. Chi-square test for whether the respondents live in an urban or rural area, and whether they have ever tried marijuana or cannabis.

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	50.081[a]	1	<.001		
Continuity Correction[b]	49.490	1	* <.001		
Likelihood Ratio	50.551	1	<.001		
Fisher's Exact Test				<.001	<.001
Linear-by-Linear Association	50.063	1	<.001		
N of Valid Cases	2793				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 382.38.

b. Computed only for a 2x2 table

Those who answered the questions of “have you ever tried or used marijuana or cannabis?” and “is the respondent’s school in an urban or rural region?” were included in this analysis. A total of 32 missing cases were excluded. A “*” indicates a significant value.

As shown in Figure 2, rural high school students used cannabis or marijuana more often, while urban high school students used cannabis or marijuana less frequently. From this graph, it is visible that roughly 18% of urban students responded with “I have not done this in the last 12 months”, as compared to 14% of rural students. Rural students were found to have more frequent use of cannabis as 13% of rural students consumed cannabis every day, and only 9% of urban students consumed it every day. However, the difference between urban and rural students was small and insignificant.

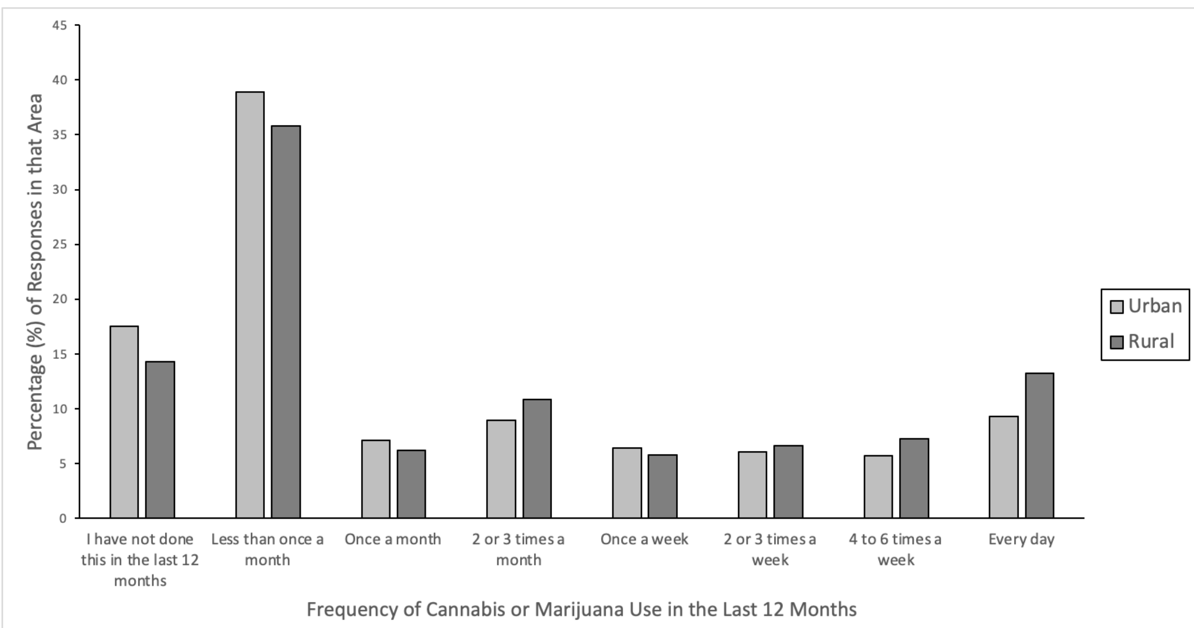

Figure 2. Frequency of users’ cannabis consumption and percentage of responses in urban or rural areas [n=749]. The 1,996 participants who answered “no” and the 32 who did not respond to “have you ever tried or used marijuana or cannabis?” are excluded from this graph. The number of respondents for each frequency of consumption was divided by the total number of marijuana or cannabis users in that region to obtain percentages of the population.

In Table 4, the p-value obtained was equal to 0.040, however, the correlation coefficient obtained for Spearman's rho was 0.075, indicating no significant relationship between these variables.

Table 4: Spearman's *Rho* Analysis for the region of respondent's school and frequency of cannabis use.

Correlations

			In the last 12 months, how often did you use marijuana or cannabis?	Is the respondent's school in an urban or rural region?
Spearman's rho	In the last 12 months, how often did you use marijuana or cannabis?	Correlation Coefficient	1.000	.075*
		Sig. (2-tailed)	.	.040
		N	749	749
	Is the respondent's school in an urban or rural region?	Correlation Coefficient	.075*	1.000
		Sig. (2-tailed)	.040	.
		N	749	749

*. Correlation is significant at the 0.05 level (2-tailed).

The two variables used in the analysis were, "in the last 12 months how often did you use marijuana or cannabis?" and "is the respondent's school in an urban or rural region?". There were 2,076 missing cases excluded from the frequency of cannabis use.

Table 5 shows a summary table of all the p-values from 8 different chi-square analyses between the region of the respondent's school and the frequency of cannabis use. The p-values from each test were greater than 0.05, therefore, no significant relationships were found between groups.

Table 5: Chi-square analysis p-values comparing all proportions from all groups.

Groups	p-value from Chi-Square Test
I have not done this	0.284
Less than once a month	0.439
Once a month	0.718
2 or 3 times a month	0.467

Once a week	0.830
2 or 3 times a week	0.891
4 to 6 times a week	0.507
Every day	0.134

There were 2,076 missing cases excluded from the groups analyzed.

Discussion

There was an association between high school students attending school in rural and urban areas in P.E.I. and the consumption of marijuana or cannabis. Most often, respondents attending school in an urban area have never tried cannabis or marijuana, and most of those who have tried it were found to attend school in a rural area. Additionally, there was more frequent use of cannabis or marijuana in rural areas, however, the association was not significant between the frequency of cannabis or marijuana use and those who attend school in rural areas versus rural areas.

Our study found that there was a significant association between a student's school location and marijuana or cannabis use. Specifically, there were more high school students in rural areas who have tried or used marijuana or cannabis. Contrary to these results, past research reported a significant difference in marijuana use between youths in urban and rural regions, as they commonly reported that youth from rural areas consumed less marijuana than their urban counterparts (Ousey & Maume, 1997). In this study, the higher rates of cannabis or marijuana use in rural regions could be due to rural regions having a lack of recreation and access to care, higher rates of isolation, and more relaxed attitudes towards illicit substance use (Warren et al., 2015). In addition, previous studies have found that rural schools can sometimes be one of the main places, if not the only source, for students to connect with their peers (Rostosky et al., 2003). Urban areas are found to have more social outlets and more resources providing support to students who are in need (Rostosky et al., 2003). Consequently, the psychosocial health of rural students may be worsened as compared to their urban counterparts, so they may resort to cannabis as a solution for their problems (Rostosky et al., 2003). However, a limitation to the study performed by Rostosky et al. (2003) is that it was performed roughly 2 decades ago, but developments have been made to infrastructure and social support systems with time that alters these results.

There was found to be no significant difference between the frequency of cannabis use and attending school in an urban versus rural region. These results can be supported by a study that found no consistent association between students who attended school in an urban versus rural area and their daily use of cannabis (McInnes et al., 2015). Another study that looked at urban and rural youth daily marijuana use found that there was a higher prevalence in urban youth at the beginning of the study period (Cronk & Sarvela, 1997). This study monitored substance use in 3-year intervals, and by the end of the final interval, the difference between daily consumption between urban and rural youth was reduced (Cronk & Sarvela, 1997). A potential reason for no difference between these groups could be due to a lack of participation in the survey. If the survey was taken while at school, perhaps students who use cannabis more frequently were skipping school and, therefore, did not participate in the study (Sznitman, 2007). In urban areas, youth have easier access to illicit drugs through their social circles (Warren et al., 2015). Alternatively, urban areas may have less frequent use due to a greater awareness of the risks associated with substance abuse (Cronk & Sarvela, 1997). In rural areas, there is a lack of recreation and healthcare resources, and more relaxed attitudes toward illicit drug use (Warren et al., 2015). Furthermore, rural students may have a more frequent use due to less effective or uncommon preventative efforts (Cronk & Sarvela, 1997). Therefore, both urban and rural regions have reasons why youth would or would not use marijuana, which may be why it was difficult to find differences between the groups. These results are important because determining which youth are at a greater risk allows health officials to determine the groups which will need more interventions, preventative measures, and education on the risks of marijuana use. Interventions will not be effective if they are not targeted to the groups that need them.

Although this study provided some insightful information, there were several limitations. A possible limitation for our study is that the database did not specify their definition of what is considered to be an urban or rural area, and did not have an option for suburban communities. Therefore, if the database went by the Canadian definition of an urban region, it’s a very loose definition that may not accurately reflect the region. Moreover, there were unequal participants in the urban and rural groups making it difficult to make a comparison. Additionally, due to the cross-sectional design of our study, causal relationships cannot be inferred because the variables were examined at the same time. Moreover, the survey used to collect results was based on a self-report questionnaire, which may introduce self-report bias, leading to the incomplete or inaccurate answering of survey questions. As the legal age for marijuana use is 19-years-old in P.E.I., these underage students may have been afraid to admit whether or not they have used cannabis and the frequency of their consumption. Lastly, since this study focuses on students attending school, it may not be indicative of all cannabis users in that age range, as students who have dropped out of school have a higher rate of cannabis use (Sampasa-Kanyinga et al., 2018).

Future studies could investigate these relationships in other Canadian provinces and territories to see if consistent results could be obtained. For example, a territory like Nunavut has a short growing season and it is costly to import goods (Panchen, 2016). Therefore, perhaps they are less likely to consume cannabis or marijuana due to these conflicting factors and may have less of an importance for implementing drug-use resources than a province where cannabis is more prevalent. Additionally, future studies could look deeper into variables that may mediate the relationship between urban versus rural living and youth marijuana use. This includes attitudes toward drug use, accessibility of marijuana, peer drug use, socioeconomic status, and prevalence of mental illness. This study only looked at the consumption of cannabis and the frequency of use, but evaluating the risks associated with frequent use could be beneficial. Once future studies can determine which groups are at high risk for youth cannabis use, the next steps are to implement increased supportive resources, cannabis abuse education systems, and prevention methods targeted and catered toward these areas.

References

Chang L., Yakupov R., Cloak C., Ernst T. (2006) Marijuana use is associated with a reorganized visual-attention network and cerebellar hypoactivation. *Brain (2006)*129, 1096-1112. doi:10.1093/brain/awl064

Chaves C., Bittencourt P.C.T., Pelegrini A. (2020). Ingestion of a THC-Rich Cannabis Oil in People with Fibromyalgia: A Randomized, Double-blind, Placebo-Controlled Clinical Trial. *Pain Medicine, (21)*10, 2212-2218.

Cronk, C. E., & Sarvela, P. D. (1997). Alcohol, tobacco, and other drug use among rural/small town and urban youth: A secondary analysis of the monitoring the future data set. *American Journal of Public Health, 87*(5), 760-4. https://doi.org/10.2105/AJPH.87.5.760

Huestis M.A, Henningfield J.E, Cone E.J. (1992). Blood Cannabinoids I. Absorption of THC and Formation of 11-OH-THC and THCOOH During and After Smoking Marijuana. *Journal of Analytical Toxicology, 16*(5), 276-282. https://doi.org/10.1093/jat/16.5.276

Kimura T., Takaya M., Usami N., Watanabe K., Yamamoto I. (2019). Δ_9-Tetrahydrocannabinol, a major marijuana component, enhances the anesthetic effect of pentobarbital through the CB_1 receptor. *Forensic Toxicol* (37), 207–214. https://doi.org/10.1007/s11419-018-0457-2

Maggs J.L., Staff J., Kloska D.D., Patrick M.E., O'Malley P.M., Schulenberg J. (2015). Predicting Young Adult Degree Attainment by Late Adolescent Marijuana Use. *Journal of Adolescent Health, (57)*2, 205-211.

Martino, S. C., Ellickson, P. L., & McCaffrey, D. F. (2008). Developmental trajectories of substance use from early to late adolescence: a comparison of rural and urban youth. *Journal of studies on alcohol and drugs, 69*(3), 430–440. https://doi.org/10.15288/jsad.2008.69.430

McInnis, O.A., Young, M.M., Saewyc, E., Jahrig, J., Adlaf, E., Lemaire, J., Taylor, S., Pickett, W., Stephens, M., Di Gioacchino, L., Pica, L., Levin, D., Tonita, A., Wang, H., & Xiong, H. (2015). Urban and Rural Student Substance Use, Ottawa, Ont.: Canadian Centre on Substance Abuse. https://ccsa.ca/sites/default/files/2019-05/CCSA-Urban-Rural-Student-Substance-Use-Report-2015-en_0.pdf.

Nguyen, H.V., Bornstein, S., Gamble, JM. *et al.* Too young for Cannabis? Choice of minimum legal age for legalized non-medical Cannabis in Canada. *BMC Public Health* 20, 557 (2020). https://doi.org/10.1186/s12889-020-08639-z

Ousey, G. C., & Maume, M. O. (1997). The Grass is Always Greener: Explaining Rural and Urban Differences in Marijuana Use. *Sociological Focus*, *30*(3), 295–305. https://doi.org/10.1080/00380237.1997.10571080

Panchen, Z. A. (2016). Arctic plants produce vastly different numbers of flowers in three contrasting years at Lake Hazen, Quttinirpaaq National Park, Ellesmere Island, Nunavut, Canada. *The Canadian Field-Naturalist*, *130*(1), 56–63. https://doi.org/10.22621/cfn.v130i1.1806

Propel Centre for Population Health Impact. (June 2019). *Canadian Student Tobacco, Alcohol and Drugs Survey, 2018-2019.* [Data file]. Retrieved from http://odesi2.scholarsportal.info/webview/index.jsp?object=http://142.150.190.128:80%2Fobj%2FfStudy%2Fcstads-E-2018-2019-TEST&mode=documentation&v=2&top=yes

Rostosky, S.S., Owens, G.P., Zimmerman. R.S., & Riggle, E.D. (2003). Associations among sexual attraction status, school belonging, and alcohol and marijuana use in rural high school students. *Journal of Adolescence, 26*(6):741-51. https://doi.org/10.1016/j.adolescence.2003.09.002

Rotermann, M. (2019). Analysis of trends in the prevalence of cannabis use and related metrics in Canada. *Health Reports, 30*(6), 3-13. DOI:10.25318/82-

Sampasa-Kanyinga, H., Hamilton, H. A., LeBlanc, A. G., & Chaput, J.-P. (2018). Cannabis use among middle and high school students in Ontario: A school-based cross-sectional study. *CMAJ Open*, *6*(1), E50–E56. https://doi.org/10.9778/cmajo.20170159

Sznitman, S. Rø. (2007). An examination of the normalisation of cannabis use among 9th grade school students in Sweden and Switzerland. *Addiction Research & Theory*, *15*(6), 601–616. https://doi.org/10.1080/16066350701433233

Statistics Canada. (2017). *Population Centre and Rural Area Classification.* Retrieved from: https://www.statcan.gc.ca/en/subjects/standard/pcrac/2016/introduction

Warren J.C, Smalley K.B, Barefoot K.N. (2015). Perceived Ease of Access to Alcohol, Tobacco, and Other Substances in Rural and Urban US Students. *Rural Remote Health, 15*(4), 3397. https://doi.org/10.1111/j.1748-0361.2007.00128.x

Zuckermann, A. M. E., Battista, K. V., Bélanger, R. E., Haddad, S., Butler, A., Costello, M. J., & xLeatherdale, S. T. (2021). Trends in youth cannabis use across cannabis legalization: Data from the COMPASS prospective cohort study. *Preventive Medicine Reports*, *22*, 101351. https://doi.org/10.1016/j.pmedr.2021.101351

Association between Canadian women's education level and fertility behaviour; exploring age at first childbirth, total number of children, and use of contraceptives and abortion.

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Introduction

Fertility refers to the ability to conceive and bear children. There are many different factors in life that might affect someone's attitudes towards fertility, more specifically, whether someone chooses to conceive and bear many children or if they take the steps to avoid conceiving and bearing children. A study by Woldemicael and Beaujot (2012) depicted that the increasing number of immigrants migrating to Canada are characterized by high fertility levels. In particular, it is documented that the discrepancy in higher fertility for foreign born individuals compared to second generations may be caused in part by sociodemographic factors (Woldemicael & Beaujot, 2012). Zelkowitz et al. (2015) have further supported that immigrants born outside Canada are subject to more unemployment and lower incomes, which may contribute to their reduced access to fertility resources as well as fertility education.

Kravdal (2001) provided the finding that women who had more education tended to have reduced fertility rates. Primary education contributed only slightly to the increasing age of the mother during first childbirth, whereas secondary school education resulted in the mother having her first child at a later age (Kravdal, 2001). Family planning education impacts fertility control by increasing spousal communication, providing a sense of control about one's destiny, and by increasing the potential income of couples, thus making contraceptives more available (Weinberger, 1987). In Tanzania, the fertility desires of women were largely influenced by their education (Kravdal, 2001). A shift has been observed in the preferences of Tanzanian women from children towards consumer goods or other satisfaction sources (Kravdal, 2001). This is presumed to be due to an increased access to knowledge about the modern world and a desire to hold positions in professional careers, which require higher education (Kravdal, 2001).

A study conducted by Eskild et al. (2007) explored the impact of education and ethnic background on childbearing and induced abortion. The researchers included women between the ages of 15-50 years from Norwegian (n = 94,428) and Pakistani (n = 5,390) populations (Eskild et al., 2007). For Norwegian women who received education upto university level, Eskild et al. (2007) found that 15.3% of them gave birth and 2.9% had an induced abortion between the years 2000 and 2002. For Norwegian women who recieved less than high school education, 5.3% delivered a child while 4.3% had induced abortions (Eskild et al., 2007). For Pakistani women, Eskild et al. (2007) found that among the women who received university education, 23.0% gave birth and 2.9% had an induced abortion. Among the high school education Pakistani women, 20.8% delivered a baby while 2.8% had an induced abortion (Eskild et al., 2007). Overall, it was seen that lower education in Norwegian women correlated with lower rates of child birth and a higher frequency of induced abortions. Childbirth was not related to education level in Pakistani women, but the frequency of induced abortions increased with higher educaiton. These results specifically showed the rates of childbirth and abortions relative to education levels for Norwegian and Pakistani women (Eskild et al., 2007).

Another study found that education levels of women, and youth in general, had a correlation with their contraceptive usage (Lou et al., 2004). Researchers of this study explored how promoting safe sex behvaiour – using contraception and condoms – affected youth aged between 15-24 in Shanghai, China. To do this, one town in Shanghai was taught about sexuality and reproduction, while another town was used as the control and not given this education (Lou et al., 2004). Lou et al. (2004) found that there was a greater proportion of individuals reporting using contraceptives and condoms regularly within the intervention group – the town that was provided information – showing that education did in fact influence their behaviours.

Both of these previous studies occurred outside of Canada, but there has not been Canadian research done on the age at which a woman has her first child and how many children she has in total as a result of the amount of education received. It is also unknown whether Canadian women who obtain higher levels of education tend to avoid having children early on or any at all, and whether they partake in an increased frequency of abortions and contraceptive use. After the 1959 Baby Boom peak, Canada was distinguished as having relatively low fertility (Bashir & Guzzo, 2021). The rate of fertility had been stabilized at 1.5 children per woman (Bashir & Guzzo, 2021). Due to this, fertility related questions are important to answer because they determine the resources that must be made available for future generations (for instance, if more primary schools need to be built, if more abortion clinics and access to contraceptives needs to be implemented, etc). The fertility decline in a country has implications for its economy, population, resource allocation, and future planning, all of which need to be studied.

The goal of this research study was to explore the association between education levels and fertility among Canadian women using The Canadian Fertility Survey (1984). Specifically, is there an association between a higher level of education (anything above a high school diploma) and the age at which Canadian women between the ages 18-49 have their first child, as compared to the age that women of the same age group who have a lower level of education (high school diploma or less) have their first child? As a secondary outcome, this research study will look at the total number of children a woman (aged 18-49) has as a result of their level of education. As a tertiary outcome, this study will explore the prevalence of abortions and contraceptive usage among women between the ages of 18-49 who receive a higher level of education.

Methods

Study design and database

The Canadian Fertility Survey (CFS) was conducted from April through June of 1984. It was the first national study done in Canada that looked at the fertility of women during their childbearing years. This observational, cross-sectional survey, which was retrospective in nature, collected data concerning Canadian women's fertility, contraceptive use, marriage and work histories, fertility expectations, attitudes towards marriage and family, and socio-economic characteristics (Balakrishnan et al., n.d.). The project was executed by co-investigators from the University of Montreal, The University of Alberta, and The University of Western Ontario (Balakrishnan et al., n.d.).

Study participants

The Canadian Fertility Survey interviewed and collected data from women between the ages of 18-49 (n=5315) exclusively over the phone. Both the selection of the sample and the interview were done over the phone, and for this reason, only households accessible over the phone were included in the sample. All ten Canadian provinces were covered, but the Yukon and the Northwest Territories were excluded due to cost and efficiency. Individuals unable to speak English or French were also excluded from the study, as well as individuals living in institutions.

The process of collecting data included dialing randomly generated numbers instead of using numbers from the telephone book, allowing for an equal chance of all households to be selected for the study. This also avoided an under-representation of individuals living alone, young people, separated and divorced individuals, and renters, who generally tend to have a lesser chance of having a working number in the telephone directory. Researchers identified Canadian women aged 18-49 to participate and answer questions regarding fertility.

For the purpose of this study, we excluded individuals who did not specify their highest level of education, specifically their highest diploma/degree/certificate received. We are also not including participants with missing data in the dependent variables – age at birth of first child, number of total live births, and contraceptive and abortion use. The total sample size used in this study was 1704.

Study outcomes

The primary outcome of this study is the age at which participants with a higher level of education had their first child compared to those with a lower level of education. To determine the level of education, participants were asked "What is the highest degree, certificate, diploma or grade you have obtained?" Participants' responses included: no diploma, elementary school certificate, trades school certificate/diploma, secondary school graduate certificate, technical school diploma, teacher school diploma, general college degree/diploma, technical college degree/diploma, college degree/diploma with no specialization, university certificate, or a bachelor's degree. This outcome was selected to determine if age and education are correlated as to when women have children.

A secondary outcome of this study is the total number of children participants have as a result of their level of education. To determine this, the level of education is looked at, the same as above, and the total number of live births. Participants were asked, "How many live births have you had up to now including those who died after birth or who do not live with you?" This question is asked as the number of live births will help determine how fertility rates correlate to level of education.

Lastly, the tertiary outcome of this study is the prevalence of contraceptive usage and abortions to prevent early or overall pregnancy in participants with a higher level of education.

Participants were asked if they have used various types of contraceptive methods. From these responses, two categories were created; one which combined all of the contraceptive methods and another category which represented no contraceptive usage. An additional question participants were asked was whether they have had an abortion before, and the answer categories included yes, no, and no answer. This outcome is observed to see if there is a relationship between level of education, and contraceptive use and abortion.

Additional data collection

Participants were also asked their age at the time of the interview, which was used along with the year their first child was born to determine their age at the birth of their first child.

Statistical analysis

For our analysis of the Canadian Fertility Survey version 28.0.0.0(190) of the SPSS program was used to run statistical tests on the variables. To test for normality, the Shapiro-Wilk test was used. The data in Table 1 is summarized in the ascending order of the study outcomes. The Mann-Whitney U test is used for our primary analysis as the data is not normally distributed and the dependent variable of age at first birth is continuous. For our secondary analysis, a Spearman correlation is used as we are evaluating a monotonic relationship between the ordinal variables of education level and the total number of live births. A chi-square test is used for our tertiary analysis as we are determining association between categorical variables. The p-value for significance used for our statistical analyses is 0.05.

Results

After removing 2371 cases of the complete dataset (n=5315) that were missing complete data for education level, 2994 participants remained. After removing 1222 cases with missing data for the age at the birth of the first child, 1722 participants remained. Finally we removed 18 cases because of missing data about contraceptive use and abortion, and 1704 participants remained which were ultimately included in our study. These participants were all women that ranged from the ages 18-49 years. Of these women, 699 received education higher than a high school diploma, while 1005 received either a high school diploma or less. All of these women have had at least one child.

The main characteristics of interest between the lower education level group (n=1005) compared to the higher education level group (n=699) were looked at in Table 1. Because the data was not normally distributed, the median and interquartile range were reported for the continuous variables including the age of the participants, the number of live births, and the age at the birth of their first child. The frequency and percent were reported for the categorical variables 'contraceptive method use' and 'have you used abortion'. These between group differences were used to conduct statistical tests to determine whether there was a significant difference between the lower and higher education level groups.

Table 1. Characteristics of participants who have a lower level of education compared to participants who have a higher level of education.

Variable	Lower Level of Education (High school diploma or less) (n=1005)	Higher Level of Education (Anything greater than a high school diploma) (n=699)
Age of respondent at interview [a], years	32.00(11)	34.00(9)
Number of live births [a]	2.00(2)	2.00(2)
Age at birth of first child [a], years	22.00(5)	25.00(5)
Contraception		
Contraceptive Method Use		
Yes	925(92.0)	654(93.6)
No	80(8.0)	41(6.4)
Abortion		
Have you used abortion		
Yes	58(5.8)	45(6.4)
No	947(94.2)	654(93.6)

Data are presented as number(%) unless otherwise stated.
Median(IQR) denoted using [a].

Findings from primary analysis

The Mann-Whitney U test was used to look at the between group of the lower and higher education level groups in relation to the age at the birth of their first child. The p-value found when testing the between group difference was <0.001 suggesting that the null hypothesis, which states that the median age at the birth of the first child is the same in both the lower and higher education groups, is rejected. As depicted in Figure 1, the median age of participants at the birth of their first child in the lower education group was around 22 years of age. This is significantly different from the median age of participants at the birth of their first child in the higher education group, which was around 25 years of age.

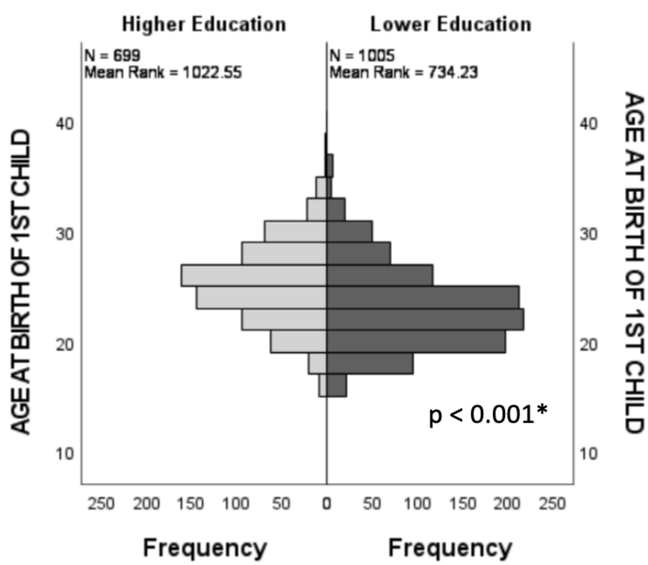

Figure 1. The between group difference of the age at the birth of their first child of participants with a lower education level (n=1005) compared to participants with a higher education level (n=699).

Findings from secondary analysis

Spearman's correlation was computed to assess the relationship between education level of women between the ages 18-49 (n=1704) versus the total number of live births that they had.

There was a negative correlation between the two variables. The spearman's rho coefficient from this analysis was r(1704) = -0.018, p = 0 .469. This rho value depicts that the strength between the two variables is trivial.

Findings from tertiary analysis

The chi-squared test was run to determine the between group differences among the groups of participants with higher versus lower education. This test displayed results for the proportion of responses to categorical-type questions including whether the participants partook in abortion and contraceptive method use. As depicted in Table 2, 5.8% (58/1005) of the participants with a lower education had opted for abortion while 94.2% (947/1005) had not. 6.4% (45/699) of the participants with a higher education have had an abortion while 93.6% (654/699) have not. The chi-square test produced a significance value of 0.642, indicating that the proportion of participants opting for abortion was not significantly different between the groups of higher and lower education. The chi-square analysis for the contraceptive use between the two groups is presented in Table 3. 92.0% (925/1005) of the participants with a lower education had used contraceptives while 8.0% (80/1005) had not. 94.1% (658/699) of the participants with a higher education had used contraceptives while 5.9% (41/699) had not. The chi-square test produced a significance value of 0.119, indicating that the proportion of participants using contraceptives was not significantly different between the groups.

Table 2. Prevalence of abortion use between groups of higher education (n=699) and lower education (n=1005).

		HAVE YOU USED ABORTION		
		YES	NO	Total
Education: Higher or Lower	Lower Education	58	947	1005
	Higher Education	45	654	699
Total		103	1601	1704

Table 3. Prevalence of contraceptive use between groups of higher education (n=699) and lower education (n=1005).

		Contraceptive use: Yes or No		
		No	Yes	Total
Education: Higher or Lower	Lower Education	80	925	1005
	Higher Education	41	658	699
Total		121	1583	1704

Discussion

Main findings

We found that while level of education did have an association with the age at which Canadian women have their first child, there was no association when it came to the total number of children a woman has, or the prevalence of abortions and contraceptive use.

The main goal of this study was to determine whether there was an association between level of education and the age at which Canadian women had their first child. The Mann-Whitney U test shows that there was, in fact, a difference in the median age at which women had their first child. The results showed that while most women in the higher level of education group had their first child at 25-26 years of age, the women in the lower level of education group had their first child about 4 years earlier. This could be due to the understanding that women who have received more education did so with the objective of obtaining a professional career (which often takes longer to obtain than an occupational career). Having a child often halts the progression of completing higher education or receiving promotions, hence, the women who received a higher level education may put off having their first child until after they have established themselves.

The findings from the secondary question, looking at whether there was a difference in the total number of children women had based on their education level, were not significant. The

Spearman rho's correlation coefficient was of trivial value. This meant that there was not a noteworthy difference in the total number of children Canadian women had based on a higher or lower amount of education. This inconvenient result could be due to the fact that education does not play a key role in determining how many children a woman will conceive and give birth to. The total number of children a woman has could just be due to personal preference, financial situations, past experiences, health complications, etc.

The tertiary goal of this study was to determine whether education level made a difference on the prevalence of contraceptives and abortions among Canadian women aged 18-49. The findings from chi-square analysis depict that the level of education did not make a significant difference to the prevalence of contraceptives or abortions, meaning that education was not a contributing factor. The reasoning for this could be that having a higher education did not necessarily mean that one also had a greater amount of knowledge on the topics of contraceptives and abortion. Schools do not have a great amount of time devoted to sex-education, and this means that the women who received lesser education were not missing out on key information. For instance, physical and health education is only mandatory in the first year of high school in Ontario, and so, it does not make a difference whether or not a woman decides to obtain higher education since the education often is not related to contraception methods and abortions.

Comparison of results

A study done by Bader et al. (2014), supported our hypothesis that contraceptive use among young women is influenced by education but also included moral attitudes toward contraception as a contributing factor in contraceptive use. The findings of our tertiary analysis adds to this study in support that there are other contributing factors to the use of contraceptives and abortion. The limitations of this study were influenced by the way many cross-sectional research are, in that data was obtained by telephone interview. Survey responses do not allow for rationale behind answers to be explained, for example it is difficult to understand how participants came to their conclusions of whether contraceptive use is morally right or wrong (Bader et al., 2014). A study conducted by Monstad et al. (2008), indicates that postponement of first births is due to increasing education, thus decreasing teenage pregnancy and increasing first births for women in their 20s to a range of 35 to 40 years of age. These results support the findings from our primary analysis in that women with a higher level of education had their first child at a later age than women with a lower level of education. It is important to note that these findings are interpreted as a correlational relationship rather than a causal relationship. This means that increased education does not necessarily induce women wanting to remain childless or having children at a later age, but more so be due to increased human capital accumulation (Monstad et al., 2008). While our findings showed a significant difference between women of different levels of education, we also consider different factors contributing to the age when women decide to have their first child. For example, a woman may want to pursue higher education resulting in postponement of having her first child as it could put a delay in her educational and career goals. As this study was conducted in Norway, our data adds to the research as we focus on Canadian women, broadening the discussion of the purpose and findings of these studies. Though, this adds a limitation to the comparison of results as policies and attitudes regarding family and education differ from country to country.

Limitations

Limitations of this study were influenced primarily by how the data in the Canadian Fertility Survey was collected. Since the survey was conducted over the phone only households that could be reached over the phone were included in the study. This may have resulted in excluding women of lower socioeconomic status who may not be able to afford a telephone. Women living in Yukon and Northwest Territories were also excluded from participating in this study which also may have impacted the results because it excluded First Nations communities who primarily live in these regions of Canada. Communities living in the Territories of Canada potentially have less access to resources like contraceptives and abortions, thus it may have impacted results, had they been included in the study. Women who did not speak English or French were also not included in the study which means that women who have immigrated to Canada, which is a significant portion of the population, were overlooked. Additionally, women living in hospitals, nursing homes, institutions or were in jail were excluded which may have impacted results. The participants may have also provided answers to the survey questions which were not completely honest or unbiased. This may have been caused by cultural and religious influences concerning fertility behaviours, feelings of embarrassment, and the fear of judgment. Another limitation of this study is that the Canadian Fertility Survey was conducted in the year 1984, which means that the data collected in the survey is not very indicative of the fertility patterns of women in our current time.

Future directions/implications

To move forward from this study, future possibilities must be considered. To observe the most recent fertility trends, data should be collected about the fertility of current Canadian women. This will allow a critical analysis of how trends have changed from the 80s, which is when The Canadian Fertility Survey was conducted. In addition, a need exists for data to be collected representing those individuals who have immigrated to Canada. These non-English or French speakers were underrepresented in the current study, thus they must be accounted for moving forward. The missing data of these immigrants can influence the outcomes of results by allowing for a larger sample size in which more variation of results may be observed.

More research is also required pertaining to how specific contraceptives affect fertility in women. One contraceptive may guarantee greater effectiveness against pregnancy over another, so there is potentially a correlation between what types of contraceptives women are using and how educated they are. With gaps in knowledge, the potentially child-bearing population of women remains susceptible to uninformed decision-making. As a future direction, it is essential to ensure that the entirety of the Canadian women population is well informed about such topics. In their schooling years, students should be taught about the various contraceptive options available to them. Often, students are unaware of the resources available to them, so they must be informed about the access they have to contraceptives, as well as abortions. These individuals must be educated on where they can access such resources. This may be implemented by means such as a change in the schooling curriculum to include more education on contraceptives and abortions. Sex-education may also be made its own mandatory course to separate it from the traditional side role it plays in physical education courses. The importance of sex-education is often undermined, and it is rushed in school in comparison to the focus placed on physical education. From a public health standpoint, doing so will be progressive in terms of overall public health because a greater proportion of the population will be informed on these matters and safer regarding their fertility decisions.

References

Bader, V., Kelly, P. J., Cheng, A. L., & Witt, J. (2014). The role of previous contraception education and moral judgment in contraceptive use. *Journal of midwifery & women's health*, *59*(4), 447-451. https://doi.org/10.1111/jmwh.12149

Balakrishnan, T. R., Krotki, K. J., & Lapierre-Adamcyk, E. (n.d.). *Canadian fertility survey, 1984*. Scholarship@Western. Retrieved November 29, 2021, from https://ir.lib.uwo.ca/sociologydata/1/.

Bashir, S., & Guzzo, K. (2021). Women's Education, Spousal Agreement on Future Fertility Intentions, and Contraceptive Use in Pakistan. *Studies in Family Planning*, *52*(3), 281–298. https://doi.org/10.1111/sifp.12167

Eskild, A., Nesheim, B., Busund, B., Vatten, L., & Vangen, S. (2007). Childbearing or induced abortion: the impact of education and ethnic background. Population study of Norwegian and Pakistani women in Oslo, Norway. *Acta Obstetricia et Gynecologica Scandinavica*, *86*(3), 298–303. https://doi.org/10.1080/00016340601133780

Kravdal, Ø. (2001). Main and Interaction Effects of Women's Education and Status on Fertility: The Case of Tanzania. *European Journal of Population / Revue Européenne de Démographie*, *17*(2), 107–135. https://doi.org/10.1023/A:1010725506916

Lou, C., Wang, B., Shen, Y., & Gao, E. (2004). Effects of a community-based sex education and Reproductive Health Service program on contraceptive use of unmarried youths in Shanghai. *Journal of Adolescent Health*, *34*(5), 433–440. https://doi.org/10.1016/s1054-139x(03)00341-0

Monstad, K., Propper, C., & Salvanes, K. G. (2008). Education and fertility: Evidence from a natural experiment. *Scandinavian Journal of Economics*, *110*(4), 827-852. https://doi.org/10.1111/j.1467-9442.2008.00563.x

Weinberger, M. B. (1987). The Relationship Between Women's Education and Fertility: Selected Findings From the World Fertility Surveys. *International Family Planning Perspectives*, *13*(2), 35–46. https://doi.org/10.2307/2947826

Woldemicael, G., & Beaujot, R. (2012). Fertility behavior of immigrants in Canada: Converging trends. *Journal of International Migration and Integration*, *13*(3), 325–341. https://doi.org/10.1007/s12134-011-0199-z

Zelkowitz, P., King, L., Whitley, R., Tulandi, T., Ells, C., Feeley, N., Gold, I., Rosberger, Z., Chan, P., Bond, S., Mahutte, N., Ouhilal, S., & Holzer, H. (2015). A comparison of immigrant and Canadian-born patients seeking fertility treatment. *Journal of Immigrant and Minority Health*, *17*(4), 1033–1040. https://doi.org/10.1007/s10903-014-0037-4

An investigation into the self-reported feelings of isolation and alcohol and cannabis consumption change over the course of the COVID-19 pandemic in Canadian youths and adults: A cross-sectional observational study

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An investigation into the self-reported feelings of isolation and alcohol and cannabis consumption change over the course of the COVID-19 pandemic in Canadian youths and adults: A cross-sectional observational study

In March 2020, the world changed dramatically when the COVID-19 virus outbreak was declared a pandemic. The multiple stay-at-home orders for Canadians led to many individuals working from home or attending school online, ultimately causing prolonged isolation from family and friends. As such, one of the potential outcomes of isolation is deteriorating mental health and consequential substance use.

Before the pandemic, substances such as alcohol and cannabis remained popular among youths and adults in Western countries. This is attributed to social and cultural norms that encourage the use of these substances in social gatherings. According to Novacek et al. (2007), the most common reasons for substance use among youths include social acceptance and pleasure. Adults claim to consume alcohol for positive reinforcement defined by celebratory occasions and recreation (Abbey et al., 1993). As for cannabis consumption in Canada, cannabis was the most consumed drug even before legalization (Lowry & Corsi, 2020). After legalization, the social acceptance of cannabis gained more popularity, resulting in a greater rise of Canadian cannabis users (Lowry & Corsi, 2020). Specifically, the Canada's National Cannabis Survey reported an increase in the daily use of cannabis in middle-aged and older-aged individuals (Haines-Saah & Fischer, 2021).

While alcohol and cannabis are predominantly associated with social settings amongst youths and adults, these substances are also consumed to alleviate stress. Alcohol has addictive properties that allow individuals to escape negative stressors in their day-to-day life by enhancing positive memories (Abbey et al., 1993). Cannabis belongs to a class of drugs used to reduce anxiety (Spradlin & Cuttler, 2019). Isolation from loved ones is a form of stress that has the potential to lead to substance dependence. According to Stockdale et al. (2007), individuals residing in neighborhoods with low social support systems reported having a higher chance of suffering from alcohol, drugs and mental health (ADM) disorders. This is attributed to the lack of positive relationships that can be fostered in such environments (Stockdale et al., 2007). In general, adolescents who are feeling more depressed, anxious, and fearful for their safety due to the COVID-19 pandemic may engage in solitary substance use as a coping mechanism (Dumas et al., 2020).

Although previous studies have explored the effects of self-isolation on substance use behaviors, not much dedication has been given to this matter in the Canadian population, especially during the COVID-19 pandemic. Moreover, recent publications on substance use during the COVID-19 pandemic are predominantly based on the adult population. There is limited knowledge on the effects of pandemic-related isolation on the substance use behaviors of youths and limited knowledge on how these behaviors compare to that of adults. Dumas et al. (2020) claim that it is important to investigate this in youths as solitary substance use in adolescents during the pandemic is not well-rooted in evidence. Many of the studies are overgeneralized to the whole population which leads to biases and exclusions of demographics that may need more attention, such as youths. For example, previous research by Capasso et al. (2021) suggests that older adults with depression and anxiety reported the greatest increase in alcohol consumption compared to youth during the COVID-19 pandemic. However, one of the distinct limitations in this study was that the majority of the respondents were in their 50s and 60s (Capasso et al., 2021). This suggests that there was an underrepresentation of younger individuals in the survey and the results could be different if there was an accurate portrayal of age groups across the study.

Based on the pressing concerns mentioned above, our study's primary research question is: Is there a difference in the proportion of self-reported substance use of alcohol and cannabis in Canadian youths aged 15 to 24 compared to Canadian adults aged 45 to 54 since the beginning of the COVID-19 pandemic? The secondary research question is: Is there a correlation between self-reported feelings of isolation and the consumption of alcohol and cannabis in Canadian youths aged 15 to 24 years old and Canadian adults aged 45 to 54 years, and how do these correlations compare? The main outcomes we hope to bring to attention in this study are the substance use differences, if any, that may exist in both age groups and if these changes are correlated to self-isolation.

Methods

Study Design and Database

This study was conducted by analyzing the cross-sectional database; *Canadian Perspectives Survey Series 6, 2021: Substance Use and Stigma During the Pandemic* accessed through the Odesi database. Statistics Canada collected the data through an online survey. The information in the dataset includes substance use behaviors, demographic information and feelings of stigma towards substance use. The data was collected from residents in the ten Canadian provinces, aged 15 years and above. Individuals excluded from the survey were those living in reserves, institutionalized persons, households in extremely remote areas with low population density, and the three Canadian Territories as these groups together represent less than 2% of the Canadian population. The sampling procedure for this dataset was conducted by contacting a subset of participants from the Impacts of COVID-19 crowdsource collection to participate. The collection response rate was 54.4% which resulted in a total of 3941 responses. The period of data collection was from January 25th to January 31st, 2021.

Study Participants

The original dataset contained 3941 participants of varying ages. 158 of those participants were youth aged 15 to 24, and 654 were adults aged 45 to 54. The participants from these age groups were further filtered to only include pre-existing alcohol and cannabis users, and those who provided valid responses on their feelings of isolation. This resulted in a final study sample of 812 participants. The remaining cases that did not meet this criteria (i.e. those who answered valid skip, don't know, refusal, chose not to answer, not applicable, or had missing data), were excluded from the statistical analyses. In the youth category this resulted in a total of 35 excluded cases for alcohol consumption and 102 excluded cases for cannabis consumption. In the adult category there were 147 excluded cases for alcohol consumption and 527 excluded cases for cannabis consumption. This resulted in a total of 123 participants in the Canadian youth aged 15-24 category and 507 participants in the Canadian adults aged 45-54 category for self-reported alcohol consumption. The final sample size for cannabis consumption was 56 participants in the Canadian youth aged 15-24 years category and 127 in the Canadian adults aged 45-54 years category.

Study Outcomes

The primary outcome of this study was to understand how the substance use of alcohol and cannabis has changed during the pandemic between adults and youth and to observe which age group had a greater difference in consumption. Participants answered the survey questions: “On average, over the course of the COVID-19 pandemic, how has your alcohol consumption changed when comparing to before the pandemic” and “On average, over the course of the

COVID-19 pandemic, how has your use of cannabis changed when comparing to before the pandemic?" (Canadian Perspectives Survey Series [CPSS], 2020). The response options were: increased, decreased, not applicable, stayed about the same, and do not know. Cannabis consumption was referred to as marijuana, hashish, oil or any other product of the cannabis plant that is smoked, eaten, vaped, drank, dabbed, or consumed by some other method. Alcohol consumption was referred to as drinking one bottle, a can of beer, one glass of wine, a wine cooler, one drink, or a cocktail with one and a half ounces of liquor. The main dependent variable was the change in consumption of alcohol and cannabis and the independent variable was age, particularly the age group of 15-24 and 45-54. The secondary outcome was to investigate if self-reported feelings of isolation were correlated with alcohol and cannabis consumption in youths and adults. Participants were asked "In general, how often have you felt the following since the start of the COVID-19 pandemic: Isolated from others" (CPSS, 2020). Response options were: never, hardly ever, some of the time, often, always, and do not know. Assessing the correlation between isolation and substance use could provide a deeper insight into the ways youths and adults were impacted by the pandemic which could be used to create support programs.

Additional Data Collection

Additional data collected were sex, employment status, needed help for managing emotions, mental health, alcohol and drug use but did not receive it, life satisfaction, mental health now compared to pre-pandemic, amount of stress since the start of the pandemic, and the number of relatives and friends participants felt close with. The variable sex was used to further analyze the changes in alcohol and cannabis consumption in youths and adults to assess if there were any sex differences in the study sample.

Statistical Analysis

The IBM SPSS software was used to analyze, cleanse, and perform all statistical tests. The results for Table I were reported as the number and percentage of participants who provided valid responses. All variables were measured using a Likert scale, with the exception of “sex”, “employment status”, and “Needed help for managing emotions, mental health, alcohol and drug use but did not receive it”. In order to conduct a Chi-square analysis, the variables were transformed into dichotomous variables using SPSS. An alpha value of 0.05 was used for each variable in accordance with Norman & Streiner (2014). Chi-square tests were used to answer the primary research question and a significance value of 0.05 was used for each test (Norman & Streiner, 2014). Alcohol and cannabis consumption variables were re-coded and binned to create 3 new categories with 0 indicating decrease, 1-stayed about the same, and 2-increase. A Spearman’s rho analysis was used to answer the secondary research question and a 0.01 significance value was used (Norman & Streiner, 2014).

Results

The original survey sample consisted of 3,941 individuals of varying ages. In this study, 812 participants were examined which consisted of 158 (19.5%) youths aged 15 to 24 years and 654 (80.5%) adults aged 45 to 54 years. 123 (19.5%) youths and 507 (80.5%) adults were used to investigate the difference in alcohol consumption change over the course of the pandemic, and 56 (30.6%) youths and 127 (69.4%) adults were used to assess the changes in cannabis consumption. The majority of participants in both age groups were females and reported being employed, having a satisfied life, and decreased mental health (see Table I). Most participants reported experiencing frequent to severe levels of stress since the beginning of the pandemic and having close relationships with five or less family members and/or friends. Although both study groups reported feeling isolated most of the time, a greater proportion of youths (84.8%) reported feeling isolated compared to adults (72.0%).

Table I. Descriptive characteristics of Study Population from The Canadian Perspectives Survey Series 6, 2021: Substance Use and Stigma During the Pandemic (N = 812).

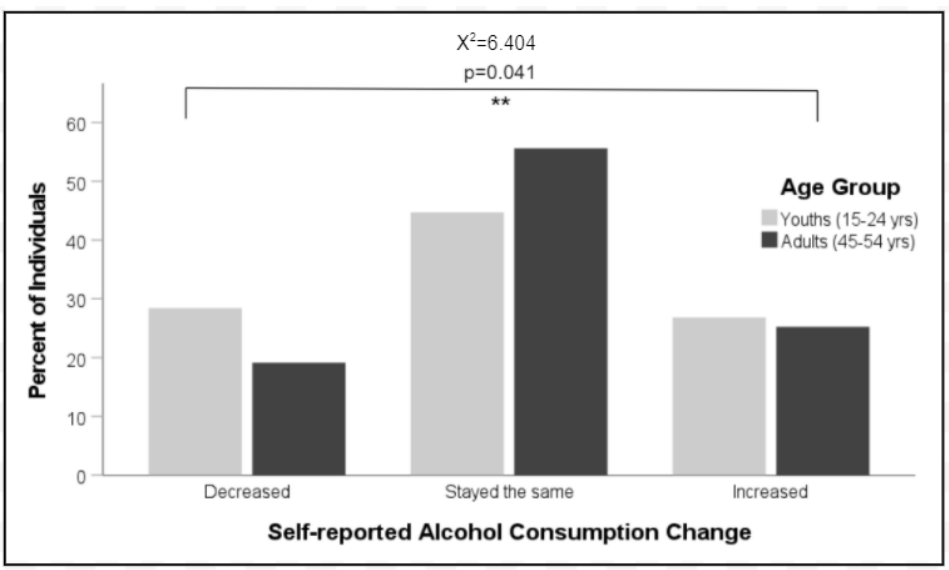
Characteristics	Youth (15-24 yrs) (n = 158)	Adult (45-54 yrs) (n = 654)	P-value
Sex			
Female	102 (64.6)	359 (54.9)	0.035
Male	56 (35.4)	295 (45.1)	
Employment status			
Employed	83 (52.5)	564 (86.2)	<0.001
Not employed	75 (47.5)	90 (13.8)	
Needed help for managing emotions, mental health, alcohol and drug use but did not receive it			
Yes	45 (28.5)	94 (14.4)	<0.001
No	113 (71.5)	560 (85.6)	
How often you felt isolated from others			
Often	134 (84.8)	471 (72.0)	0.001
Hardly	24 (15.2)	183 (28.0)	
Change in alcohol consumption compared to before pandemic			
Increased	33 (26.8)	128 (25.2)	0.806
Decreased or Stayed about the same	90 (73.2)	379 (74.8)	
Change in cannabis usage compared to before pandemic			
Increased	26 (46.4)	28 (22.0)	0.002
Decreased or Stayed about the same	30 (53.6)	99 (78.0)	
Life Satisfaction			
Satisfied	94 (59.5)	462 (70.8)	0.008
Dissatisfied	64 (40.5)	191 (29.2)	
Mental health now compared to before pandemic			
Better	23 (14.6)	47 (7.2)	0.005
Worse	134 (85.4)	606 (92.8)	
Amount of stress in your life since the start of the pandemic			
Frequent or severe	156 (98.7)	620 (95.1)	0.068
Little or none	2 (1.3)	32 (4.9)	
Number of relatives and friends you feel close to			
Five or less	137 (86.7)	562 (86.1)	0.934
Six or more	21 (13.3)	91 (13.9)	

Values are presented as the number (%) of study participants. All variables with the exception of “sex”, “employment status”, and “Needed help for managing emotions, mental health, alcohol and drug use but did not receive it”, were measured using a Likert scale. A Chi-square test and an alpha value of 0.05 were used to calculate the p-value for each variable.

Alcohol and Cannabis Consumption

Most youths (44.7%) and adults (55.6%) reported that their alcohol consumption remained about the same when compared to before the pandemic (see Figure 1). Using a 5% significance value, a Chi-square analysis revealed a significant difference in the proportions of alcohol consumption in youths and adults (X^2= 6.404, p=0.041), as seen in Figure 1. A slightly greater proportion of youths (26.8%) reported an increase in alcohol consumption over the course of the pandemic compared to adults (25.2%). Figure 2 shows a significant difference in the proportions of cannabis consumption in youths and adults through a Chi-square analysis (X^2= 12.739, p=0.002). Most youths (46.4%) reported a greater increase in their cannabis consumption compared to adults (22.0%) and most adults (63.8%) reported their current cannabis consumption remained about the same when compared to before the pandemic.

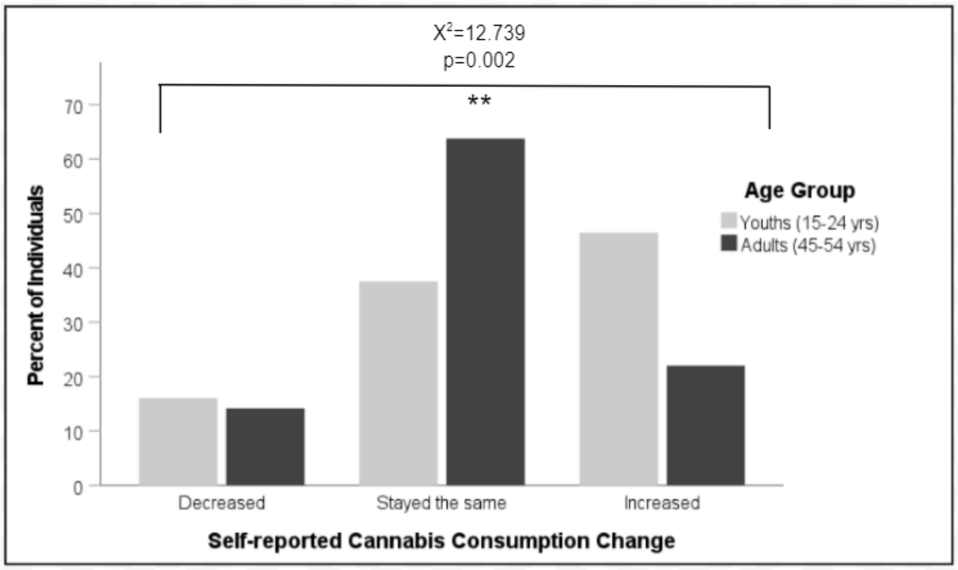
Figure 1. Bar graph of Chi-square analysis depicting the average alcohol consumption change over the course of the pandemic in youths (15-24 years) and adults (45-54 years).



Using an alpha value of 0.05, the graph shows that the proportions of alcohol consumption in youths and adults were significantly different (**) with a Chi-square statistic of 6.404 and a

2-sided asymptotic significance p-value of 0.041. Total sample size was 630 individuals (youth: n=123; adults: n=507).

Figure 2. Bar graph of Chi-square analysis depicting the average cannabis consumption change over the course of the pandemic in youths (15-24 years) and adults (45-54 years).



Using an alpha value of 0.05, the graph shows that the proportions of cannabis consumption in youths and adults were significantly different (**) with a Chi-square statistic of 12.739 and a 2-sided asymptotic significance p-value of 0.002. Total sample size was 183 individuals (youth: n=56; adults: n=127).

The differences in alcohol and cannabis consumption between males and females were also analyzed. Using a significance value of 0.05, a Chi-square analysis revealed that there were no significant differences in the proportion of alcohol consumption in males and females in both youths and adults (X^2_{Youths}= 4.557, p_{Youths}=0.102 and X^2_{Adults}=2.516, p_{Adults}=0.284) (see Table II). A second Chi-square analysis revealed that there were no significant differences in the proportion of cannabis consumption between males and females in youths and adults (X^2_{Youths}=0.77, p_{Youths}=0.681 and X^2_{Adults}=0.066, p_{Adults}=0.968).

Table II. Chi-square analysis comparing the change in alcohol consumption in males and females over the pandemic in Canadian youths (15 to 24 years) and adults(45 to 54 years).

Age Group	Alcohol Consumption Change: Decreased	Stayed The Same	Increased	Chi-Square	P-value
Youth (n=123)					
Male (n=42)	17 (40.5)	16 (38.1)	9 (21.4)	4.557	0.102
Female (n=81)	18 (22.2)	39 (48.1)	24 (29.6)		
Adult (n=507)					
Male (n=234)	40 (17.1)	128 (54.7)	66 (28.2)	2.516	0.284
Female (n=273)	57 (20.9)	154 (56.4)	62 (22.7)		

Using a 2-sided asymptotic significance value of 0.05, the test amongst youths (X^2=4.557, p>0.05) and adults (X^2=2.516, p>0.05) revealed that there was no significant difference in the change in alcohol consumption between males and females. Values are presented as the number (%) of study participants.

Table III. Chi-square analysis comparing the change in cannabis consumption in males and females over the pandemic in Canadian youths (15 to 24 years) and adults(45 to 54 years).

Age Group	Cannabis Consumption Change: Decreased	Stayed The Same	Increased	Chi-Square	P-value
Youth (n=56)					
Male (n=18)	2 (11.1)	8 (44.4)	8 (44.4)	0.77	0.681
Female (n=38)	7 (18.4)	13 (34.2)	18 (47.4)		
Adult (n=127)					
Male (n=67)	9 (13.4)	43 (64.2)	15 (22.4)	0.066	0.968
Female (n=60)	9 (15.0)	38 (63.3)	13 (21.7)		

Using an alpha value of 0.05, the results indicate that there were no significant differences in the change in cannabis consumption between males and females in youths (X^2=0.77, p>0.05) and adults (X^2=0.066, p>0.05). Values are presented as the number (%) of study participants.

Correlation Between Isolation and Substance Use

Tables IV and V display Spearman's rho correlation coefficients (ρ) for the relationship between feeling isolated and the substance use of alcohol and cannabis in youths and adults.

Using a significance value of 0.01, a small, but significant positive correlation (i.e. ρ is between 0.1- 0.29) was found between feelings of isolation and alcohol consumption in both youths and adults (ρ_{Youths}=0.250, p_{Youths}=0.005, and ρ_{Adults}=0.126, p_{Adults}=0.005). A positive correlation was found between feelings of isolation and cannabis consumption in youths and adults, however, these correlations were not significant (ρ_{Youths}=0.234, p_{Youths}=0.083, and ρ_{Adults}=0.141, p_{Adults}=0.113). In both analyses, youths have a slightly stronger correlation between feelings of isolation and substance use compared to adults.

Table IV. Spearman's rho analysis for feelings of isolation and alcohol consumption change over the pandemic in Canadian youths (15-24 years) and adults (45-54 years).

Age Group	Spearman's rho (ρ)	P-value
Youths (n= 123)	0.250**	0.005
Adults (n= 507)	0.126**	0.005

There is a small, positive correlation between feelings of isolation and alcohol consumption change over the COVID-19 pandemic in youths (ρ= 0.250, $p<0.01$) and adults (ρ=0.126, $p<0.01$). However, there is a slightly stronger correlation in youths compared to adults. "**" indicates the correlation is significant at the 0.01 level (2-tailed).

Table V. Spearman's rho analysis for feelings of isolation and cannabis consumption change over the pandemic in Canadian youths (15-24 years) and adults (45-54 years).

Age Group	Spearman's rho (ρ)	P-value
Youths (n= 56)	0.234	0.083
Adults (n= 127)	0.141	0.113

A weak, positive correlation exists between feelings of isolation and cannabis consumption change over the COVID-19 pandemic in youths (ρ=0.234, $p>0.01$) and adults (ρ=0.141, $p>0.01$). However, there is a slightly stronger correlation in youths compared to adults.

Discussion

This study investigated the changes in alcohol and cannabis consumption in Canadian youths aged 15 to 24 years and Canadian adults aged 45 to 54 years, over the course of the COVID-19 pandemic. It also assessed the correlation between feelings of isolation and alcohol and cannabis consumption between the two age groups. A significant difference was found in the proportion of alcohol and cannabis consumption in youths and adults since the beginning of the pandemic, however, no significant difference was found between males and females. Additionally, a small, but significant positive correlation was found between feelings of isolation and alcohol use in both youths and adults, but not in cannabis consumption.

Chi-square tests were used to compare the differences in alcohol and cannabis consumption change over the COVID-19 pandemic in youths and adults. The Chi-square statistic for alcohol consumption was 6.404 and 12.739 for cannabis consumption. Both tests resulted in a p-value less than 0.05, indicating significant differences in both age groups for alcohol and cannabis consumption. Most youths and adults reported that their alcohol consumption stayed the same whereas most youths reported that their cannabis consumption increased over the course of the pandemic. These differences indicate that youths and adults were impacted by the pandemic in different ways. This can be seen in Table I where there were significant differences in the self-reports of life satisfaction and mental health status in youths and adults. About 40.5% of youths reported living a dissatisfied life compared to 29.2% of adults, and approximately 92.8% of adults reported a decline in their mental health compared to 85.4% of youths. These varying conditions amongst youths and adults could have led to the differences in consumption changes observed in Figures 1 and 2.

Our results support the findings by MacEachern et al. (2021) who found that both men and women between the ages of 18 to 44 who reported showing depressive symptoms, were more likely to report increased cannabis and alcohol use. This population is similar to the population in our study as our participants also reported a decrease in their mental health. Additionally, a study done by Imtiaz et al. (2018) on cannabis use during the pandemic also found that a large proportion of the population had an increase in cannabis use during the pandemic. This suggests a need for interventions to limit increased cannabis use and address policy measures monitoring the use of cannabis during and after the pandemic.

Sex was an additional factor that was considered to further understand the substance use behaviours in youths and adults. Previous research has shown that there are sex differences in the consumption of drugs. Namely, males have been found to report a higher use of psychoactive drugs like alcohol, tobacco, and marijuana compared to women (Kuhn, 2015). Using a Chi-square test, our study found that there were no significant differences in alcohol or cannabis consumption between males and females in either age group (see Table II and III). Although these results are contrary to Kuhn's findings (2015), it is important to note their research observed high levels of consumption which may not be applicable to this study. However, our findings support Alvanzo et al.'s (2011) study who discovered that sex had no relationship with alcohol dependence or age of initiation into substance use. Our findings suggest that the substance use behaviours in males and females were similarly impacted during the pandemic.

The Spearman's Rho test showed a significant correlation between feelings of isolation and alcohol consumption in youths and adults, but indicated no significant correlation with cannabis consumption in youths or adults. In both tests, there was a slightly higher correlation between substance use and feelings of isolation in youths, which could be because a larger proportion of youths (84.8%) reported feeling isolated most of the time compared to adults (72%). These results are consistent with the findings by Gutkind et al. (2022) who discovered that loneliness is associated with an increased frequency of alcohol use amongst pre-existing substance users. Contrary to their study, we did not find a significant correlation between loneliness and increased cannabis use in our study sample. This could be explained by the idea that cannabis is a social drug and could have been incorporated in social settings which decreases its association with feeling isolated. Dumas et al. (2020) found that many youths reported engaging in cannabis use with peers through technology or face-to-face interactions during the pandemic. This suggests that although youths may have felt isolated during the pandemic, there was still an emphasis on connecting via technology (i.e. video chatting, texting, posting on social media etc.) to engage in substance use behaviors together (Dumas et al., 2020).

While our study had meaningful observations, there were limitations that should be addressed in future research. A logistic regression analysis could not be included as the predictor variables were related and did not meet all the assumptions. Future studies should consider using other variables listed in this study such as mental health status, life satisfaction, and stress levels. By performing such tests it allows for a better understanding of the driving factors related to substance use behaviours during the pandemic. The sample size in this study was exclusive and only included individuals from ten provinces, so the results cannot be generalized to all Canadians. Additionally, qualitative and self-reported data was used to conduct our analyses which limited the scope of our study and the statistical tests that could be performed. The survey questionnaire also used general terms such as “increased” and “stayed about the same” but this terminology can have different interpretations and is an ambiguous measure for assessing the change in substance. Future studies should develop more definitive terms and/or definitions, if using self-reported data or use other forms of quantitative measures as this would increase the accuracy of the study.

The results from this study are important as it provides a better understanding of how the COVID-19 pandemic affected substance use behaviours in youths and adults. Future studies could explore potential reasons for the increase in cannabis use in youths. Factors such as the recent legalization of cannabis in Canada, accessibility, and the recent decrease in the stigmatization of cannabis could be explored as potential reasons for the increased usage. Previous studies have also found a relationship between race, age of initiation into substance use, and substance dependence (Alvanzo et al., 2011). Although sex differences were accounted for in this study, the impact of ethnicity and socioeconomic status was not assessed which should be explored in future studies. The results from this study showed that youths reported an increase in cannabis use. Research and healthcare professionals can implement these findings for future studies to educate youths on the long-term effects of prolonged cannabis use. This can then be used to develop programs that promote positive coping strategies for feelings of isolation and loneliness. Interactive education campaigns in schools are an example of an effective way to spread awareness to target youth audiences and to increase education on the various effects of cannabis. Another strategy would be to educate youths and parents on cannabis consumption by emphasizing positive reinforcement measures that promote learning and acceptance in drug rehabilitation rather than negative reinforcement such as punishment which fuels feelings of stigmatization and shame in seeking help. Substance use in Canada is a silent epidemic that has been ongoing long before the COVID-19 pandemic. These results highlight the immediate need to implement meaningful changes before negative consequences are deep-rooted in youths well beyond the pandemic.

References

Abbey, A., Smith, M. J., & Scott, R. O. (1993). The relationship between reasons for drinking alcohol and alcohol consumption: An interactional approach. *Addictive Behaviors*, *18*(6), 659-670. https://doi.org/10.1016/0306-4603(93)90019-6

Alvanzo, A., Storr, C., La Flair, L., Green, K., Wagner, F., & Crum, R. (2011). Race/ethnicity and sex differences in progression from drinking initiation to the development of alcohol dependence. *Drug And Alcohol Dependence, 118*(2-3), 375-382. https://doi.org/10.1016/j.drugalcdep.2011.04.024

Capasso, A., Jones, A. M., Ali, S. H., Foreman, J., Tozan, Y., & DiClemente, R. J. (2021). Increased alcohol use during the COVID-19 pandemic: The effect of mental health and age in a cross-sectional sample of social media users in the U.S. *Preventive Medicine*, *145*, 106422. https://doi.org/10.1016/j.ypmed.2021.106422

Dumas, T. M., Ellis, W., & Litt, D. M. (2020). What does adolescent substance use look like during the COVID-19 pandemic? Examining changes in frequency, social contexts, and pandemic-related predictors. *Journal of Adolescent Health*, *67*(3), 354-361. https://doi.org/10.1016/j.jadohealth.2020.06.018

Gutkind, S., Gorfinkel, L., & Hasin, D. (2022). Prospective effects of loneliness on frequency of alcohol and marijuana use. *Addictive Behaviors, 124*, 107115. https://doi.org/10.1016/j.addbeh.2021.107115

Haines-Saah, R. J., & Fischer, B. (2021). Youth cannabis use and legalization in Canada - Reconsidering the fears, myths and facts three years in. *Journal of the Canadian Academy of Child and Adolescent Psychiatry = Journal de l'Académie canadienne de psychiatrie de l'enfant et de l'adolescent, 30*(3), 191–196.

Hill MacEachern, K., Venugopal, J., Varin, M., Weeks, M., Hussain, N., & Baker, M. M. (2021). Applying a gendered lens to understanding self-reported changes in alcohol and cannabis consumption during the second wave of the COVID-19 pandemic in Canada, September to December 2020. *In Health Promotion and Chronic Disease Prevention in Canada 41*(11), 331–339. https://doi.org/10.24095/hpcdp.41.11.03

Imtiaz, S., Kurdyak, P., Samokhvalov, A. V., Mobashir, M. M., Que, B., Elliot, D., & Rehm, J. (2018). Trends in treatment of problematic cannabis use in Ontario’s specialized addiction treatment system from 2010/11 to 2015/16: a repeated cross-sectional study of a health administrative database. *CMAJ Open, 6*(4), E495–E501. https://doi.org/10.9778/cmajo.20170152

Kuhn, C. (2015). Emergence of sex differences in the development of substance use and abuse during adolescence. *Pharmacology & Therapeutics, 153*, 55-78. https://doi.org/10.1016/j.pharmthera.2015.06.003

Lowry, D. E., & Corsi, D. J. (2020). Trends and correlates of cannabis use in Canada: A repeated cross-sectional analysis of national surveys from 2004 to 2017. *CMAJ Open*, *8*(3), E487-E495. https://doi.org/10.9778/cmajo.20190229

Norman, G. R., & Streiner, D. L. (2014). *Biostatistics: The bare essentials*. People's Medical Pub. House.

Novacek, J., Raskin, R., & Hogan, R. (1991). Why do adolescents use drugs? Age, sex, and user differences. *Journal of youth and adolescence*, *20*(5), 475-492. https://doi.org/10.1007/BF01540632

Statistics Canada. (2021). *Canadian Perspectives Survey Series 6: Substance Use and Stigma During the Pandemic.* Ottawa, Ontario: Statistics Canada Ottawa, Ontario: Data

Liberation Initiative, Statistics Canada https://www-statcan-gc-ca.libaccess.lib.mcmaster.ca/eng/dli/dli

Spradlin, A., & Cuttler, C. (2019). Problems associated with using cannabis to cope with stress. *Cannabis*, *2*(1), 29-38. https://doi.org/10.26828/cannabis.2019.01.003

Stockdale, S. E., Wells, K. B., Tang, L., Belin, T. R., Zhang, L., & Sherbourne, C. D. (2007). The importance of social context: Neighborhood stressors, stress-buffering mechanisms, and alcohol, drug, and mental health disorders. *Social science & medicine*, *65*(9), 1867-1881. https://doi.org/10.1016/j.socscimed.2007.05.045

An investigation of the relationship between health care access and insurance, and self-reported presence of depression: an observational, cross-sectional study

Assignment 2

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LIFESCI 3LL3: Living Systems Laboratory Practicum

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December 8th, 2021

Introduction

Mental health has become a prominent topic amongst the age range of 12-25, as studies have found that the onset of 75% of mental disorders, such as depression, occur before this upper age boundary (Malla et al., 2018). Various studies have been conducted to examine relationships between the prevalent psychopathology of depression and a multitude of potential underlying factors. With the rapid advances of technology and constant evolution of society, distinct variables may affect the lifestyles of the younger adult population than previously reported or considered. Thus, the frequency and causation of depression in this population should be particularly assessed. A 2017 US study assessed this relationship and revealed that 44% of the young adult sample reported problematic social media use, which was significantly correlated with depressive symptoms assessed through a survey (Shensa et al., 2017). Additionally, a 2018 study conducted on an Appalachian college population examined the relationship between mental health and diet (Wattick et al., 2018). The study demonstrated that food insecurity was a significant predictor of depression. The authors suggested that poor diet, added sugar, and college lifestyle could potentially contribute to the increased depression incidence among young adults (Wattick et al., 2018). Based on this research, depression is common among undergraduate students and could be attributed to a variety of factors, one being health care. Health care access may play a role in the development of psychopathology in conjunction with additional factors.

The Mental Health portion of the Canadian Community Health Survey previously reported a high prevalence of youth mental health problems and inadequate or late care (Malla et al., 2018). Prior research reports that current services in Canada are insufficient to address youth mental health problems, potentially due to the current structure which delineates adolescent and adult mental health services as separate systems (Malla et al., 2018). Radez et al. identified the four largest barriers to accessing professional help amongst adolescents as limited mental health knowledge, social stigma, perception of therapeutic relationships with a professional, and systemic as well as structural barriers such as cost and availability (2021). General practitioners also play a role in lack of access to professional mental health help as they identify the need for specialist referrals (Radez et al., 2021). Due to these barriers to health care access, a large proportion of adolescents do not receive professional mental health care, resulting in less beneficial self-help methods and lower future help-seeking intentions (Sheppard et al., 2018). This can ultimately lead to comorbidities and poor future outcomes (Malla et al., 2018).

Mental Health and Addiction services in Canada addresses a range of conditions, such as depression, anxiety, substance abuse disorders, and psychoses (Moroz et al, 2020). 2.3 million Canadians believe their mental health care needs are unmet or partially met; Canadians spend $950 million annually on private psychotherapists, 30% of whom pay out of pocket (Moroz et al, 2020). In 2015, only 7% ($15.8 billion) of Canadian healthcare funds were spent on mental health care, a number which the Mental Health Commission suggests will increase to 9% by 2022 (Moroz et al, 2020). Although there is little research surrounding health insurance and mental health, a 2012 study conducted in Northwest China found that symptoms of depression were more severe in individuals who were not insured (Tian et al., 2012). These individuals were also found to be at greater risk of developing severe depressive symptoms. Regular access to health insurance has continuously been proven to result in improved physical health status (Tian et al., 2012). However, the relationship between health insurance and mental health status is yet to be fully understood. This relationship has also yet to be examined amongst Canadian individuals, specifically between the ages of 18-24.

There is a current lack of quantitative research surrounding a relationship between mental health problems such as depression and access to health care in Canadian individuals aged 18-24. Our research question is: Is there a relationship between health care access (presence of a primary health care provider and health insurance) and the self-reported prevalence of depression amongst individuals aged 18-24 in Canada? We hypothesize that the relationship between health care access (with access comprised of presence of a primary health care provider and insurance coverage) and prevalence of self-reported depression does exist. Specifically, we predict a decreased prevalence of depression among those who reported having access to health care services. This study will involve data analysis from the Canadian Community Health Survey, 2017-2018: Annual Component data set to address our objective of identifying a relationship between presence of health care access and self-reported presence of depression.

Methods

Study Design and Database

Our research study used the Canadian Community Health Survey 2017-2018 Annual Component database from the Health Statistics Division of Statistics Canada, obtained from the Odesi data portal. The objective of this biannual survey is to collect health-related data of regions across Canada with variables such as health status and use of health care services (Statistics Canada Health Statistics Division, 2020). The collected data is commonly used by federal and provincial departments for surveillance and health research as well as non-profits and the media to raise awareness about various health topics. Previous uses of this database include research surrounding mental health and well-being, prevalence of diseases, and examining health care areas that require more attention such as unmet mental health needs.

The study design was observational and cross-sectional, with participants being 12 years of age or older. The researchers used extensive sampling methods involving a multi-stage sample allocation strategy which accounted for location, and measures to ensure only one participant was chosen from the same household to obtain a fair sample distribution (Statistics Canada Health Statistics Division, 2020). Participants were excluded if they lived on reserves, resided in a foster home, were a full-time member of the Canadian Forces, were institutionalized, and lived in specific Quebec health regions. The survey was carried out via phone or in-person interviews and collected data on 1051 total variables (Statistics Canada Health Statistics Division, 2020). Due to the self-report survey design, participants' answers were subject to self-report bias and inaccuracy which is important to note when analyzing results.

Study Participants

The original sample size of the database was 113 290 participants. Our study sample size was 7001 after selecting our variables of analysis and age range. Participants were included if they were 18-24 years of age and reported a valid response for the variables of access to health care, primary health care provider, health insurance coverage, and presence of depression. Participants were excluded if they were younger than 18 or older than 24 and had a missing response or indicated 'valid skip', 'don't know', 'refusal', or 'not stated' for the four previously mentioned variables.

Study Outcomes

Our primary study outcome was to determine if there is a relationship between health care access, health insurance coverage, and self-reported presence of depression among individuals 18-24 years of age in Canada. This outcome is of importance as research has shown that many Canadians have reported an unmet need for mental health care (Sunderland & Findlay, 2013). Additionally, researchers have found that the rates of unmet needs are higher in individuals with a diagnosed mental illness, especially depression, further emphasizing the importance of our research study (Sunderland & Findlay, 2013). We included the variables of access to health care, having a regular health care provider, and having health insurance coverage as independent variables to assess the prevalence of health care access amongst our study population. This allowed us to further analyze if there is a relationship between the presence of depression and availability of health care. Self-reported presence of depression, as diagnosis of a mood disorder was not needed to answer this survey question, was examined as the dependent variable to compare the prevalence of depression between those who have access to health care services and those who do not in our study population. All variables were asked as individual yes or no questions, with 'yes' indicating the participant had access to health care services, had a regular health care provider, had insurance, and had depression, and 'no' indicating lack of these variables. Other response options included skip, don't know, refusal to answer, and not stated.

Additional Data

Additional data pertaining to demographic characteristics were collected to present in Table 1. Inclusion of variables such as sex, age, education level, student status, employment status, and having other health care providers allow for examination of demographics that may impact an individual's access to health care. This would aid in the analysis of our results when examining potential reasons behind the relationship between health care access and depression.

Statistical Analysis

To summarize data in Table 1, participants were organized into one of two groups; Group 1 included participants who answered ‘yes’ to both having access to health care services and having a regular health care provider, and Group 2 included participants who responded ‘no’ to one of these variables or ‘no’ to both variables. We used IBM SPSS version 28.0 for all statistical tests and figure creation. We used the program to obtain frequencies of all variables for Table 1 and our variables of analysis. To handle missing data, variables that were not used in our analysis and participants that had missing responses for our variables of analysis were removed from our data set. Chi-squared tests were used to determine the presence of between-group differences regarding self-reported presence of depression and health care access, having a regular health care provider, and having health insurance coverage. The p-value for significance in our analyses was $p<0.05$ in which a p-value of less than 0.05 indicated that proportions were significantly different between groups.

Results

The study consisted of 7001 participants who had valid answers for the variables of analysis. The missing data was removed from the dataset. There is missing data in Table 1, as identified by the varying values of N, however this demographic data was not used for analysis.

Table 1. *Demographic frequencies of study population (N = 7001).*

Total sample (N = 7001)				
	Group 1 (N = 214)		Group 2 (N = 6787)	
Characteristics		%		%
Sex	N = 214		N = 6787	
Male	88	41.1	3389	49.9
Female	126	58.9	3398	50.1
Age	N = 214		N = 6787	

B/w 18-19	41	19.2	1855	27.3
B/w 20-24	173	80.8	4932	72.7
Level of education	N = 210		N = 6722	
Less than secondary school	20	9.5	796	11.8
Secondary school grad	118	56.2	3537	52.6
Post-secondary grad	72	34.3	2389	35.5
Student Status	N = 76		N = 2863	
Full-time or full-time and part-time	74	97.4	2514	87.8
Part-time	2	2.6	349	12.2
Working status	N = 130		N = 4515	
Full-time	100	76.9	3024	67.0
Part-time	30	23.1	1491	33.0
Employed or self-employed	N = 131		N = 4543	
Employee	126	96.2	4378	64.5
Self-employed	5	3.8	165	2.4
Has a mood disorder	N = 211		N = 6776	
Yes	45	21.3	793	11.7
No	166	78.7	5983	88.3
Other Healthcare Provider				
Psychologist	N = 213		N = 4763	
Yes	15	7.0	321	6.7
No	198	93.0	4442	93.3
Social Worker	N = 213		N = 4762	
Yes	5	2.3	109	2.3

No	208	97.7	4653	97.7

Table 1 was divided based on the presence of a health care provider and access to health care, as stated in the methods. Group 1 indicated the presence of a health care provider and access to health care. Group 2 reports individuals without a health care provider, health care access, or a lack of both.

Collection of demographic data shows that most of the study population are full or part time students and had graduated secondary school. The study population was between the ages of 18-24. It is important to note that a greater number of participants reported having a mood disorder in group 2 than in group 1. The demographic data presented in Table 1 is important in determining the characteristics of the study population to aid in the analysis of the results, however, this grouped data was not used in the Chi-squared statistical analyses.

Table 2. *Frequency table of individuals who have reported the presence or absence of health care access, a health care provider, and health insurance (N=7001*).

	N (%)	
Characteristic	**Yes**	**No**
Health care Access	383 (5.5)	6618 (94.5)
Health care Provider	4986 (71.2)	2015 (28.8)
Health care Insurance	397 (5.7)	6604 (94.3)

Table 2 displays the frequencies of the total population in respect to our variables of analysis. The frequencies show that most of the study population has a regular health care provider but does not have health insurance and general access to health care.

The frequencies displayed in Table 2 are used to construct a crosstabulation of variables for Chi-Squared analyses of these variables in relation to the self-reported presence of depression.

Table 3. *Summarized Chi-Squared analyses (N=7001).*

	Value (χ^2)	Degrees of Freedom	Asymptotic Significance (2-Sided)
Health care Access	9.998	1	0.002
Health care Provider	45.220	1	<0.001
Health care Insurance	10.423	1	0.001

The values obtained by the Chi-Squared test are used to report the significance value. To determine this significance, the continuity correction value was reported as a 2x2 table was obtained while performing crosstabulation of the variables with one degree of freedom.

Table 3 summarizes the statistical analyses obtained from SPSS. Since a p value below 0.05 is obtained for all three variables, a significant difference between the groups is present. At a degree of freedom of 1, a χ^2 value above 3.841 is significant at a 5% significance level (Norman & Streiner, 2000).

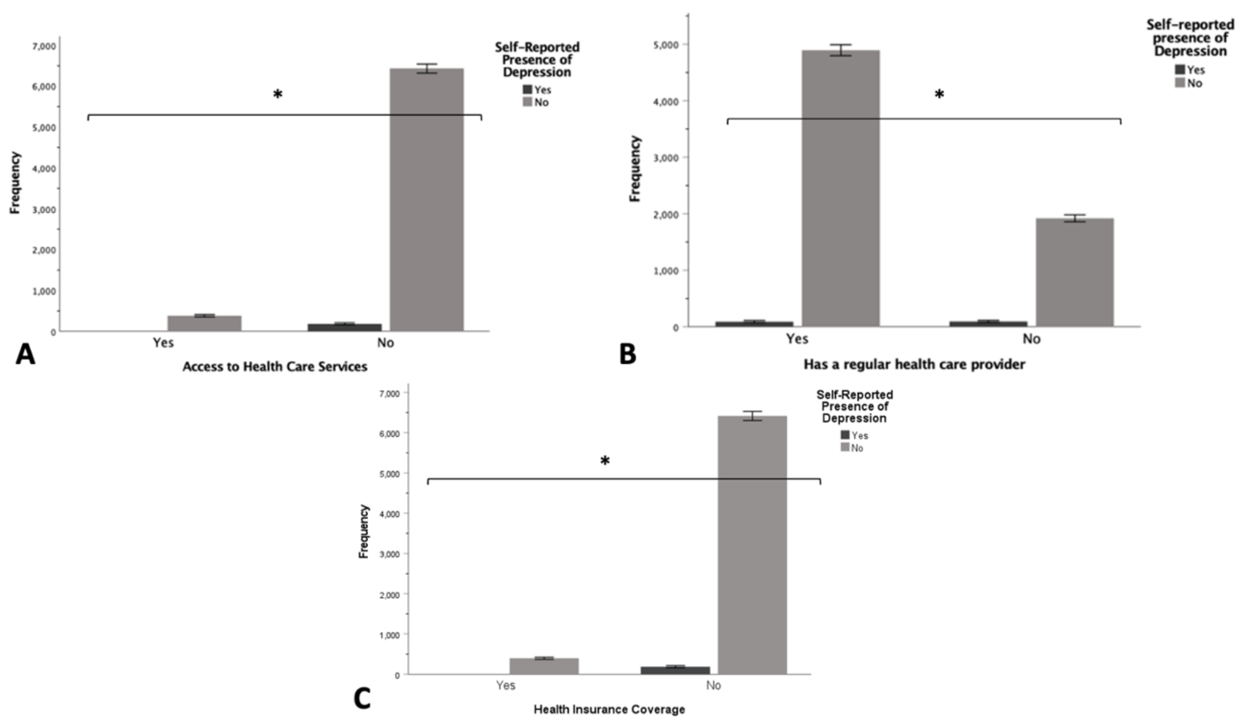

Figure 1. *Bar graph with standard error bars displaying the frequency of self-reported depression in relation to (**A**) having access to health care services (p=0.002), (**B**) having access*

*to a regular health care provider (p <0.001), and (**C**) having health insurance coverage (p=0.001).*

Chi-Squared Test, 1 df, * indicating a significant result with a significance level of $p < 0.05$ (N=7001).

Figure 1 summarizes the crosstabulation frequencies of the Chi-squared analyses in a bar graph for all three variables of interest in relation to the self-reported presence of depression. The error bars indicate a 95% confidence interval for the given frequencies. In Figure 1A and 1C, individuals who self-reported presence of depression did not have access to health care services as well as health insurance coverage. After analysis using a Chi-Squared Test, all three variables (access to health care services, access to health insurance coverage, and access to a health care provider) demonstrated significant differences amongst the groups. These significance values are 0.002, 0.001 and < 0.001, respectively (Table 3).

Discussion

Results from our study revealed there were significant between-group differences with each of the Chi-squared analyses performed. This means there were differences between those who answered "yes" and those who answered "no" in each of the three groups of health care access, provider, and insurance, in whether participants reported the presence of depression. This supports our initial prediction of the existence of a relationship between these variables. It was found that those who reported "yes" to any of the three groups had a lower prevalence of depression, while a greater number of individuals reported "yes" to depression if they reported "no" to these variables. The most notable outcome of the study was that there were no responses indicating "yes" to self-reported depression in those who answered "yes" to either having health care access or health care insurance. This poses the question as to why this occurred in these two variables but not the health care provider variable. As we will further discuss, various confounding factors not accounted for in our study could be responsible for this difference.

A study by McAlpine and Mechanic explores a similar relationship. While the study used a logistic regression with a population of a wider age range of 18-97, their results highlight the significant relationship between socioeconomic disadvantage (including lack insurance and access to health services) and the presence of severe mental illness (McAlpine & Mechanic, 2000). Our study outcomes align with these findings, further supporting the potential presence of a relationship between depression and health care access. However, McAlpine and Mechanic's study only involved a small sample size, potentially limiting the analysis of group differences. Their study also involved self-reported data, challenging the validity of the study relationships (McAlpine & Mechanic, 2000). This coincides with the limitations of our study and establishes the need for further research in this area.

A potential reason for the findings from the analyses between the variables of health care access and health care provider with self-reported depression to be significantly different is a direct, causal relationship, where having a regular health care provider or regular health care access could lead to a reduced occurrence of depression. This could be caused by a variety of reasons, one example being reduced stress and anxiety over health issues, leading to the individual feeling secure in knowing their health is being taken care of and regularly assessed. However, since our analysis does not provide detailed information on the relationship between the two variables, this relationship may be a coincidence due to confounding factors or may exist as a relationship in the opposite direction. For example, those with more economic and life stability likely have a regular health care provider, and it may not be health care access or provider itself which is leading to lower depression levels. It could in fact be that those with a lack of stability in their environment are predisposed to developing depression. Again, when examining the findings from the analysis between health insurance and self-reported depression, direct or causal relationships cannot be determined due to the lack of information obtained from the Chi-squared analysis. One possible inference of the relationship is that those who are covered by health insurance are less depressed due to reduced mental or financial stress over health. Those with insurance likely receive more health check-ins and feel more secure in their financial situation, so depression is less likely to stem from worry over health issues. Individuals covered by insurance would not face stress about paying for hospitalization or health procedures, eliminating the helplessness which accompanies this financial burden. Another possible reason for this association could be that those with a stable income and full-time job inherently have better mental health and this relationship may not be directly related to insurance. It may be that positive mental health is required to maintain a full-time working status, and insurance is simply a coinciding benefit. This is supported by a study by Hovenkamp-Hermelink et al., which demonstrates a relationship between locus of control and depression, revealing that an external locus of control predicted depression severity (Hovenkamp-Hermelink et al., 2019). This suggests and supports a possible confounding factor regarding locus of control, where individuals who have an external locus of control attribute life events to factors outside of their control and are more likely to feel helpless. It could be that those who possess an internal locus of control and believe they have control over their life are less likely to develop depression. Based on these findings, locus of control influences mental health and is an additional factor to consider. Overall, depression is a multi-faceted condition with many factors likely contributing to its presence and development, making it difficult to isolate each specific factor.

There are three primary limitations to our study. First, the only available analysis option for our data was the Chi-Squared Test. Due to a lack of continuous variables within our data, we were unable to conduct a Spearman Rank Order Correlation or an Analysis of Covariance. Our data was also not suited for logistic regression analysis since our independent variables were significantly related, indicating that the data does not follow the lack of multicollinearity assumption necessary to carry out a logistic regression analysis. While there was a significant relationship found between the self-reported presence of depression and health care access, the nature and the directionality of the relationship is unknown due to this limitation. Second, the potential presence of biases in our study could have altered our findings. Since depression is a self-reported measure, the relationship between health care access and the presence of depression may not be valid or may be bidirectional. Response and/or social desirability bias could have influenced our outcomes by leading participants to respond in a manner they perceived to be expected by the experimenter or socially desirable, respectively. Additionally, since our study was cross-sectional, it is not certain the result will be representative of the population in another time period. Finally, as already discussed, since our study was observational it should be noted that there was no control for confounding variables such as pre-existing mental health conditions and socioeconomic status, which may also contribute to the self-reported presence of depression.

Considering these limitations, our results have important implications. It is crucial to reassess the healthcare system and available health care services, as well as establish groups of individuals who are unlikely to receive help. Examining the reasons they are unable to access health care could also be beneficial in mediating health care inequities. Those with mental illness may have more difficulties accessing health care services due to the nature of their illness or the stigma surrounding receiving treatment for invisible conditions. Additionally, those with socioeconomic disadvantages, such as income level and lack of insurance, may also experience greater difficulties in accessing health care for financial reasons. Policy intervention involving an increase in insurance coverage is necessary to improve health care access to populations in need.

For future research, longitudinal studies could assess the direct effects of utilization of mental health care services on mental health. To control for confounding variables, it is crucial to restrict or randomize the study population so that the observed effect can be attributed to the variables of interest. Moreover, measures of depression could be taken before and after individuals receive health care access or insurance in order to further control the study and obtain an improved understanding of the relationships between variables. Finally, continuous data, such as depression severity scale data, should be included through standardized psychological testing so that other analyses, like Spearman's Rank Order Correlation, can be used to further analyze the relationship between depression and aspects of health care access.

To conclude, according to our analysis, there is a relationship between healthcare access, provider, and insurance, and self-reported presence of depression, however, the manner and degree of this relationship between variables cannot be fully understood until further research in this area is conducted.

References

Hovenkamp-Hermelink, J. H. M., Jeronimus, B. F., Van der Veen, D. C., Spinhoven, P., Penninx, B. W. J. H., Schoevers, R. A., & Riese, H. (2019). Differential associations of locus of control with anxiety, depression and life events: A five-wave, nine year study to test stability and change. *Journal of Affective Disorders, 253*, 26-34. https://doi.org/10.1016/j.jad.2019.04.005

Malla, A., Shah, J., Iyer, S., Boksa, P., Joober, R., Andersson, N., Lal, S., & Fuhrer, R. (2018). Youth mental health should be a top priority for health care in Canada. *The Canadian Journal of Psychiatry*, *63*(4), 216-222. https://doi.org/10.1177%2F0706743718758968

McAlpine, D. D., & Mechanic, D. (2000). Utilization of specialty mental health care among persons with severe mental illness: The roles of demographics, need, insurance, and risk. *Health Services Research*, *35*(1 Pt 2), 277–292.

Moroz, N., Moroz, I., & D'Angelo, M. S. (2020). Mental health services in Canada: Barriers and cost-effective solutions to increase access. *Healthcare Management Forum, 33*(6), 282–287. https://doi.org/10.1177/0840470420933911

Norman, G. R., & Streiner, D. L. (2000). *Biostatistics: The bare essentials*. Hamilton: B.C. Decker.

Radez, J., Reardon, T., Creswell, C., Lawrence, P. J., Evdoka-Burton, G., & Waite, P. (2021). Why do children and adolescents (not) seek and access professional help for their mental health problems? A systematic review of quantitative and qualitative studies. *European child & adolescent psychiatry*, *30*(2), 183-211. https://doi.org/10.1007/s00787-019-01469-4

Shensa, A., Escobar-Viera, C. G., Sidani, J. E., Bowman, N. D., Marshal, M. P., & Primack, B. A. (2017). Problematic social media use and depressive symptoms among U.S. young adults: a nationally representative study. *Social Science & Medicine, 182*, 150-157. https://doi.org/10.1016/j.socscimed.2017.03.061

Sheppard, R., Deane, F. P., & Ciarrochi, J. (2018). Unmet need for professional mental health care among adolescents with high psychological distress. *Australian & New Zealand Journal of Psychiatry*, *52*(1), 59-67. https://doi.org/10.1177%2F0004867417707818

Statistics Canada, Health Statistics Division (2020). *Canadian Community Health Survey, 2017-2018: Annual Component* (cchs-82M0013-E-2017-2018-Annual-component) [Data set]. Statistics Canada. https://odesi.ca/#/details?uri=/odesi/cchs-82M0013-E-2017-2018-Annual-component.xml

Sunderland, A., & Findlay, L. C. (2013). *Perceived need for mental health care in Canada: results from the 2012 Canadian Community Health Survey-Mental Health* (pp. 3-9). Ottawa: Statistics Canada.

Tian, D., Qu, Z., Wang, X., Guo, J., Xu, F., Zhang, X., & Chan, C. L.-W. (2012). The role of basic health insurance on depression: an epidemiological cohort study of a randomized community sample in Northwest China. *BMC Psychiatry*, *12*(1). https://doi.org/10.1186/1471-244x-12-151

Wattick, R. A., Hagedorn, R. L., & Olfert, M. D. (2018). Relationship between diet and mental health in a young adult Appalachian college population. *Nutrients, 10*(8), 957. https://doi.org/10.3390/nu10080957

Examining the Relationship Between Poor and Excellent Perceived Mental Health of Canadians Aged 15 Years and Older and the Increased Alcohol and Cannabis Consumption: A Cross-Sectional Study

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Group 20

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Introduction

Background Information

The COVID-19 pandemic originated in China during the winter of 2019 and has since then changed many aspects of society (Meyer et al., 2020). To mitigate the spread of COVID-19, countries across the world have issued the practice of social distancing, resulting in changes in interaction patterns of individuals worldwide. Many have been forced to alter their day-to-day routines. Humans have been forced to rely on other mechanisms to cope with the lack of social interactions (Meyer et al., 2020). As a result of bar and restaurant closures, alcohol and cannabis sales for residential use have increased significantly (Vanderbruggen et al., 2020). Although some individuals consumed alcohol and cannabis for celebrations as well as relieving stress for many generations, substituting it as a coping mechanism can be detrimental to overall health (Vanderbruggen et al., 2020). The outcome of a pandemic could potentially introduce changes in mental health as well as substance use disorders (Magson et al., 2020).

Related Studies

Several researchers conducted studies in the past to help the health sector in maintaining safe alcohol and cannabis consumption. According to Weitzman (2004), the 1997 and 1999 survey of the Harvard College Alcohol study was utilized to analyze the relationship between poor mental health in college aged students and alcohol consumption and abuse. Weitzman chose to study this age group due to the lack of published reports about mental health and substance abuse in the college setting (Weitzman, 2004). According to Knight et al. (2002), 31% of college students meet the DSM-IV criteria for alcohol abuse, therefore Weitzman found it important to analyze the role that mental health plays in alcohol overuse. The results of the study revealed that female students who come from ethnic or racial minority groups or have parents who 3 did not pursue college have more mental health problems. The poor mental health respondents of the study were more likely to report drinking to get drunk, as well as binge drinking, suggesting that individuals with mental health problems are more likely to seek out alcohol as a coping or self-medicating mechanism. Weitzman recognizes that there are several factors that contribute to poor mental health development in college aged students, and further research is needed to identify these connections (Weitzman, 2004). Another research paper by McGee et al. (2000) examined the association between cannabis use and mental health in adolescence to early adulthood (15 to 21 years). Participants self-reported their use of cannabis and participated in a standard diagnostic interview that assessed mental health. The researchers conducted the study on this topic because they wanted to understand the longitudinal association between cannabis use and mental health as opposed to a cross-sectional association. Findings revealed that cannabis use at age 18 elevated the risk of mental disorder at age 21. Alcohol use and cigarette smoking had independent associations with later mental health disorders. Study participants who reported earlier use of cannabis have socio-economic disadvantage, behaviour problems, low levels of parental attachment in adolescence and adolescent mental health problems. McGee et al. acknowledged that several variables, demographics play a role in the relationship between cannabis and mental health and the prevalence of cannabis dependence and frequent cannabis use among young adults is relatively high (McGee et al., 2000).

Knowledge Gap and Research Question

Although there has been several research conducted on the impact on factors such as stress that contribute to the excessive use of substances before the pandemic, there is limited data collected on the impact of mental health and its association with 4 substance abuse during the COVID-19 pandemic (Welte & Russell, 1993). According to Gili et al. (2021), there is currently a lack of information about health and social consequences of the pandemic, therefore, increasing the likelihood of an emerging research field related to the COVID-19 pandemic. Due to the unpredictable nature of the pandemic, the perceived mental health of individuals is constantly evolving, making it difficult to examine data related to mental health and substance abuse over a period of time (Abramson, 2021). According to research papers related to the COVID-19 pandemic, it is important to examine the effects of the COVID-19 pandemic on individuals who have previously abused drugs as well individuals who recently started to engage in drug use (Zaami et al., 2020). The current health crisis governs certain restrictions that favour self-isolation and other factors that could contribute to a change in perceived mental health. Research studies that focus on preventing the risk group of substance abusers can become a start to ending a pandemic and encouraging safety precautions (Zaami et al., 2020). This research paper investigates: is there a difference in the consumption of alcohol and cannabis during the pandemic in the past 30 days among Canadians aged 15 and older who report their mental health as poor, compared to Canadians aged 15 and older who report their mental health as excellent by looking at the association of factors such as stress, boredom and loneliness? The primary outcome of our study is to assess the difference between the frequency of substance use for individuals who perceive their mental health as poor or excellent and the secondary outcome for our study is assessing the reasons associated with an increased use of substance abuse during the pandemic due to factors such as stress, boredom and loneliness. The variables interested in this paper include the frequency of alcohol and cannabis consumed within the past 30 days during the pandemic.

Methods

Study Design and Database

Our study is based on the Canadian Perspectives Survey Series 6: Substance Use and Stigma During the Pandemic, an observational and cross sectional study conducted by Statistics Canada (Zajacova et al., 2020). The dataset was obtained from Odesi, an extraction and analysis tool. The survey was administered online to Canadians 15 years and older living in the 10 Canadian provinces who previously participated in the Labour Force Survey (Findlay et al., 2020). The LFS survey excluded participants living on reserves or Aboriginal settlements, members of the Canadian Armed Forces, and households in areas with low population density (Findlay et al., 2020). The goal of the survey was to collect data about Canadians' outlooks on trends and changes in society in an effective manner that is fast and low-cost (Government of Canada, 2020). The study covered a variety of social topics, and had several series' that focused on different issues. The series we chose to analyze in our study focuses on substance use and stigma during the pandemic (Government of Canada, 2020). We analyzed and extracted information from this dataset using SPSS, a software used to conduct statistical analysis (IBM, 2021).

Study Participants

The original database invited 31,896 people to participate in the survey, and 3,941 people were surveyed in Series 6. We constricted our participant group by focusing on their perceived mental health status, which was self-reported by participants. Our survey included participants who reported their perceived mental health to be poor or excellent. We chose to exclude participants who did not report in one of these groups in order to look at the relationships between the two extremes of mental health and our outcome variables. We did not exclude participants based on age, as we decided to look at all participants aged 15 years and older. After considering this inclusion and exclusion criteria, the number of participants was reduced to 683.

Study Outcomes

The primary outcome of our study was to assess the difference between the frequency of alcohol or cannabis use for individuals who perceive their mental health as poor or excellent. According to Kumar & Nayar (2020), the result of the COVID-19 pandemic has introduced new measures that concern the mental health of individuals. We chose to assess this outcome in order to evaluate whether there is a correlation between perceived mental health and substance abuse as a result of the COVID-19 pandemic. The secondary outcome for our study was to assess the reasons associated with an increased use of substance abuse during the pandemic due to factors such as stress, boredom and loneliness. According to researchers, pandemic-related conditions involve individuals using substances as a coping mechanism for a variety of reasons (Gritsenko et al., 2020). After investigating the main cause for the increased substance use, health interventions can be proposed to alleviate the use of substances such as cannabis and alcohol.

Additional Data Collection

There are a number of different variables that are used in our statistical analysis that describe the study population in different ways. The majority of the variables we used are categorical, as the survey was structured so that participants picked a specific answer. Perceived mental health is used to analyze respondents' status of mental health at the two extremes of mental health, poor and excellent, and serves as the dependent variable in our analysis. The variables that are used to assess our primary outcomes include frequency of alcohol usage in the last 30 days as well as frequency of cannabis in the last 30 days. These variables are used to analyze and compare the frequency of these substances consumed with the participants' perceived mental health of poor or excellent. The variables that are used to assess our secondary outcomes include the reasons why participants may have increased their use of alcohol or cannabis, which include stress, boredom, and convenience. These variables are used to analyze and compare the frequency of respondents in the poor and mental health groups and their individual reasons for increased alcohol and cannabis use.

Statistical Analysis

Table 1 outlines the values as frequencies in the form of number and percentage in brackets. The SPSS database was used to perform a statistical analysis such as the chi-squared test to analyze the difference between groups of perceived mental health of poor and excellent and our primary and secondary outcome variables. The chi-squared test was used because of the nature of our data being categorical, as well as the ability of the test to analyze the difference between two experimental groups. Our study considered a p-value significance level of 0.05 in order to assess the significance of a variable.

Results

683 participants were included in the final analysis. The descriptive statistics regarding participants' responses are outlined in Table 1. There were no missing cases for any of the observed variables. There was a total of 195 individuals who perceive their mental health as poor and 488 individuals who perceive their mental health as excellent. Most of the population that was chosen in our database were middle-aged adults.

Primary Outcomes

When looking at the descriptive characteristics outlined in Table 1, we can observe some key characteristics in the variables related to the primary outcomes. For the consumption of alcohol during the pandemic, there are a substantial number of participants who said that they consumed alcohol in the last 30 days. There was a similar percentage of individuals who said they consumed alcohol during the pandemic for both poor and excellent perception of mental health. For the frequency of cannabis use, there was a higher percentage of individuals with an excellent perception of mental health who never used cannabis. Compared to the other categories, there was a higher percentage of participants who did not consume cannabis in the last 30 days.

After we performed the chi-squared test for poor and excellent perceived mental health, we observed if there was a significant difference between the groups for the frequency of alcohol consumption and the frequency of cannabis use during the past 30 days. According to Table 2, there were no significant differences ($p = 0.166$) observed between the poor and excellent perceived mental health groups for the frequency of alcoholic beverages drank in the past 30 days. There was a statistical difference ($p < 0.001$) observed for the frequency of cannabis use in the past 30 days.

Secondary Outcomes

When analyzing the descriptive characteristics outlined in Table 1, we can observe some key characteristics in the variables related to the secondary outcomes. For all the reasons for the increased use of both alcohol and cannabis in the last 30 days, there was a higher percentage of participants with poor perceived mental health who reported an increased consumption of substance due to either stress, boredom, or loneliness compared to participants with excellent perceived mental health.

After performing the chi-square test for poor and excellent mental health, we observed if there was a difference in the groups due to increased alcohol and cannabis use due to stress, loneliness, and boredom. Referencing Table 3, there was a statistically significant difference observed in both increased alcohol usage due to stress ($p < 0.001$), increased alcohol usage due to loneliness ($p < 0.001$) as well as increased alcohol usage due to boredom ($p= 0.006$). There was a statistically significant difference observed in increased cannabis usage due to stress ($p < 0.001$) as well as increased cannabis usage due to loneliness ($p = 0.015$). There was no statistical difference between the perceived mental health groups for increased cannabis use due to boredom. Figure 1 showcases a visual comparison of the poor and excellent perceived mental health groups for the reasons for the increased consumption of alcohol.

Table 1. Baseline Characteristics of the Respondents from the Canadian Perspectives Survey Series 6 (N=683) by Random Assignment.

Characteristics (Age in years)	**Poor Mental Health Perception** (n=195)	**Excellent Mental Health Perception** (n=488)
15 to 24	16 (8.2)	4 (0.8)
25 to 34	45 (23.1)	47 (9.6)
35 to 44	45 (23.1)	52 (10.7)
45 to 54	44 (22.6)	67 (13.7)
55 to 64	31 (15.9)	124 (25.4)
65 to 74	10 (5.1)	128 (26.2)
75+	4 (2.1)	66 (13.5)
Alcohol Beverage consumed within the past 30 days during the pandemic		
Yes	127 (65.1)	322 (66.0)
No, not during the past 30 days	34 (17.4)	61 (12.5)
Never drank alcohol	34 (17.4)	105 (21.5)
Frequency of cannabis consumed within the past 30 days during the pandemic		
Never used cannabis	101 (51.8)	403 (82.6)
No, not during the past 30 days	29 (14.9)	48 (9.8)

1 day in the past 30 days	5 (2.6)	8 (1.6)
2 or 3 days in the past 30 days	10 (5.1)	9 (1.8)
1 or 2 days per week	11 (5.6)	3 (0.6)
3 or 4 days per week	8 (4.1)	5 (1.0)
5 or 6 days per week	6 (3.1)	3 (0.6)
Daily	25 (12.8)	9 (1.8)
Increased use of alcohol: Stress		
Yes	67 (34.4)	5 (1.0)
No	9 (4.6)	22 (4.5)
Increased use of alcohol: Boredom		
Yes	51 (26.2)	10 (2.0)
No	25 (12.8)	17 (3.5)
Increased use of alcohol: Loneliness		
Yes	44 (22.6)	4 (0.8)
No	32 (16.4)	23 (4.7)
Increased use of cannabis: Stress		
Yes	38 (19.5)	2 (0.4)
No	4 (2.1)	8 (1.6)
Increased use of cannabis: Boredom		
Yes	27 (13.8)	4 (0.8)
No	15 (7.7)	6 (1.2)
Increased use of cannabis: Loneliness		
Yes	22 (11.3)	1 (0.2)
No	20 (10.3)	9 (1.8)

Values are presented as number (%) of respondents unless stated otherwise.

Table 2: Statistical values for the Chi-square Test Analysis for the Primary Outcome.

Statistical significance was evaluated using a significant level of p= 0.05.

Variable	Pearson Chi-Square Value	Degrees of Freedom	P-value
Drink any alcoholic beverage in the past 30 days	3.596	2	0.166
Frequency of cannabis use in the past 30 days	91.294	7	<0.001

Table 3: Statistical values for the Chi-square Test Analysis for the Secondary Outcome.

Statistical significance was evaluated using a significant level of p= 0.05.

Variable	Pearson Chi-Square Value	Degrees of Freedom	P-value
Increased use of alcohol due to stress	45.923	1	< 0.001
Increased use of alcohol due to loneliness	14.858	1	< 0.001
Increased use of alcohol due to boredom	7.458	1	0.006
Increased use of cannabis due to stress	22.599	1	< 0.001
Increased use of cannabis due to boredom	1.979	1	0.160
Increased use of cannabis due to loneliness	5.881	1	0.015

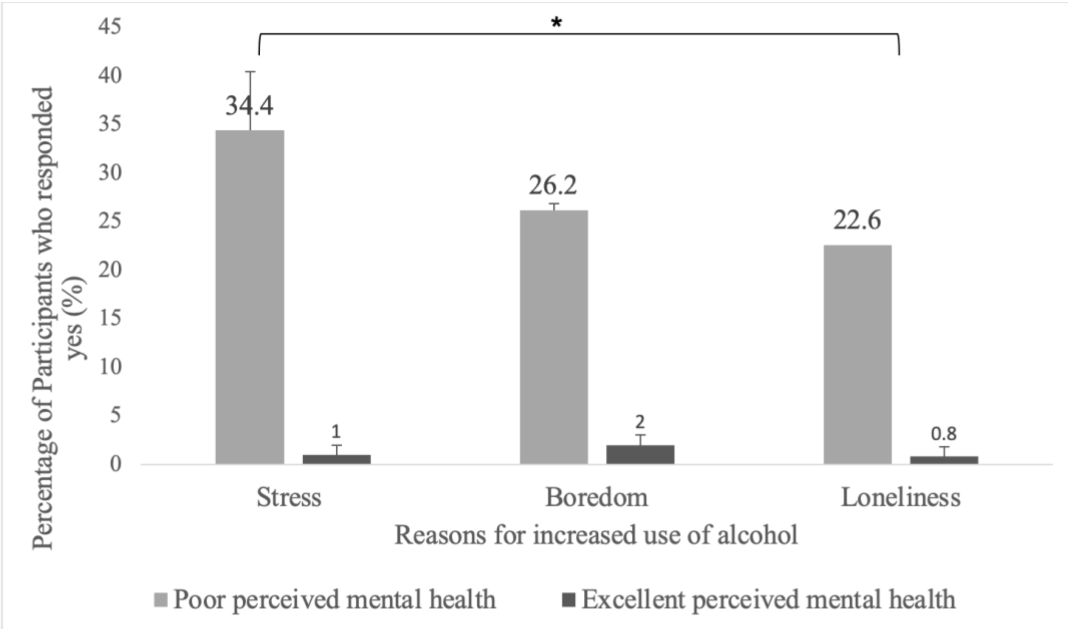

Figure 1. Comparison of the various reasons for increased consumption of alcohol of individuals aged 15 and older who perceive their mental health as poor or excellent (N=683). Error bars represent standard deviation for the percentage of participants.

Discussion

Summary of Main Findings

After we conducted several analyses, some of the main findings of the study were that a larger number of individuals with excellent mental health compared to poor mental health use alcohol. A substantial number of participants with excellent mental health reported never having used cannabis. More individuals with poor mental health reported increased use of alcohol and cannabis due to factors of stress and loneliness.

Analysis of Main Findings

As highlighted in Table 2, we found a statistically significant difference for frequency of cannabis use due to the pandemic. Based on the p-value of 0.166, there was no significant difference for alcohol abuse, however, further analysis suggests a negative result between alcohol use and perceived mental health. Data showed that individuals in the poor and excellent mental health categories generally consumed more alcohol. According to Table 3, p-values for increased alcohol use due to stress and loneliness ($p < 0.001$) as well as increased cannabis use due to stress ($p < 0.001$) were statistically significant suggesting that the relationship for alcohol and cannabis abuse during COVID-19 is due to factors of stress and loneliness for individuals with poor mental health.

Results vs Published Findings

We can look at some key findings from previously published studies to see how they align with our findings. A study by McGee et al. examined the association between cannabis use and mental health in adolescence to early adulthood (McGee et al., 2000). The study established a relationship between cannabis use prior to 18 years and future mental health problems (McGee et al., 2000). Our study demonstrated similar findings as we observed a higher number of individuals with poor mental health reporting to use cannabis compared to those with excellent mental health. This finding could be explained by the fact that cannabis was being used as a mechanism to cope with poor mental health. A limitation in the study by McGee et al. is that specific variables and demographic variables were not identified which may play a role in the relationship between cannabis and mental health. Our study explored the association of the factors stress, boredom, and loneliness to low mental health, to further expand on the previous field of research.

Another study by Weitzman reported individuals with poor mental health to seek alcohol as a coping strategy (Weitzman, 2004). However, the findings from our study indicated that a higher number of individuals with excellent mental health reported to use alcohol compared to those with poor mental health. A possible reason explaining these findings may be that those with excellent mental health used alcohol as a form of entertainment or celebration, while those with poor mental health chose to stay away from alcohol in efforts to prevent the possibility of addiction. Weitzman recognizes that there are several factors that contribute to poor mental health development in college aged students, and further research is needed to identify these connections (Weitzman, 2004). Our study explored the factors stress, boredom, and loneliness to find these associations that contribute to poor mental health. We can also conduct future studies to see if household income had any effect on alcohol use during the pandemic. Since the pandemic took a financial toll on many individuals, income and finances may have been a barrier for some to purchase alcohol.

Limitations and Future Directions

It is important to understand that there are possible limitations that may have affected the outcomes of the study. One limitation is that there was a lot of missing data from the initial population that was surveyed, which caused us to reduce our sample size when conducting our analysis, which may have altered the outcomes of the survey. There may have also been self-reporting bias since our study was based on a self-reported survey. This could have been avoided if the researchers conducted the survey rather than holding the participants responsible for the self-reported survey. Asking participants to self-report their mental health status may come with some bias, as mental health is constantly fluctuating and may not be clinically diagnosed, which may alter results of the study if participants had been clinically diagnosed. The nature of the variables in the survey may have also been a limitation to the study. Most of the variables in the survey are categorical, which limited the types of analyses that could have been conducted. The survey questions also did not consider factors such as previous alcohol and cannabis use, which may have influenced the findings or could have been something that was taken into account when conducting analysis. Additionally, because the pandemic was a very unpredictable event, there was no data collected prior to the beginning of the pandemic, and so we cannot directly visualize the trends associated with these variables, which may have limited the extent to which we are able to analyze the statistical analyses. Possible confounding variables could have also impacted why an individual may resort to cannabis and alcohol use apart from the variables that we explored.

To avoid such forms of limitations in the future, there are some changes that we can make to the design of the study. Future studies can follow a randomized controlled trial, a design that increases the strength of the cause-effect relationship and allows researchers to attribute differences in the outcomes between groups to the incorporation of the target intervention. Further baseline statistics and background information about the participants prior to the pandemic can be collected to make concrete conclusions about our findings. Some information that can be collected includes medical history, and alcohol and substance use prior to the pandemic. Having these factors in our analysis will help us determine the root cause of increased substance abuse during the pandemic and reduce the number of confounding variables in our analysis. By incorporating these changes into the design of the study, we can improve the reliability of the findings that we achieve. We can also investigate conducting a longitudinal study rather than a cross-sectional study that assesses changes in participants post-pandemic. This type of study may be helpful in order for us to assess the fluctuations in cannabis and alcohol usage as well as mental health status, and possibly look at whether or not the aftereffects of the pandemic have made a significant difference on Canadians' mental health and alcohol and cannabis usage. By implementing these next steps, we may be able to unfold new findings about the relationship between substance abuse and mental health.

Implications

The findings from our study provide prospective researchers with a true understanding of the root cause of alcohol and cannabis use in relation to the pandemic. With limited research conducted for factors including stress, loneliness and boredom during the pandemic, our research provides support programs information on how to alleviate substance abuse. Additionally, as the COVID-19 pandemic is still new to many of us, protocols and measures that are put into place by the government are not always effective for the public, and it is crucial to have studies that analyze how these measures are affecting the general population. Our research can help modify existing protocols to better serve the public in terms of attempting to reduce some of the adverse effects that may result after the pandemic is over. In the event that another pandemic occurs, we hope that our findings will help researchers understand how to tackle these issues that arise as a result of the pandemic. We hope that our study can help the government and additional partners create programs and preventative methods to refrain people from using substances to cope with their possible decline in mental health status.

Conclusion

Overall, we can see that the recent COVID-19 pandemic has played a significant role in the increased use of cannabis and alcohol and its association with one's perceived mental health. We hope that our research drives future research and can positively impact affected individuals who abuse substances during the pandemic because of their decline in mental health.

References

Abramson, A. (2021). Substance use during the pandemic. Https://Www.apa.org. https://www.apa.org/monitor/2021/03/substance-use-pandemic

Findlay LC, Arim R, Kohen D. Understanding the Perceived Mental Health of Canadians During the COVID-19 Pandemic. Health Rep. 2020 Jun 24;31(4):22-27. doi: 10.25318/82-003-x202000400003-eng. PMID: 32644764.

Gili, A., Bacci, M., Aroni, K., Nicoletti, A., Gambelunghe, A., Mercurio, I., & Gambelunghe, C. (2021). Changes in Drug Use Patterns during the COVID-19 Pandemic in Italy: Monitoring a Vulnerable Group by Hair Analysis. International Journal of Environmental Research and Public Health, 18(4), 1967. https://doi.org/10.3390/ijerph18041967

Government of Canada, Statistics Canada. (2020). Canadian Perspectives Survey Series (CPSS). Statcan.gc.ca. https://www.statcan.gc.ca/en/survey/household/5311#q2

Gritsenko, V., Skugarevsky, O., Konstantinov, V., Khamenka, N., Marinova, T., Reznik, A., & Isralowitz, R. (2020). COVID 19 Fear, Stress, Anxiety, and Substance Use Among Russian and Belarusian University Students. International Journal of Mental Health and Addiction, 19(6), 2362–2368. https://doi.org/10.1007/s11469-020-00330-z

Knight, J. R., Wechsler, H., Kuo, M., Seibring, M., Weitzman, E. R., & Schuckit, M. A. (2002). Alcohol abuse and dependence among U.S. college students. Journal of Studies on Alcohol, 63(3), 263–270. https://doi.org/10.15288/jsa.2002.63.263

Kumar, A., & Nayar, K. R. (2020). COVID 19 and its mental health consequences. Journal of Mental Health, 30(1), 1–2. https://doi.org/10.1080/09638237.2020.1757052

Magson, N. R., Freeman, J. Y. A., Rapee, R. M., Richardson, C. E., Oar, E. L., & Fardouly, J. (2020). Risk and Protective Factors for Prospective Changes in Adolescent Mental Health during the COVID-19 Pandemic. Journal of Youth and Adolescence, 50(1), 44–57. https://doi.org/10.1007/s10964-020-01332-9

McGee, R., Williams, S., Poulton, R., & Moffitt, T. (2000). A longitudinal study of cannabis use and mental health from adolescence to early adulthood. Addiction, 95(4), 491–503. https://doi.org/10.1046/j.1360-0443.2000.9544912.x

Meyer, J., Herring, M., McDowell, C., Lansing, J., Brower, C., Schuch, F., Smith, L., Tully, M., Martin, J., Caswell, S., Cortes, N., & Boolani, A. (2020). Joint prevalence of physical activity and sitting time during COVID-19 among US adults in April 2020. Preventive Medicine Reports, 20, 101256. https://doi.org/10.1016/j.pmedr.2020.101256

Vanderbruggen, N., Matthys, F., Van Laere, S., Zeeuws, D., Santermans, L., Van den Ameele, S., & Crunelle, C. L. (2020). Self-Reported Alcohol, Tobacco, and Cannabis Use during COVID-19 Lockdown Measures: Results from a Web- Based Survey. European Addiction Research, 26(6), 309–315. https://doi.org/10.1159/000510822

Weitzman, E. R. (2004). Poor Mental Health, Depression, and Associations With Alcohol Consumption, Harm, and Abuse in a National Sample of Young Adults in College. Journal of Nervous & Mental Disease, 192(4), 269–277. https://doi.org/10.1097/01.nmd.0000120885.17362.94

Welte, J. W., & Russell, M. (1993). Influence of Socially Desirable Responding in a Study of Stress and Substance Abuse. Alcoholism: Clinical and Experimental Research, 17(4), 758–761. https://doi.org/10.1111/j.1530-0277.1993.tb00836.x

Zaami, S., Marinelli, E., & Varì, M. R. (2020). New Trends of Substance Abuse During COVID-19 Pandemic: An International Perspective. Frontiers in Psychiatry, 11. https://doi.org/10.3389/fpsyt.2020.00700

Zajacova, A., Jehn, A., Stackhouse, M., Denice, P., & Ramos, H. (2020). Changes in health behaviours during early COVID-19 and socio-demographic disparities: a cross-sectional analysis. Canadian Journal of Public Health, 111(6), 953–962. https://doi.org/10.17269/s41997-020-00434-y

Examining the Associations Between Age of Initiation of Alcohol Consumption and Learning Problems: A Cross-Sectional Study

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Examining the Associations Between Age of Initiation of Alcohol Consumption and Learning Problems: A Cross-Sectional Study

Ethyl alcohol, known colloquially as alcohol, is an intoxicating compound found in beer, wine, and liquor (Sullivan et al., 2010). Alcohol is generally classified as a depressant drug due to its sedative and depressant psychoactive effects on the central nervous system (Karlsson & Roman, 2016). At low doses, alcohol can induce feelings of euphoria; however, high quantities can lead to exhaustion, respiratory depression, organ failure, coma, or death associated with damage to the nervous system (Karlsson & Roman, 2016; Pfefferbaum & Sullivan, 2005).

Recent research has linked alcohol use to more than 60 acute and chronic diseases contributing to physical and cognitive decline (Griswold et al., 2018). However, as a result of factors such as acute and chronic alcohol consumption, adverse effects on internal systems and consequently, psychological impairment, the true extent of harm attributed to alcohol use remains unclear (Griswold et al., 2018).

In Canada, the legal drinking age is 19 years, except in Alberta, Manitoba and Quebec, where it is 18 years (Callaghan et al., 2014). Alcohol is one of the most common substances used in underaged Canadians with 64.5% of grade 10-12 students having reported alcohol drinking and more than 25% report binge drinking (Gohari et al., 2021; Miller et al., 2007). Youth who engage in drinking alcohol are more likely to experience school problems such as higher rates of absences, lower grades, memory problems, and changes in brain development that can have lasting effects (Miller et al., 2007).

According to the National Survey on Drug Use and Health (2019), 85.6% of individuals 18 and older self-reported using alcohol at some point in their lifetime. Many choose to consume alcohol for recreational and social purposes. However, there is a growing trend of individuals turning to alcohol to blunt emotional trauma and cope with daily stresses (Glassman et al., 2010; LaBouvie & Bates, 2002). Culture is another important factor to consider when discussing reasons for alcohol consumption, especially in youth. Drinking culture involves multiple elements that can affect the age an individual begins consuming alcohol. These include cultural practices, occasions, and pressure pertaining to societal influence (Katainen et al., 2021). A qualitative study by Friese and colleagues also reported that parents who ineffectively communicate the dangers of alcohol consumption may unintentionally provoke underaged drinking (Freise et al., 2012).

Individual differences such as genetics, family history of alcohol use, overall physical and mental health, sex and gender differences, and the age of onset of alcohol consumption can have an impact on the extent and location of brain damage (Oscar-Berman & Marinković, 2007). The duration an individual uses alcohol also contributes to cognitive and structural brain health outcomes ranging in severity. Acute effects depend on an individual's blood alcohol concentration as well as their tolerance to acute intoxication. These effects do not cause major damage to the brain. (Oscar-Berman & Marinković, 2007). Acute effects can include difficulty walking, blurred vision, slurred speech, slowed reaction times, and impaired memory (Oscar-Berman & Marinković, 2007). In contrast, the effects of chronic alcohol use on the brain can lead to permanent damage and dysfunction (Oscar-Berman & Marinković, 2007). In particular, this can arise in the frontal lobe, which is important for executive function and the hippocampus, which is responsible for learning and memory formation (Nagel et al., 2005; Meda et al., 2018).

The prefrontal cortex (PFC), which is the anterior region of the frontal lobes, is essential for assorted cognitive functions including, detailed thought processes, self-control, personality growth, and appetitive behaviours such as drinking (Oscar-Berman & Marinković, 2007; Anderson et al., 2001; Joffe, 2018). The development of the PFC during infancy and adolescence stages is crucial, as it builds the foundation for complex learning abilities (Anderson et al., 2001). Alcohol use during this critical developmental period of the PFC can lead to impairments that persist into adulthood and increase the risk of developing alcohol use disorders (Joffe, 2018). Despite Canada's legal drinking age beginning from age 18-19, the PFC does not reach full maturation until age 20-25. To ensure the function of the PFC is not damaged, the initiation of alcohol consumption would be more appropriate after it is fully matured (Anderson et al., 2001).

Numerous studies have investigated the association between alcohol use and potential learning deficits in young individuals (Balsa et al., 2011; Gohari et al., 2021). Specifically, researchers have looked at relationships between heavy alcohol consumption and learning outcomes, including long-term effects on the brain (Gohari et al., 2021). However, the correlation between the initial age of alcohol consumption and consequent challenges in learning remains unknown. Understanding potential factors that contribute to learning problems can assist researchers and clinicians in developing prevention and treatment strategies that improve learning outcomes. Therefore, the purpose of this analysis is to demonstrate the presence of learning challenges that can arise from alcohol consumption depending on the age of initiation of consumption. This analysis will investigate if there is a difference in the prevalence of self-reported learning problems in relation to the age that alcohol was first consumed in one's first 19 years of life compared to later use in life (>19) in Canadian females and males aged 15 years and older.

Methods

Study Design and Database

The Canadian Addiction Survey (CAS) 2004 is a major national survey that assessed Canadians' attitudes, beliefs and personal use of alcohol and other drugs (Health Canada & Canadian Executive Council on Addictions, 2013). It was an observational, cross-sectional study that was designed to fill a critical gap in knowledge about prevalence rates, trends, and changes in alcohol and other drug use. The results of this study aimed to help addiction agencies allocate financial and human resources where they are most needed (Health Canada & Canadian Executive Council on Addictions, 2004). The study had 5 main goals: (1) to determine the prevalence, incidence and frequency of alcohol and other drug use in Canada; (2) to measure the extent of harms that are associated with those individuals who use alcohol and other drugs; (3) to assess the context of use and identify the risk and protective factors related to the use and consequences of alcohol and other drug use; (4) to measure the public's opinions, views and knowledge regarding existing and potential addiction policies and to identify emerging policy issues; (5) to provide baseline data for future evaluations of the effectiveness of Canada's Drug Strategy and other efforts to reduce the harm associated with alcohol and other drug use ((Health Canada & Canadian Executive Council on Addictions, 2004)).

This study was administered through telephone interviews done by the research firm Jolicoeur et associés. Computer-assisted telephone interviewing (CATI) was utilized, and was based on a two-stage (telephone household, respondent), random sample, and used random-digit-dialing methods (Health Canada & Canadian Executive Council on Addictions, 2004).

Study Participants

The study participants included Canadian females and males 15 years of age and older living in a Canadian province. Individuals who were residents of prisons, hospitals, military establishments as well as transient populations such as the homeless were excluded from the study (Health Canada & Canadian Executive Council on Addictions, 2013). Individuals who did not respond to relevant questions pertaining to the study outcomes were omitted from the analysis.

Study Outcomes

The primary outcome of the study was learning problems in relation to the age of initial alcohol consumption. The data for this outcome was collected during a telephone interview that asked the participant, “Was there ever a time when you had difficulty learning things because of your alcohol use?”. In the case that there was poor understanding of the question asked, the interviewer followed up with “What about difficulty learning things?”. Participants were given the option of answering “yes”, “no”, or “don’t know”. The survey also asked “Not counting small sips, how old were you when you started drinking alcoholic beverages?” and participants responded by stating their age corresponding to the question.

The survey relied on self-reported data from participants. The questionnaire was favourable to subjects as questions were easy to understand and answers were anonymous. Self-reported data was important to this study as it is easily reproducible due to not requiring in-depth background information from alternative sources such as medical records. Self-reported learning problems due to alcohol consumption provides insight on individual life-experiences associated with particular ages that subjects began drinking. Phone surveys are more accessible compared to in-person and written surveys. This accessibility provides individuals with the opportunity to participate from a location of their choice.

Assessing self-reported learning problems is important in terms of establishing a relationship between the primary outcome and alcohol consumption in minors. It is possible that self-reported data may provide a high test-retest reliability under the right conditions (Harrison, 1995). According to Harrison (1995), the validity of self-reported data often depends on multiple factors including the social desirability of the substance in question as well as anonymity of the study. This study will contribute to the literature by Balsa et al. (2011) and Gohari et al. (2021) by looking specifically at the age alcohol was first consumed and comparing it to subsequent self-perceived learning problems. This will effectively answer our primary research question as we analyze the data collected by the Canadian Addiction Survey (2004).

Additional Data Collection

Additional descriptive variables that were used for data collection included age, sex, education, and province. The purpose of including this data is to ensure that there is knowledge pertaining to participants' identity and general demographics. The variable age had one constriction of the minimum being 15 years, and the sex of participants was collected as either "male" or "female". For the variable education, participants were asked "What is the highest level of education you have completed?", ranging from less than high school to university degree as seen in Table 1. The variable province was simply stated by the participant based on their current location.

Statistical Analysis

All data collected is categorical and is represented using frequencies and percents. The dependent variable is self-reported learning problems, whereas the independent variable is the age individuals started drinking. To answer this study's primary research question, the chi-squared test (χ^2) was chosen because the dependent and independent variables are categorical with 2 categories each. Performing a chi-squared test effectively determined between-group differences in proportions of the age individuals started drinking and self-reported learning problems. Respondents that did not answer the two questions associated with our primary outcome were removed from the data set. Significance was reported if $p<0.05$. All statistical analyses were performed using IBM SPSS Statistics (Version 28.0) (IBM SPSS, 2021).

Results

A total of 13,909 individuals responded to the Canadian Addiction Survey (2004). Of these responses, there were 1,421 participants who did not respond to one or both of the questions regarding alcohol use causing learning problems, as well as the age they first consumed alcohol. These cases were removed from the data set leaving 12,488 participants who responded to both questions. A summary of the participants' demographic characteristics are reported in Table 1.

Table 1. Descriptive Characteristics of Study Participants [n=12488]

Variables	**Began drinking ≤19 years** (n=9685)	**Began drinking >19 years** (n=2803)
Age in years (n=12266)		
15-24	1800 (18.6)	47 (1.7)

	25-44	4213 (43.5)	533 (19.0)
	45+	3536 (36.5)	2137 (96.9)
Sex (n=12488)			
	Females	5178 (53.5)	2040 (72.8)
	Males	4507 (46.5)	763 (27.2)
Province (n=12488)			
	Newfoundland	626 (6.5)	252 (9.0)
	Prince Edward Island	668 (6.9)	213 (7.6)
	Nova Scotia	654 (6.8)	248 (8.8)
	New Brunswick	642 (6.6)	244 (8.7)
	Quebec	652 (6.7)	258 (9.2)
	Ontario	663 (6.8)	234 (8.3)
	Manitoba	1074 (11.1)	265 (9.5)
	Saskatchewan	783 (8.1)	135 (4.8)
	Alberta	1769 (18.3)	400 (14.3)
	British Columbia	2154 (22.2)	554 (19.8)

Highest Completed Education (n=12416)			
	< High school	1441 (14.9)	555 (19.8)
	High School	2726 (28.1)	815 (29.1)
	Some Post-Secondary	3201 (33.1)	772 (27.5)
	University Degree	2269 (23.4)	637 (22.7)
Has your alcohol use ever caused learning problems? (n=12488)			
	No/never	9387 (96.9)	2780 (99.2)
	Yes	298 (3.1)	23 (0.8)

Table 1 displays the demographic characteristics of participants. Values were analyzed using SPSS and reported as n (%).

Table 2 shows the number of individuals that selected specific answers in 2 questions of the survey. Figure 1 shows the difference in the proportion of respondents who have a learning problem attributed to alcohol use. Of the 321 respondents who reported a learning problem, 298 (92.8%) out of 321 were in the 0-19 age group and 23 (7.2%) out of 321 were in the greater than 19 group.

Table 2. Chi-square test count

	Age started drinking alcoholic beverages?		
	≤19	>19	Total

Has your alcohol use ever caused learning problems?	Never	9387	2780	12167
	Yes	298	23	321
Total		9685	2803	12488

Table 2 displays the 2x2 contingency table for the chi-square analysis. Values represent the number of participants.

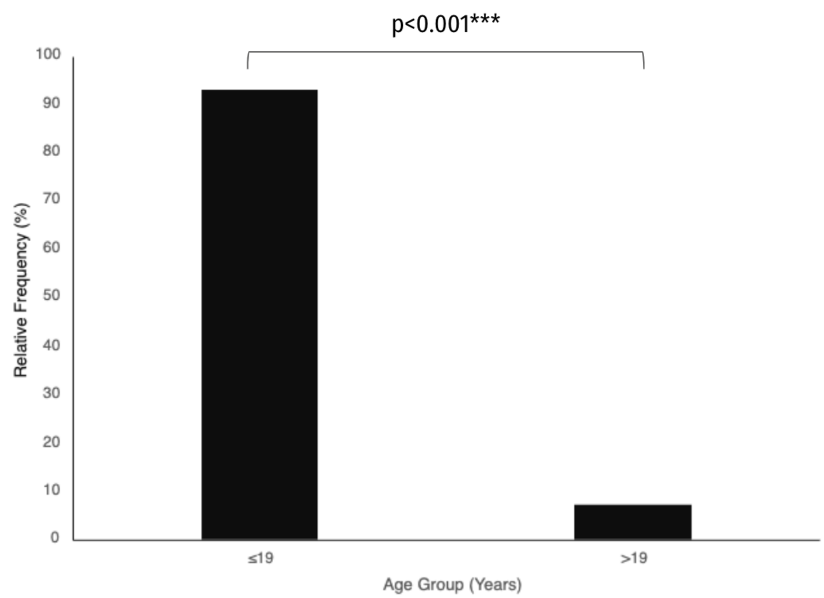

Figure 1. Comparing the number of respondents reporting learning problems in relation to age of first alcohol consumption. This bar graph displays the percent of respondents who self-reported learning problems in relation to the age alcohol was first consumed. Age groups are separated from less than or equal to 19 years and greater than 19 years (n=12488). P-value from chi-square test $p<0.001$.

Discussion

The present study identified a significant association between the age an individual begins drinking alcohol and experiencing learning problems. The results showed that individuals who reported drinking at a younger age had a higher proportion of self-reported learning problems.

The findings of this study may have been attributed to alcohol-induced damage to the brain development process relating to consequential neurotoxicity in the central nervous system (Pfefferbaum & Sullivan, 2005). Alcohol consumption prior to age 25 could contribute to harmful deficits and dysfunction in areas important for learning such as the hippocampus and PFC (Anderson et al., 2001). Previous studies have found similar associations with alcohol use and school-related problems (Zeigler et al., 2005; Miller et al., 2007; Gohari et al., 2021). Unlike other studies, the present study also considered the age of initiation of alcohol use in relation to learning problems. It has been shown that a younger age of initial alcohol use has been strongly related to higher levels of alcohol misuse in adolescents aged 17-18 (Hawkins et al., 2007).

Underage alcohol use has been associated with neurodegeneration in brain regions responsible for learning and memory such as the hippocampus, which has implications in learning and intellectual development (Zhao et al., 2013). Alcohol misuse, specifically binge drinking in adolescence has previously been linked to poor school performance as well as health risk behaviours (Miller et al., 2007). In adolescents, alcohol use has been shown to have a small negative effect on GPA, mediated by school absences and difficulties with school-related tasks in males, and a higher probability of difficulties at school in females (Balsa et al., 2011). When compared to other studies, our study yielded analogous results in regards to the potential relationship between early alcohol consumption and learning problems.

Previous studies have only considered factors associated with learning problems that are correlated with alcohol use early in life. As a result, they have failed to consider whether the initiation age of alcohol use contributes to the pervasiveness of learning problems in early drinkers. The current study consolidates the results from previous research to show that individuals who began drinking at a younger age had greater levels of self-reported learning problems attributed to alcohol consumption that began before the age of 19.

The study was limited by several factors that may have reduced the quality of self-reported outcomes. Participant identities were anonymous, therefore, leaving a greater chance of under-reported alcohol use and learning problems (Davis et al., 2010). These inaccuracies can be attributed to social desirability bias, leading individuals to present a socially acceptable self-image (Davis et al., 2010). As a result, it may be unlikely for participants to attribute their learning problems to alcohol consumption. Additionally, due to subjectivity, one's perception of learning problems may not fit into standardized criteria used by health professionals used to identify these problems. This study also does not account for pre-existing learning conditions, not attributed to early alcohol consumption. Furthermore, recall bias can influence an individual's ability to accurately remember whether they have experienced learning challenges. Therefore, self-reported learning problems may not accurately reflect the true extent of learning challenges individuals experience as a result of alcohol consumption.

Another limitation of the study was its generalizability as it only included participants residing in Canadian provinces. Due to unique societal factors such as drinking culture and drinking age that influence Canadian drinking behaviours, the outcomes of this study cannot be applied to other populations. Since the study excluded participants from Canadian territories, the outcomes can not be generalized to all Canadians. Also, with consideration that the study data was collected in 2004, trends in alcohol consumption may have changed. Therefore, it is uncertain whether study results would be replicated in modern-day. Lastly, to answer our research question, we ran a chi-square analysis. Since our variables of interest had 2 categories each, it is not possible to determine where exactly the statistical significance lies.

Future research is needed to understand the type and severity of learning impairments identified in this study. Doing so can help researchers and clinicians understand the extent of self-reported learning problems as well as develop targeted prevention and treatment strategies to improve learning outcomes. Additionally, future analyses should assess the influence of other variables such as quantity of alcohol consumption, sex, ethnicity, and geographic location. Collectively, analyzing these variables can further highlight whether early alcohol consumption contributes to potential learning problems or if other variables such as cultural, societal, environmental, or biological factors should be considered. Future studies should also analyze the reliability, validity, responsiveness, and interpretability of the Canadian Addiction Survey (2004). This is necessary to understand the methodological quality of the survey and its ability to effectively assess self-reported learning problems associated with early alcohol consumption. This survey can also be evaluated in non-Canadian populations to assess its generalizability in international populations.

Ultimately, this study has identified an association between early alcohol consumption (younger than 19 years of age) and self-reported learning problems in comparison to those who start drinking after 19 years of age. This information can assist researchers, clinicians, and public health professionals in understanding the prevalence of self-reported learning problems among early drinkers. Furthermore, these findings can inform the development of harm reduction programs that strive to reduce early alcohol consumption among youth to improve quality of life.

References

Anderson, V. A., Anderson, P., Northam, E., Jacobs, R., & Catroppa, C. (2001). Development of Executive Functions Through Late Childhood and Adolescence in an Australian Sample. *Developmental Neuropsychology*, *20*(1), 385–406. https://doi.org/10.1207/S15326942DN2001_5

Balsa, A. I., Giuliano, L. M., & French, M. T. (2011). The effects of alcohol use on academic achievement in high school. Economics of Education Review, 30(1), 1–15. https://doi.org/10.1016/j.econedurev.2010.06.015

Callaghan, R. C., Sanches, M., Gatley, J. M., & Stockwell, T. (2014). Impacts of drinking-age laws on mortality in Canada, 1980–2009. *Drug and Alcohol Dependence*, *138*, 137–145. https://doi.org/10.1016/j.drugalcdep.2014.02.019

Davis, C. G., Thake, J., & Vilhena, N. (2010). Social desirability biases in self-reported alcohol consumption and harms. *Addictive behaviors*, *35*(4), 302–311. https://doi.org/10.1016/j.addbeh.2009.11.001

De Bellis, M. D., Clark, D. B., Beers, S. R., Soloff, P. H., Boring, A. M., Hall, J., Kersh, A., & Keshavan, M. S. (2000). Hippocampal Volume in Adolescent-Onset Alcohol Use Disorders. *American Journal of Psychiatry*, *157*(5), 737–744. https://doi.org/10.1176/appi.ajp.157.5.737

Friese, B., Grube, J. W., Moore, R. S., & Jennings, V. K. (2012). Parents' Rules about Underage Drinking: A Qualitative Study of Why Parents Let Teens Drink. Journal of Drug Education, 42(4), 379–391. https://doi.org/10.2190/de.42.4.a

Glassman, T. J., Dodd, V. J., Sheu, J. J., Rienzo, B. A., & Wagenaar, A. C. (2010). Extreme ritualistic alcohol consumption among college students on game day. *Journal of*

American College Health, 58(5), 413-423.

Gohari, M. R., Zuckermann, A. M. E., & Leatherdale, S. T. (2021). A longitudinal examination of alcohol cessation and academic outcomes among a sample of Canadian secondary school students. *Addictive Behaviors*, *118*, 106882. https://doi.org/10.1016/j.addbeh.2021.106882

Griswold, M. G., Fullman, N., Hawley, C., Arian, N., Zimsen, S. R. M., Tymeson, H. D., Venkateswaran, V., Tapp, A. D., Forouzanfar, M. H., Salama, J. S., Abate, K. H., Abate, D., Abay, S. M., Abbafati, C., Abdulkader, R. S., Abebe, Z., Aboyans, V., Abrar, M. M., Acharya, P., … Gakidou, E. (2018). Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet, 392(10152), 1015–1035. https://doi.org/10.1016/s0140-6736(18)31310-2

Harrison, L. D. (1995). The validity of self-reported data on drug use. *Journal of drug issues*, *25*(1), 91-111.

Hawkins, J. D., Graham, J. W., Maguin, E., Abbott, R., Hill, K. G., & Catalano, R. F. (1997). Exploring the Effects of Age of Alcohol Use Initiation and Psychosocial Risk Factors on Subsequent Alcohol Misuse. *Journal of Studies on Alcohol*, *58*(3), 280–290.

Health Canada & Canadian Executive Council on Addictions. (2004). *Canadian Addiction Survey (CAS): A National Survey of Canadians' use of alcohol and other drugs*. Canadian Center on Substance Abuse.

Health Canada & Canadian Executive Council on Addictions. (2013). *Canadian Addiction Survey, 2004 Study Documentation*. Health Canada.

Health Canada. (2004). Canadian Addiction Survey (1.0). *Odesi*: Data and Government

Information Centre, Queen's University Data Centre, Carleton University, Data Resource Centre, University of Guelph. https://odesi.ca/#/details?uri=/odesi/cas-E-2004.xml

IBM SPSS 28.0. (2021). IBM. Retrieved November 1, 2021, from https://www.ibm.com/account/reg/us-en/signup?formid=urx-19774

Joffe, M. E. (2018). Persistent “Sag” in Prefrontal Cortex Function following Adolescent Binge Drinking. *Journal of Neuroscience*, *38*(45), 9615–9617. https://doi.org/10.1523/JNEUROSCI.1755-18.2018

Karlsson, O., & Roman, E. (2016). Dose-dependent effects of alcohol administration on behavioral profiles in the MCSF test. *Alcohol*, *50*(Complete), 51–56. https://doi.org/10.1016/j.alcohol.2015.10.003

Katainen, A., Härkönen, J., & Mäkelä, P. (2021). Non-Drinkers’ Experiences of Drinking Occasions: A Population-Based Study of Social Consequences of Abstaining from Alcohol. *Substance use & misuse*, 1-10. https://doi.org/10.1080/10826084.2021.1990331

Labouvie, E., & Bates, M. E. (2002). Reasons for alcohol use in young adulthood: validation of a three-dimensional measure. *Journal of Studies on Alcohol, 63*(2), 145-155.

Meda, S. A., Hawkins, K. A., Dager, A. D., Tennen, H., Khadka, S., Austad, C. S., Wood, R. M., Raskin, S., Fallahi, C. R., & Pearlson, G. D. (2018). Longitudinal Effects of Alcohol Consumption on the Hippocampus and Parahippocampus in College Students. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *3*(7), 610–617. https://doi.org/10.1016/j.bpsc.2018.02.006

Miller, J. W., Naimi, T. S., Brewer, R. D., & Jones, S. E. (2007). Binge Drinking and Associated Health Risk Behaviors Among High School Students. *Pediatrics*, *119*(1), 76–85. https://doi.org/10.1542/peds.2006-1517

Nagel, B. J., Schweinsburg, A. D., Phan, V., & Tapert, S. F. (2005). Reduced hippocampal volume among adolescents with alcohol use disorders without psychiatric comorbidity. *Psychiatry Research: Neuroimaging*, *139*(3), 181–190. https://doi.org/10.1016/j.pscychresns.2005.05.008

Oscar-Berman, M., & Marinković, K. (2007). Alcohol: Effects on Neurobehavioral Functions and the Brain. *Neuropsychology Review*, *17*(3), 239–257. https://doi.org/10.1007/s11065-007-9038-6

Pfefferbaum, A., & Sullivan, E. V. (2005). Disruption of brain white matter microstructure by excessive intracellular and extracellular fluid in alcoholism: evidence from diffusion tensor imaging. *Neuropsychopharmacology*, *30*(2), 423-432. https://doi-org.libaccess.lib.mcmaster.ca/10.1038/sj.npp.1300623

Section 2 PE Tables – Results from the National Survey on Drug Use and Health: Detailed Tables, *SAMHSA, CBHSQ*. (2019). https://www.samhsa.gov/data/sites/default/files/reports/rpt29394/NSDUHDetailedTabs2019/NSDUHDetTabsSect2pe2019.htm#tab2-17b

Zhao, Y.-N., Wang, F., Fan, Y.-X., Ping, G.-F., Yang, J.-Y., & Wu, C.-F. (2013). Activated microglia are implicated in cognitive deficits, neuronal death, and successful recovery following intermittent ethanol exposure. *Behavioural Brain Research*, *236*, 270–282. https://doi.org/10.1016/j.bbr.2012.08.052

Determination of the Relationship Between Smoking E-cigarettes with Nicotine in the Last 30 Days and Disrupted Sleep Patterns of Canadian Male Students Compared to Canadian Female Students in Grades 7 to12 - A Cross-Sectional study

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Dr. Pritchard

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Introduction:

The popularity of electronic cigarettes, otherwise referred to as e-cigarettes, among teens as a source of nicotine has heightened from previous decades (Pisinger, C., & Døssing, M. (2014). E-cigarettes contain chemicals, artificial flavorings, and, often, nicotine which are compressed for inhalation (Callahan-Lyon, 2014). They are marketed as a safer alternative and are intended to deliver pure nicotine (Pisinger, C., & Døssing, M. (2014). Many studies have found an association between smoking e-cigarettes and poor sleep (Kianersi et al., 2021) since consuming nicotine affects the endocrine system by increasing blood pressure, heart rate, and blood glucose level (Tweed et al., (2012), which results in delayed sleep (Wiener et al., (2020)). Nicotine is the primary compound that causes irresistible drug-seeking behavior and may further affect the central nervous system by stimulating the release of neurotransmitters. These include serotonin, dopamine, acetylcholine, and norepinephrine, which assist in regulating the sleep-wake cycles (Dugas et al., (2017)). In their research study, Park et al. (2019) found that individuals who regularly use e-cigarettes consume higher doses of nicotine and may get fewer hours of sleep due to a drop in their blood nicotine levels during sleep, leading to cravings. Park et al. (2019) recorded a p-value, <0.05, highlighting a solid statistical significance for the association between e-cigarettes use and sleep deprivation.

Although multiple studies have investigated the association between e-cigarettes and disrupted sleep patterns, the effects have not been monitored in Canadian students from grades 7 to 12. The majority of studies took place in other nations and included older age and grade participants, resulting in limited knowledge of Canadian students. For instance, a cross-sectional study executed by Zvolensky et al. (2020) in the US included 304 e-cigarette users (53.6% female, Mage = 36.7 years, SD = 10.3) as participants. The age of the participants was different from the age group being analyzed (12-18 years) in this study as measured by their grade level, making our research question distinct from the previous topics. Similarly, researchers Kang, S. G., & Bae, S. M. (2021) analyzed data collected from the 2018 Korean Community Health Survey (KCHS), which targeted a population of 19 years or older and 228, 340 participants completed the survey. US researchers explored gender-based discrepancies in smoking e-cigarettes and found that after acquiring information about e-cigarettes from a trusted individual, females with the mean age of 39.82 years were more likely than males to commence smoking e-cigarettes; whereas males rated e-cigarettes as more addictive (Piñeiro et al., (2016)). The goal is to determine if similar experiences would be recorded or more considerable differences between Canadian males and Canadian female students. Focusing on Canadian data, out of 8363 Ontario Secondary Schools, only 69 schools (0.0083%) have implemented policies (Milicic et al., (2018)). Since many schools across Canada lack data about educational policies to control the use of the e-cigarette, the data from this study can bring awareness on how e-cigarettes are deteriorating the health of Canadian students (Milicic et al., 2018).

Furthermore, this study questions whether there is a relationship between smoking e-cigarettes with nicotine in the last 30 days and the disruptive sleep patterns of Canadian males from grades 7 to 12 compared to female Canadian students from grades 7 to 12. The aim is to fill in the knowledge gaps and introduce preventive measures that schools can implement to control this issue for the betterment of students' health. We hypothesize that the frequency of e-cigarette use will negatively affect the sleep patterns of male participants, which will differ from the female participants. It is expected that participants who smoke e-cigarettes will experience a difficult time falling asleep, leading to decreased focus in academic activities. The participants' province of residence, type of community (rural or urban region), and household income are further assessed to screen for any secondary relations to their smoking behavior. It is common knowledge that students who get less than the recommended hours of sleep will impact their academic performance (Suni, 2021). The study population was divided into male and female categories, as it was explored in a study conducted by (Piñeiro et al. (2016)), that females are more prone to smoke by seeing their peers smoking and males get more addicted to smoking. The biological differences may be contributing to smoking behavior, sleep irregularity, and focus patterns exhibited by males and females. Because this study involves several confounding variables that can affect an individual's sleep, our obtained results may be influenced. Frequent use of over-the-counter medication, environmental factors such as domestic violence, mental health, and substance abuse are some of the confounding variables that can influence an individual’s sleep (Piñeiro et al., (2016)), (Lund et al., 2010). The null hypothesis is that there is no meaningful relationship between smoking e-cigarettes with nicotine in the last 30 days and the disruptive sleep patterns of males compared to female Canadian students from grades 7 to 12. Perhaps if the results show significant differences between the sleeping behavior and focus of different genders influenced by smoking e-cigarettes, they can help change the perspective of vaping as a trend and influence vital policy-making processes to have stricter regulation of the sales of e-cigarettes.

SPSS Data Codebook

SPSS Variable name	What is the Variable	Coding Instructions	Measurement Scale	How will the variable be used?	Independent or Dependent variables?
GRADE	Participants level of education	7= Grade 7 8= Grade 8 9= Grade 9 10= Grade 10 11= Grade 11	Ordinal	To assess level of education	N/A
SEX	Participant's sex at birth	0 = female 1 = male 2 = prefer not to answer	Nominal	To determine gender identification	N/A
DVHHINC2	Median Household Income of the area where the respondent’s school is located according to the Canadian 2016 census data.	Household income in Canadian dollars	Scale	To determine socioeconomic status	N/A

PROVID	Province ID number	10 = Newfoundland & Labrador 11 = PEI 12 = NV 13 = NB 24 = Quebec 35 = Ontario 46 = Manitoba 47 = Saskatchewan 48 = Alberta 59 = British Columbia	Nominal	To determine province of stay	N/A
DVURBAN	Participant's school region	1 = urban 2 = rural	Nominal	To assess the living environment	N/A
SLP_220	Frequency of participant's struggle to stay awake while reading, studying and doing homework in the last two weeks	1 = Every day/night 2 = Several times 3 = Twice 4 = Once 5 = Never 99 = Not Stated	Ordinal	To determine energy levels	N/A
SLP_200	Frequency of the participant's struggle to fall asleep in the last two weeks.	1 = Every day/Night 2 = Several times 3 = Twice 4 = Once 5 = Never 99 = Not stated	Ordinal	To determine quality of sleep	Dependent
ELC_026a	Frequency of participant's e-cigarette (vape, vape pen, tank & mod) with nicotine use In the last 30 days, did you use e-cigarettes	1= Daily or almost daily 2= Daily, but at least once a week 3= Weekly, but at least once in last 30 days 4= Tried, but not in the last 30 days 5= Never tried 99= Not Stated	Ordinal	Quality of life	Independent

<u>Methods</u>

Study design and database: The study design used is cross-sectional since it compares different population groups at a single point. A biennial Canadian school-based survey of a generalizable sample of students in grades 7 through 12 is conducted every two years (Aleyan, et al., 2021). Dataset titled "Canadian Student Tobacco, Alcohol, and Drugs Survey (CSTADS), 2018-2019" is used to learn about the differences in the sleep pattern due to smoking. Since 2004, the Propel Centre for Population Health Impact at the University of Waterloo has coordinated CSTADS on behalf of Health Canada. The database used to extract the dataset is odesi, a data exploration, extraction, and analysis tool that runs on the web. Ontario Data Documentation, Extraction Service, and Infrastructure (ODESI) promote data access for researchers, teachers, and students as a result of a unique relationship involving university libraries, businesses, and government (<odesi> Home, n.d.). It also most datasets to be downloaded into statistical tools for further analysis.

Study participants: The study included Canadian participants (n = 62850) from grades 7-12 and of both male (n = 31784) and female (n=31066) genders. The inclusion criteria included young Canadian residents attending private, public, and Catholic schools enrolled in grades 7-12. The exclusion criteria included individuals enrolled in schools of Yukon, Northwest Territories, and Nunavut; students who attend special schools (e.g., schools for visually impaired, schools for hearing-impaired, daycares, special needs, First Nation reserve schools, virtual schools, schools located on military bases, international schools). In addition, students from schools that do not have at least 20 students enrolled in at least one eligible grade were also excluded from the target population of schools to control data collection costs.

Study outcome: The primary outcome being measured is the frequency of the participant's struggle to fall asleep in the last two weeks, depending on their gender, grade, and frequency of e-cigarette use with nicotine. This survey question was selected to measure the primary outcome of our study as it effectively highlights any sleep irregularities that the participants may be experiencing along with their smoking behavior and gender differences (Piñeiro et al., (2016)). Since this study utilized a qualitative set of data, this question is very descriptive and directly measures the impact of smoking. The specificity of this question raises the question of whether another factor (confounding variable) has also changed in the participant's life, such as ethnicity and culture (Troxel et al., 2015). The secondary outcome being measured is the frequency of the participant's struggle to stay awake while reading, studying, and doing homework in the last two weeks. This survey question was selected to measure the secondary outcome of our study as it describes how a students' ability to focus in class may be affected by variables such as their smoking status and gender. It allows us to reproducibly and accurately measure students to categorize their focus levels, and it is descriptive enough to measure focus in academic settings as they are a large part of a students' life. Although there may be confounding variables (substance abuse, mental health, and environmental factors) that influence the question, it effectively measures our secondary outcome by linking it to the student's smoking behavior and gender (Park et al., 2021).

Additional Data Collection: The additional variables used were the participant's school region (DVURBAN), the province they were from (PROVID), and the median household income of the area where the respondent's school is located (DVHHINC2). DVURBAN focuses on the type of community (rural or urban) that the participant belongs to, and DVHHINC2 and PROVID are assessed as secondary variables which may play an additional role in altered smoking and sleep patterns.

Statistical Analyses: To assess the results and answer the research question, Chi-square statistical analysis and a p-value of 0.05 were used as a cut off for significance. The SPSS computer software was used to run the statistical tests. Any missing data for the primary variables were deleted (e-cig smoking, sleep, focus) for a clear understanding of the data and to provide more accurate results. Since the secondary variables (grade level, sex, household income, province of residence, and participants' school region) did not have any missing data, none was deleted. Our project aimed first to analyze the relationship between participants' smoking and sleeping habits, analyzed by chi-square test. Since we are relating focus with sleep, we analyzed whether focus is associated with smoking and whether grade is associated with smoking and sleeping behavior, using a chi-square test. We then proceeded to analyze the association between our secondary variables (province, rural, income levels) and the participants' smoking behavior using a chi-square test. We chose this test because we wanted to explore the correlation between smoking and sleep patterns in males compared to female participants and examine secondary variables' relation to the participants' smoking behavior. Furthermore, given that our study design was qualitative and in the form of a questionnaire with most of our data being categorical (only the income variable was continuous), most of the analysis could not have been run such as normality tests, ANCOVA, spearman for non-ordinal data, and logistic regression due to lack of dichotomous variables.

Table I a. Descriptive Characteristics of Canadian female students from grades 7-12 (n=31066) who smoke e-cigarettes containing nicotine.

Characteristics	**Female (n=31066)**
Grade Level	
7	6333(20.4)
8	6100 (19.6)
9	5661 18.2)
10	5481 (17.6)
11	4701 (15.1)
12	2729 (9.0)
Frequency of inability to stay awake	
Every day/night	2358 (7.6)
Several times	7953 (25.6)
Twice	4398 (14.2)
Once	4620 (14.9)
Never	10839 (34.9)
Not Stated	898 (2.9)
Frequency of inability to fall asleep	
Every day/night	4653 (15.0)
Several times	8166 (26.3)
Twice	5248 (16.9)
Once	5092 (16.4)
Never	6508 (20.9)
Not Stated	1399 (4.5)
Frequency of E-cigarette use	
Daily or almost daily	1699 (5.5)
Daily, but at least once a week	1631 (5.1)
Weekly, but at least once in last 30 days	1825 (5.7)
Tried, but not in the last 30 days	3078 (9.7)
Never tried	21197 (66.7)

Not stated	1176 (3.7)

Data are represented as the number of students (%) unless otherwise noted from grades 7 to 10. Data was obtained from http://odesi2.scholarsportal.info.libaccess.lib.mcmaster.ca/webview/ cigarettes containing nicotine.

Table I b. Descriptive Characteristics of Canadian male students from grades 7-12 (n=31784)

who smoke e-cigarettes containing nicotine.

Characteristics	Male (n=31784)
Grade Level	
7	6237 (19.6)
8	5951 (18.7)
9	6093 (19.2)
10	5781 (18.2)
11	4794 (15.1)
12	2928 (9.2)
Frequency of inability to stay awake	
Every day/night	1589 (5.0)
Several times	4854 (15.3)
Twice	3293 (10.4)
Once	3899 (12.3)
Never	16649 (52.4)
Not Stated	1500 (4.7)
Frequency of inability to fall asleep	
Every day/night	2883 (9.1)
Several times	6021 (18.9)
Twice	4521 (14.2)
Once	5615 (17.7)
Never	10795 (34)
Not Stated	1949 (6.1)
Frequency of E-cigarette use	
Daily or almost daily	2877 (9.1)
Daily, but at least once a week	1631 (5.1)
Weekly, but at least once in last 30 days	1825 (5.7)
Tried, but not in the last 30 days	3078 (9.7)
Never tried	21197 (66.7)
Not stated	1176 (3.7)

Data are represented as the number of students (%) unless otherwise noted from grades 7 to 10. Data was obtained from http://odesi2.scholarsportal.info.libaccess.lib.mcmaster.ca/webview/ cigarettes containing nicotine.

Table II: Variables of interest are tested using different statistical analysis such as Chi-Square Value, Spearman Rho and Pearson Correlation, and the values for the applicable variables are recorded.

Variable	Asymptotic Significance (2 sides)
SEX v/s ELC_026a	<0.001
ELC_026a v/s GRADE	0.00
SEX v/s SLP_200	<0.001
ELC_026a v/s SLP_220	0.00
GRADE v/s SLP_220	0.00
SLP_200 v/s SLP_220	0.00
ELC_026a v/s PROVID	<0.001
ELC_026a v/s DVHHINC2	<0.001
ELC_026a v/s DVURBAN	<0.001
Grade v/s SLP_200	<0.001
GRADE v/s DVHHINC2	0.000
ELC_026a v/s SLP_200	<0.001
SLP_200 v/s DVHHINC2	<0.001
SLP_220 v/s DVHHINC2	<0.001

The cut off for the significance value utilized was less than or equal to 0.05 for an association to be considered significant.

<u>Results:</u>

Deleted data: The number of participants excluding the missing data points were 55130 individuals after we deleted the total missing cases (n=7720) from the total participants (n=62850) for the questions (mention sleep, smoking and focus question). The secondary variables did not have any missing data, therefore no cases were further deleted.

*Testing primary question(s)***:** Chi-square test was used to find an association between two categorical variables that help us better understand the relationship between two primary variables. Chi-square test helps in translating the results and provides us with information if the two variables are statistically significant.

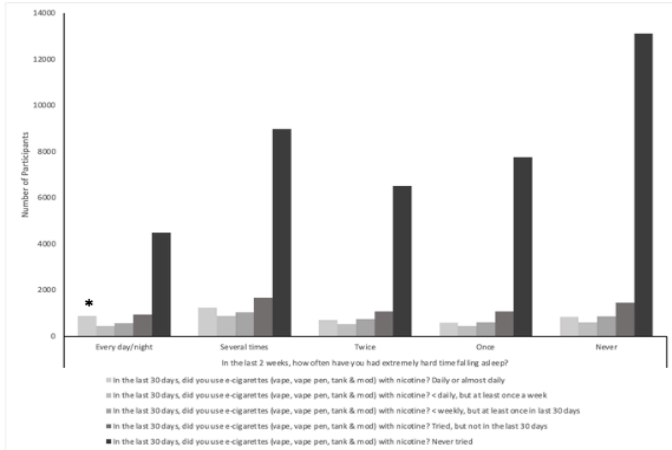

Figure 1: Participants Sleep patterns and their E-Cigarettes S mocking frequency are compared using Chi-Sqaure analysis. Chi-square data highlights that p value = <.001, reporting a statistically significant relationship between the two primary categorical variables. The bars graph above depicts the data collected in the 2018-2019 Canadian Student Tobacco, Alcohol, and Drugs Survey. Asterisk (*) indicates significant association.

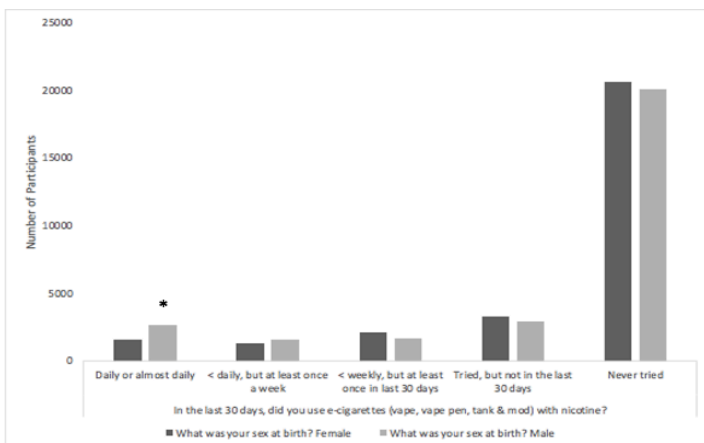

Figure 2: Chi Square Output for the variables of the frequency of e-cigarette use in the last 30 days and the sex of the participant. Chi-square data highlights that p value = <.001, highlight a significant association between participants' smoking habits and sex. The bars graph above depicts the data-collected in the 2018-2019 Canadian Student Tobacco, Alcohol, and Drugs Survey. Asterisk (*) indicates significant association.

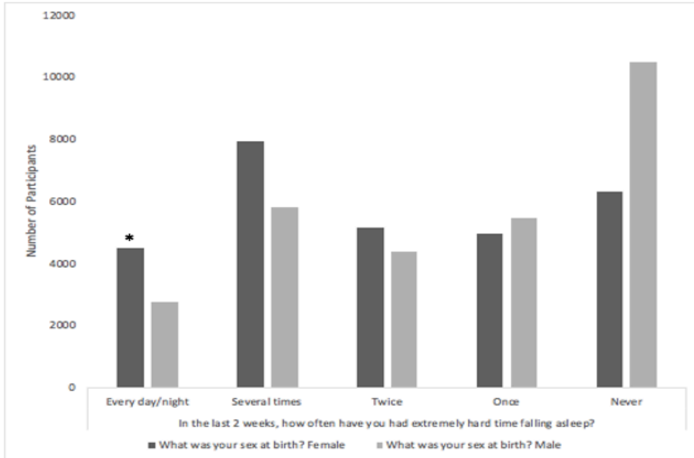

Figure 3: Chi Square Output for the variables of the frequency of having a difficult time falling asleep and sex of the participants. Chi-square data highlights that p value = <.001, highlight a significant association between participants' sleep and sex, with almost no chance of this happening by chance. The bars graph avice depicts the data collected in the 2018-2019 Canadian Student Tobacco, Alcohol, and Drugs Survey. Asterisk (*) indicates significant association.

*Testing secondary question(s)***:** Chi-square test was used to find an association between two categorical variables that help us better understand the relationship between a secondary variable and our primary variable of smoking. Chi-square test helps in translating the results and provides us with information if the two variables are statistically significant.

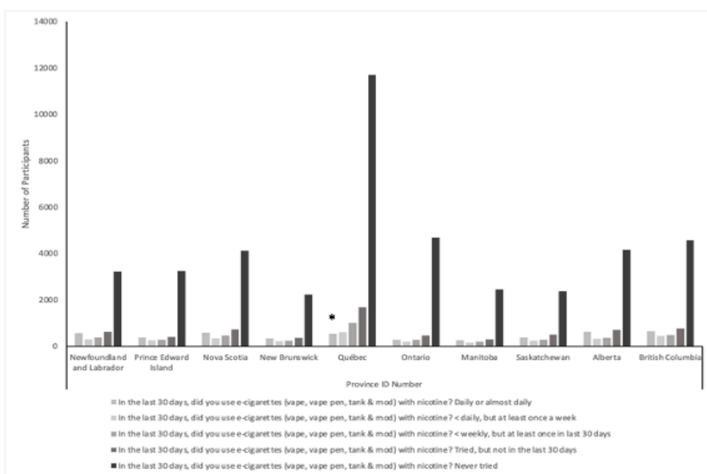

Figure 4: Chi Square Output for the variables of the frequency of e-cigarette use in the last 30 days and the province of residence of the participant. Chi-square data highlighted a p value <0.001 as there is significant association between the variables. The bars graph advice depicts the data collected in the 2018-2019 Canadian Student Tobacco, Alcohol, and Drugs Survey. Asterisk (*) indicates significant association.

Discussion:

Our results have shown an influence of smoking e-cigarettes on the disrupted sleep patterns of Canadian males compared to Canadian females in grades 7 to 12. During the survey, most participants said that they never experienced any issues with smoking and irregular sleep patterns. However, the second-highest group in each analysis highlighted that many individuals were experiencing difficulty sleeping and were smoking e-cigarettes frequently. When associated, more females had difficulty falling asleep than males, even though males reported higher daily use of e-cigarettes. Males enrolled in grades 10 and 11 reported daily use of smoking, and females belonging to these grades reported slightly more disrupted sleep patterns. As figure 1 highlights, students reported having difficulty falling asleep when the participant smoked e-cigarettes daily or at least once a week. Figures 2 and 3 show males are more prevalent in smoking e-cigarettes daily in the last 30 days, while females had a more challenging time falling asleep several times in the last two weeks, indicating potential biological gender differences. Students who reported having sleeping issues several times were also among the highest number of students who had difficulty focusing several times on academic tasks. This is concerning for students' academic growth as ample sleep is vital for a student's success (Eliasson et al., 2002).

Interestingly, all grade levels except grade 12 students had difficulty falling asleep in the last two weeks. Considering students in grade 12 generally have to take less required courses and are used to high school workload, allowing them to get more sleep. However, students in grades 10 and 11 were observed to smoke daily in the last 30 days. This reinforces the need for e-cigarette smoking awareness and education among the youth. While monitoring the use of e-cigarettes in the different provinces, Quebec was seen to have the most daily, but at least once a week smoking participants (Figure 4). Also, more participants from schools located in urban areas and from lower-income bracket ($60 000) households were smoking daily than rural locations or high-income homes. Such raises concern for this specific population and calls on targeted anti-smoking interventions

When the results from our study were compared to other published findings, some similarities and differences were found. Our results highlighted that Quebec, out of all the provinces, reported the highest number of young e-cigarettes smokers, which was in agreement with the study done by Pelekanakis (et al. (2021)) which reported high rates of smoking initiation among youth aged 12 to 17 years in Quebec. On the contrary, Krishnan (et al., 2006) found women to have a greater sleep quality and better sleep efficiency, whereas our study illustrated females having a hard time falling asleep compared to males. Although our study observes sleep patterns in relation to e-cigarette use, there are many confounding factors that may influence the participants' sleep and impact our collected data. Troxel (et al., 2015) found an influence of ethnicity and cultural influence on one's sleep. Another study highlighted the relation of physical and mental health with irregular sleep-wake patterns among young adolescents (Lund, et al., 2010). Of the students that reported disturbed sleep patterns in past research, over 60% reported taking frequent over-the-counter medications, emphasizing the relationship between sleep and medication use (Lund, et al., 2010).

Certain limitations can be found in this study since data was in a self-recorded questionnaire style it introduces areas for error and bias. The main disadvantage is the possibility of invalid and unreliable answers. There might be a discrepancy in the answers since some students may have given what they thought was the "proper" response rather than what they genuinely believed. Likewise, data may have been under/over-reported for the primary variables of sleeping, smoking, focus, etc. Over- or underreporting can be caused by various unquantifiable variables, and reporting bias might vary by subgroup. Furthermore, research from this study cannot be generalized since the questionnaire directly excluded many populations like natives, multiple provinces, special schools, etc. Also, the participants throughout the study were not kept constant, the grade levels were changing, and many confounding variables such as genetic differences and environmental factors may have contributed to a non-existing relationship between the two variables. Lastly, variables involving sleep & focus were measured in the last two weeks' time period while smoking was measured in the last 30 days. These time differences may have impacted our results; therefore, a longitudinal study and carefully inclusive questionnaires should be administered more often to the same cohort of people.

Even though there were limitations to our study, it produced some significant results, such as essential gender differences where males were more likely to smoke daily and females more likely to have sleeping disturbances. Our study is not only about finding gender differences, and it highlights the need for future targeted interventions to make a smoking curriculum a part of the education system. This curriculum would highlight the harmful effects of smoking e-cigarettes with nicotine daily. The importance of surveillance systems in monitoring potential hazards posed by consumer products is also highlighted in this study. Changes in legislation and policy limiting juvenile access to vaping goods are at various levels of adoption around the world. The government of Canada needs to reconstruct its policy for e-cigarette sales and consumption in specifically Quebec and urban regions of all provinces. This study's results can be utilized to create targeted interventions at schools that reduce the health burden on young adults, improve their overall wellbeing, and ensure their stable academic performance.

References

Aleyan, S., Ferro, M. A., Hitchman, S. C., & Leatherdale, S. T. (2021). Does having one or more smoking friends mediate the transition from e-cigarette use to cigarette smoking: a longitudinal study of Canadian youth. *Cancer Causes & Control*, *32*(1), 67-74.

Callahan-Lyon, P. (2014). Electronic cigarettes: Human health effects. *Tobacco Control*, *23*(suppl 2), ii36–ii40. https://doi.org/10.1136/tobaccocontrol-2013-051470

Dugas, E. N., Sylvestre, M. P., O'Loughlin, E. K., Brunet, J., Kakinami, L., Constantin, E., & O'Loughlin, J. (2017). Nicotine dependence and sleep quality in young adults. Addictive Behaviors, 65, 154-160.

Eliasson, A., Eliasson, A., King, J., Gould, B., & Eliasson, A. (2002). Association of Sleep and Academic Performance. *Sleep and Breathing*, *06*(1), 45–48. https://doi.org/10.1055/s-2002-23157

Kianersi, S., Zhang, Y., Rosenberg, M., & Macy, J. T. (2021). Association between e-cigarette use and sleep deprivation in U.S. young adults: Results from the 2017 and 2018 behavioral risk factor surveillance system. *Addictive Behaviors*, *112*, 106646. https://doi.org/10.1016/j.addbeh.2020.106646

Krishnan, V., & Collop, N. A. (2006). Gender differences in sleep disorders. *Current opinion in pulmonary medicine*, *12*(6), 383-389.

Lund, H. G., Reider, B. D., Whiting, A. B., & Prichard, J. R. (2010). Sleep patterns and predictors of disturbed sleep in a large population of college students. *Journal of adolescent health*, *46*(2), 124-132.

Milicic, S., DeCicca, P., Pierard, E., & Leatherdale, S. (2018). An evaluation of school-based e-cigarette control policies'impact on the use of vaping products. *Tobacco Induced Diseases*, *16*(August). https://doi.org/10.18332/tid/93594

<odesi> Home. (n.d.). Retrieved December 10, 2021, from https://search1.odesi.ca/#/

Park, E. J., Kim, S. Y., Kim, Y., Sung, D., Kim, B., Hyun, Y., ... & Park, M. H. (2021). The relationship between adverse childhood experiences and sleep problems among adolescent students: Mediation by depression or anxiety. *International journal of environmental research and public health*, *18*(1), 236.

Park, E., Kwon, M., Gaughan, M. R., Livingston, J. A., & Chang, Y.-P. (2019). Listening to adolescents: Their perceptions and information sources about e-cigarettes. *Journal of Pediatric Nursing*, *48*, 82–91. https://doi.org/10.1016/j.pedn.2019.07.010

Pelekanakis, A., O'Loughlin, J. L., Gagn, T., Callard, C., & Frohlich, K. L. (2021). Original quantitative research-Initiation or cessation: what keeps the prevalence of smoking higher in Quebec than in the rest of Canada?. *Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice*, *41*(10), 306.

Piñeiro, B., Correa, J. B., Simmons, V. N., Harrell, P. T., Menzie, N. S., Unrod, M., ... & Brandon, T. H. (2016). Gender differences in use and expectancies of e-cigarettes: online survey results. *Addictive behaviors*, *52*, 91-97.

Pisinger, C., & Døssing, M. (2014). A systematic review of health effects of electronic cigarettes. *Preventive medicine*, *69*, 248-260.

Troxel, W. M., Ewing, B., & D'Amico, E. J. (2015). Examining racial/ethnic disparities in the association between adolescent sleep and alcohol or marijuana use. *Sleep health*, *1*(2), 104-108.

Tweed, J. O., Hsia, S. H., Lutfy, K., & Friedman, T. C. (2012). The endocrine effects of nicotine and Cigarette Smoke. *Trends in Endocrinology & Metabolism*, *23*(7), 334–342. https://doi.org/10.1016/j.tem.2012.03.006

Wiener, R. C., Waters, C., Bhandari, R., Trickett Shockey, A. K., & Alshaarawy, O. (2020). The association of sleep duration and the use of electronic cigarettes, NHANES, 2015-2016. *Sleep Disorders*, *2020*, 1–12. https://doi.org/10.1155/2020/8010923

Zvolensky, M. J., D'Souza, J., Garey, L., Alfano, C. A., Mayorga, N. A., Peraza, N., & Gallagher, M. W. (2020). Subjective sleep quality and electronic cigarette dependence, perceived risks of use, and perceptions about quitting electronic cigarettes. *Addictive behaviors*, *102*, 106199.

Projecting the Economic and Psychological Impacts of the Covid-19 Pandemic on Post-Secondary Education

Group 23

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Introduction

Over the last decade, Canadian post-secondary institutions have increasingly relied on tuition fees as a source of revenue and profit. Research has shown that revenue from tuition fees have increased 41.1%, from $8.7 billion in 2014 and 2015, to $12.2 billion in 2018 and 2019 (Matias et al., 2021). However, with the Covid-19 pandemic forcing schools to close in March of 2020, multiple businesses were affected and shut down, leading to immense losses of earnings for many post-secondary students. In Canada, 3.1 million jobs were lost during the months of March and April 2020, and the unemployment rate for students between 15-24 years increased to 31.7% (Matias et al., 2021). This is reportedly the fastest decline in the early months of the pandemic as their jobs in clothing stores, food & beverage industries, and retail trade, were hit the hardest during the pandemic (Lemieux et al., 2020). In addition to lost jobs, many students were concerned about the unavailability of potential job prospects due to the closing of many research labs, healthcare centers and businesses (Statistics Canada, 2020a). In a survey spanning April to May of 2020, 57% of students reported Covid-19 causing an academic impact with 11% unable to graduate and 10% unable to complete their term in 2019. When questioned again in 2020, 17% of students reported being unable to complete their studies (Statistics Canada, 2020b).

These losses in earnings for students led to difficulties in continuing to pay for their studies and daily living expenses (food, living accommodations, etc.). With many Canadians losing their jobs and sources of income, spending fell by 13%, with the majority of their spending being on essential household items (Statistics 2020b). However, in April 2020, the Government of Canada announced the Canada Emergency Student Benefit, or CESB, which provided financial support to post-secondary students who were unable to find work due to

Covid-19 (Statistics Canada, 2020b). Before the announcement of CESB, 73% of students who participated in the survey reported extreme concerns about paying for tuition next term, increasing their student debt, or paying for current expenses. Following CESB, this number declined to 61%, although it is still a significant number (Statistics 2020b). The pandemic not only caused financial and economical constraints, but also negatively impacted students' mental health, partly due to their concerns of the unavailability of any future job prospects.

According to Belle et al. (2021), workplace experiences increase self-efficacy, optimism, resilience, and hope; however, when the Covid-19 pandemic hit, students expressed distress and anxiety, and felt less optimistic about their future. Even during pre-pandemic times, inconsistent labor markets have caused substantial declines in quality of life and mental health (Belle et al., 2021). Based on a questionnaire composed of international students, it was found that the change in teaching methods, such as moving to virtual learning, reinforcing social distancing, and quarantines, are highly associated with psychological distress. As a result, a rise in students seeking help regarding their mental health was observed (Xu, 2021). In addition, post-secondary students aged 20-25 years old experienced a sudden phase change involving their education, living arrangements, personal relationships, and financial instability, due to the pandemic. In their study, Patterson et al. (2021) reported that one-third to one-fifth of university students have been diagnosed with a mental health problem or substance abuse, because of the pandemic.

In developed countries such as Canada, a country with some of the highest numbers of college and university graduates, post-secondary students are more vulnerable to Covid-19 stress factors due to the social pressure of obtaining a degree. This adds to the individual stress preceding Covid-19 and the difficulties that post-secondary students come across on a daily basis, including socioeconomic factors, social networks, and biopsychological vulnerability

(Patterson et al., 2021). With lower opportunities for work experience during the pandemic, many students, especially those at the graduate level, are less confident in their ability to find work (Belle et al., 2021). This could have negative long-term impacts on the ability to navigate the job market, even post-pandemic when more certainty is established (Belle et al., 2021). Thus, these financial, economic and mental factors due to Covid-19 have contributed to the internal stress post-secondary students face during their post-secondary education.

So we ask the question: is there a greater financial, academic and mental impact due to the Covid-19 pandemic on students aged 24 years and younger compared to students 35 and older? We observe three outcomes through our analyses, with students' concern to pay for tuition as the primary outcome, the secondary outcome being employment status, and impact on academic performance as the tertiary outcome. Unlike previous research, this study compares the impacts of Covid-19 on two different age groups and its impact on the mental health of post-secondary students. In addition, our study accounts for differences in fields of study, living arrangements, and the impact they have on their educational and workplace abilities. Students older than 35 years old are more likely to be financially stable and independent than students younger than 24 years old as they have more available work opportunities than younger adults and have had more work and school experiences, thus a difference between the two groups in response to the pandemic should be observed and analyzed. This paper touches on an ongoing dilemma, so examining its effects on post-secondary students holds a great deal of relevance. This pandemic has affected individuals globally, especially post-secondary students, as education has been greatly affected by Covid-19. Individuals hoping to attend post secondary or are currently in attendance, will find that topics discussed and the variables studied are all affecting themselves, their peers, and their faculty.

Materials and Methods

The database used for the current study was obtained from a crowdsourced application created by Statistics Canada titled 'Impacts of the Covid-19 Pandemic on Postsecondary Students' from Odesi. As the Covid-19 pandemic is suspected to have impacted all Canadian postsecondary students, the current data collection initiative was designed to provide early insight into the extent of these educational, employment, and financial impacts. No sample selection was done for this initiative. This initiative took place online as a web questionnaire available in both English and French and data collection began on April 19th 2020, and ended on May 1st 2020.

Any postsecondary student attending colleges or universities in Canada as of March 1st 2020, were able to participate in this study. However, for purposes related to confidentiality, students attending postsecondary institutions in the territories were excluded from the public use microdata file. Participation on the questionnaire was voluntary, and no further follow-ups were conducted. Before data collection, universities and other post-secondary institutions were made aware of crowdsourcing questionnaire and students were made aware of the study through social media platforms including Facebook and Twitter.

A total of 105,492 questionnaires were completed, and 101,974 questionnaires were deemed to be qualifying post-secondary students. During this study, a total of 192,255 visits were made to the web page. 54.9% of people who visited the web page completed a questionnaire and 53% of all visits to the webpage became qualifying participants. In this study, we analyzed two age groups, less than 24-year-olds and older than 35-year-olds, thus only a total of 83,028 participants were included, and the remaining 18,946 were excluded since they belong in an age group that was not analyzed in this study. The exclusion of the "25-34 years old" age group was done to specifically compare the differences between those who fall within the traditional age range of post secondary attendees and those who do not.

To answer the research question, five chi-square tests were conducted on SPSS Statistical Software to observe if any differences between the two age groups is due to chance, or if it is due to a relationship between the two variables being analyzed. Summarized in Table 1, which is divided into the two age groups, are variables that are thought to contribute to answering the research question. The three outcomes we decided to analyze using chi-square tests were students' concern to cover tuition (primary), employment status (secondary), and academic impact (tertiary), since these variables were the most informative in answering the research question. It is important to analyze these three outcomes since these outcomes have a range spectrum as the Covid-19 pandemic has drastically changed the life of post-secondary students. The primary outcome, which is the concern of covering tuition, is crucial since a lot of students had already planned ahead financially. This situation has caused major distress because a substantial number of students were worried that extra student debt was going to be added, or that they had to "postpone" their studies because of the pandemic. The primary outcome of this study is directly related with the secondary which is the employment status. Many students were laid off from their part-time jobs, or they could not get employed and this increased their worry of covering tuition fees. The last outcome is how Covid-19 would impact their academic performance. Students had to adjust to the new online learning environment and change their studying habits and were concerned how this difference in learning was going to affect employment. The two remaining chi-square tests analyzed whether living arrangements or individual fields of study affected their academic performance. These variables are also important to consider when answering our research question. This is because some programs are more demanding than others, and can impact students differently. In addition, living arrangements can have differential impacts on students and their well-being. The data for these variables were collected through the questionnaire. Students had several options to choose from in the questionnaire, for example, having concern versus not having concern, being employed versus unemployed, having an academic impact versus not having an academic impact. Students also had the option to not answer questions with several "skip" options, such as refusal, not applicable, don't know, and valid skip.

Missing data such as refusal, not applicable, don't know, and valid skip were transformed into one category called "Not stated". Categories in "Concern to cover tuition" were simplified into 3 categories instead of 9 to streamline the interpretations of the table, and figure and ease the understanding of the paper and its impact in the research question.

This data was benchmarked to partly reduce coverage error, although it cannot guarantee its complete elimination, and to help correct for differing participation rates across gender, level of study, and province of institution. The data collected was non-probabilistic, which means not all participants had an equal chance of participating in the research, and the study lacked probability of selection and a sample design. As a result, the calculation of confidence intervals, coefficients of variation, and other precision measures is not possible.

Results

Out of 101,974 valid responses obtained from the database, only 83,028 were included in the results due to the exclusion of the "25-34 years old" age group. 92.4% of the responses came from post-secondary students younger than 24 years of age and the remaining 7.6% of the responses from post-secondary students older than 35 years of age after the exclusion of the "25-34 years old" age group.

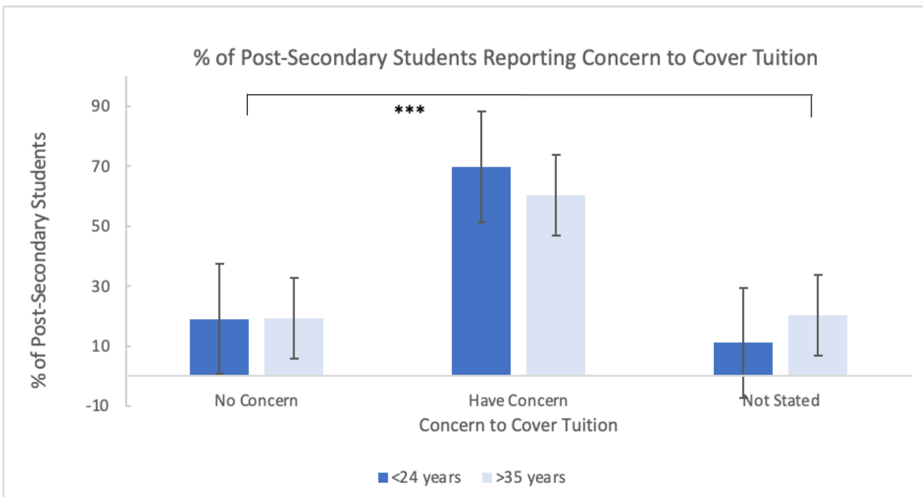

Figure 1. Percentage (%) of post-secondary students aged <24 years and >35 years expressing concern or no concern on covering tuition for their post-secondary studies during the Covid-19 pandemic. Error bars represent standard error bars and asterisk demonstrates significance. Graph was obtained from Microsoft Excel.

Results show that out of 83,028 responses, 69.8% of post-secondary students younger than 24 years old reported having concern to pay for tuition, in contrast to 60.3% of post-secondary students older than 35 years old. The remaining 19.1% of students younger than 24 years old and 19.4% of students older than 35 years old expressed no concern about their tuition payments, and 11.1% and 20.3% preferred not to say, respectively. A Pearson chi-square value of 497.595 and a p-value of < 0.001 were obtained from SPSS Statistical Software, signifying statistical difference between the two age groups.

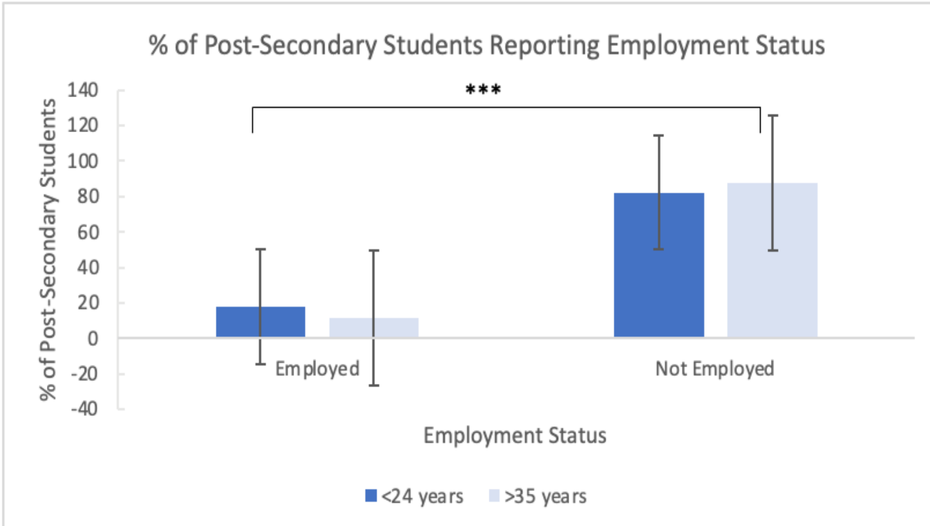

Figure 2. Percentage (%) of post-secondary students aged <24 years and >35 years reporting employment status during the Covid-19 pandemic. Error bars represent standard error bars and asterisk demonstrates significance. Graph was obtained from Microsoft Excel.

It was observed that out of 83,028 responses, 17.7% of post-secondary students younger than 24 years were employed during the Covid-19 pandemic, in comparison to only 11.7% of post-secondary students aged 35 years and older. The remaining 82.3% of post-secondary students younger than 24 years old and 87.9% of post-secondary students older than 35 years old reported loss of employment during the Covid-19 pandemic. A Pearson chi-square value of 152.896 and p-value of < 0.001 were obtained from SPSS Statistical software, showing statistical difference between the two age groups.

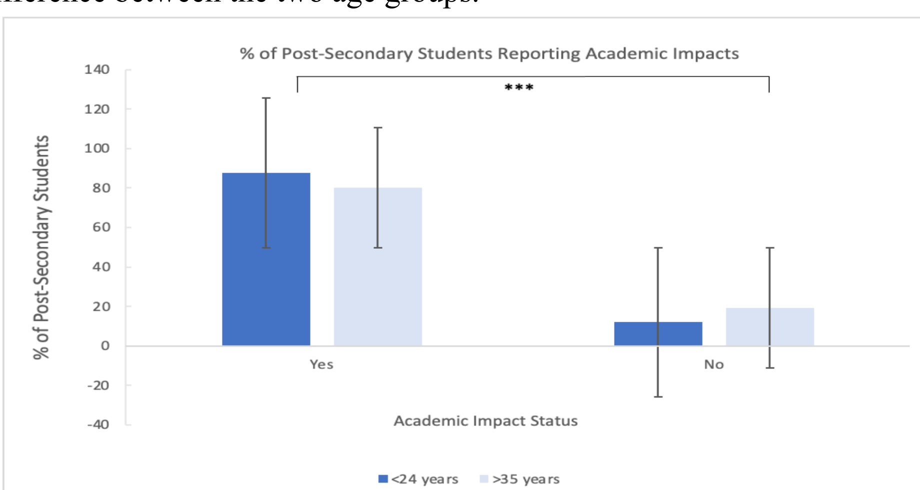

Figure 3. Percentage (%) of post-secondary students aged <24 years and >35 years reporting if the Covid-19 pandemic has impacted their academics and/or performance. Error bars represent standard error bars and asterisk demonstrates significance. Graph was obtained from Microsoft Excel.

We found that out of 83,028 responses, 87.7% of post-secondary students aged 24 years and younger reported experiencing an impact in their academics during Covid-19, compared to 80.2% of post-secondary students aged 35 years and older. The remaining 12.1% of post-secondary students aged 24 years and younger and 19.4% of post-secondary students aged 35 years and older reported not experiencing an academic impact during Covid-19. A Pearson chi-square value of 313.673 and p-value of < 0.001 were obtained from SPSS Statistical software, showing statistical difference between the two age groups.

Variable	<24 years n (%)	> 35 years n (%)
Age group	76745 (75.4)	6283 (6.2)
Field of Study		
Arts, humanities, social sciences, education	24300 (31.7)	2361 (37.6)
Business or administration	9241 (12.0)	1031 (16.4)
Health care, law	12327 (16.1)	1383 (22.0)
Science, engineering, engin tech, math or computer science	25540 (33.3)	880 (14.0)
Other	5326 (6.9)	625 (10.0)
Living Arrangements		
Live alone	5142 (6.7)	957 (15.2)
Live with family	52884 (68.9)	4841 (77.0)
Live with friends or roommates	18674 (24.3)	474 (7.6)

Not stated	45 (0.1)	11 (0.2)
Academic Impact		
Yes	67339 (87.7)	5036 (80.2)
No	9290 (12.1)	1218 (19.4)
Not Stated	116 (0.2)	29 (0.5)

Number of students and their percentage, in brackets, were obtained from SPSS Statistical Software.

Table 1: Demographic characteristics of patients. Fields of study and living arrangements were analyzed in post-secondary students 24 years and younger and students 35 years and older.

Based on the table above, more students in both the younger and older age groups live at home during the Covid-19 pandemic, with 68.9% of students younger than 24 years and 77% of students older than 35 years. In addition, science, engineering, engin tech, math or computer science were the dominant programs, with 33% of students younger than 24 years enrolled in either of those programs. In contrast, arts, humanities, social sciences, and education were the dominant programs in the 35 years and older age group (37.6%). When determining if the field of study had an effect on academic performance of students, a Pearson chi-square value of 299.876 and a p-value of <0.001 were obtained from SPSS. When determining if living arrangements had an effect on students' academic performance, Pearson chi-square value of 282.675 and a p-value of <0.001 were obtained from SPSS. Since the p-values for both tests are less than 0.05, this suggests that there is a statistical difference between the two variables, such that the field of study and living arrangements had an impact on students' academic performance (p<0.001).

Discussion

Results from the chi-square analyses reveal that there is a statistical difference between the two age groups in employment status, academic impact, and concern to cover tuition (p<0.001). In addition, students' fields of study and living arrangements impacted their academics (p<0.001). Because of these p-values, it is highly likely that there are differences between the two groups, and their relationships are likely not due to chance. However, based on the limitations in the methodologies of the dataset, we cannot definitively conclude if one age group was affected more by the pandemic than the other group. Rather, we can only conclude that there is a statistically significant difference between the two groups.

When comparing our results to those of other researchers, we assumed that the younger age group would have been more affected by the Covid-19 pandemic than the older age group. For instance, there is a statistical difference between the two age groups in regards to employment during the pandemic with results showing that the younger age group was more likely to be employed during the pandemic. This can be attributed to the fact that younger adults are more likely to be employed in retail, food and accommodation services, such as grocery stores, than older adults are (Mortimer, 2010). Even when the pandemic struck, food system workers were still employed to provide essential services for all Canadians (Parks et al., 2020). In contrast, the Covid-19 pandemic has caused laboratories, centers, thesis research labs, and other facilities that most likely employ older adults, or graduate and PhD students, to cease all operations (Borgeson et al., 2021) . This can contribute to the increased unemployment statistic of the older age group in our study compared to the younger age group. In addition, there is a statistical difference between the two age groups in their concern to pay for tuition. Achdut and Refaeli (2020) observed that individuals aged 18-35 experienced the greatest unemployment rate. Specifically in 2020, 445,000 individuals from the above age group were seeking either part time or full time jobs. Students that do not find employment before or after graduation often fail to meet their financial obligations including tuition fees. (Achdut & Rafaeli, 2020).

Because the Covid-19 pandemic has resulted in a loss of income for many families, parents reported struggling to ensure continued education for their children, inevitably forcing students to take out loans to cover costs (Nicola et al., 2020). Unfortunately, the differing academic impacts between younger and older age groups of post-secondary students have not been explicitly observed during the Covid-19 pandemic; thus, valid assumptions on why there is a statistical difference between the two groups cannot be made. However, because many students view poor grades as punishment and not as positive criticism, negative academic impacts can prove damaging to the self esteem of students (Stan, 2012). So regardless of the pandemic's negative impact on academic studies, the negative impact of having their academics affected will pervade into other aspects of their lives including social and workplace environments. Psychological distress due to unemployment and the negative impacts of poor grades can derail a student's life leading to high stress, high anxiety and overall poor mental health.

Living arrangements and fields of study were also observed to have an impact on students' academic performance. In their study, Ruth et al. (2010) observed that students who lived on campus had significantly higher GPA compared to students who lived off-campus. However, because of the Covid-19 pandemic forcing post-secondary institutions to close, younger students were forced to move in with their parents again and/or change their housing arrangements (Justo-Alonso et al., 2020). College students experience more learning burnout during the pandemic, negatively impacting their academic performance. They also observed that students aged 18-25 overall experienced the greatest effects due to the pandemic and were more anxious and stressed compared to students aged 26 to 33. In addition, Statistics Canada (2020c) found that 18% Business, 41% Healthcare, 25% Law, 15% Engineering, 56% Services and 53% of Trades had courses that were postponed and/or delayed due to the Covid-19 pandemic, delaying students' graduation. This disruption among post-secondary students increased their fear and anxiety for their futures, as the pandemic presents many uncertainties.

Patterson et al., (2020) found that stressors due to the Covid-19 pandemic combined with pre-existing stressors, such as changes in education, living arrangements, and relationships that impact academic performance, are unique to post-secondary students aged 24 years and younger. Overall, the Covid-19 pandemic has introduced academic uncertainties, economic and financial changes, isolation, loss of support, and reduced availability to mental health services (Patterson et al., 2020). The shift to online learning has disrupted the routines of many post-secondary students, posing a risk for their mental well-being. The lack of daily routines because of the sudden disturbance in their schedule and interruption of their main activities has caused a significant increase in anxiety and uncertainty for the future (Patterson et al., 2020). Students fear the uncertainty of their futures, such as lower grades, losing scholarships, delayed graduation, unavailability of prospective jobs, or anything involving plans after graduation can exacerbate stress among students (Belle et al., 2021). Due to these educational and financial stressors, various research suggests that psychological distress, such as anxiety, depression and poor sleep quality, are higher among younger individuals compared to older individuals (Patterson et al., 2020). Thus, these changes make students more vulnerable to stress enhanced by the pandemic, which may negatively impact their academic performance and mental health.

Limitations and Future Directions

Parallel to other articles, this study poses some limitations that should be taken into account for future studies in this field, especially with the ongoing Covid-19 pandemic. First, there is a very uneven distribution of the sample sizes. Out of the 102,000 responses, 92.4% came from one age group, while the remaining 7.6% came from the other. This inequality in sample sizes can skew the results, such as statistical power and Type I error rates (Rusticus & Lovato, 2014). Equal-sized sample sizes maximize the power of a study, having a better chance at finding systematic differences between variables. However, the power of a study drops the more unbalanced the sample sizes become (Rusticus & Lovato, 2014), which may contribute to the large chi-square statistics we obtained from SPSS. Secondly, the database did not include any variables to test for mental health. The impact of the Covid-19 pandemic on students' mental health is important to analyze, such that it is important to take action and meet their needs. Thus, all assumptions in the analysis were based on primary research conducted by published authors to support our findings. In addition, the database did not take into account socioeconomic status of students and their families. Students come from different social, cultural and economic backgrounds, thus their responses for the questionnaire may differ from others, which may have had an impact on the findings. There are also limitations in the methodologies of this analysis. Because the data was collected from a questionnaire, the data is self-reported, which may not be reflective of students' actual sentiments. The lack of continuous variables also limits the number of statistical analyses researchers can perform with only categorical data.

To strengthen the impact of the study, and for this study to be clinically relevant and valid, some adjustments should be made in future research. Covid-19 has impacted everyone despite their SES backgrounds, and its consequences only continue to increase. This is why it is important to be aware of its impacts on daily lives, especially on students' academic and social lives, and their mental health. For future replications, this study can serve as a guide and should incorporate a more representative and smaller sample size and include continuous variables (e.g., mental health scales) and objective measures to produce more reliable results.

References

Achdut, N., & Refaeli, T. (2020). Unemployment and psychological distress among young people during the Covid-19 pandemic: Psychological resources and risk factors. *International journal of environmental research and public health, 17*(19), 1-12. https://doi.org/10.3390/ijerph17197163

Belle, M. A., Antwi, C. O., Ntim, S. Y., Affum-Osei, E., & Ren, J. (2021). Am i gonna get a job? Graduating students' psychological capital, coping styles, and employment anxiety. *Journal of Career Development,* 1-15. https://doi.org/10.1177/08948453211020124

Börgeson, E., Sotak, M., Kraft, J., Bagunu, G., Biörserud, C., & Lange, S. (2021). Challenges in PhD education due to Covid-19-disrupted supervision or business as usual: a cross-sectional survey of Swedish biomedical sciences graduate students. *BMC Medical Education, 21*(1), 1-11. https://doi.org/10.1186/s12909-021-02727-3

IBM Corp. (2017). *IBM SPSS Statistics for Windows*. Armonk, NY: IBM Corp. Retrieved from https://hadoop.apache.org

Impacts of the COVID-19 pandemic on postsecondary students [Public use microdata file] Ottawa, Ontario: Statistics Canada [producer] Ottawa, Ontario: Data Liberation Initiative, Statistics Canada [distributor]

Justo-Alonso, A., García-Dantas, A., González-Vázquez, A. I., Sánchez-Martín, M., & del Río-Casanova, L. (2020). How did different generations cope with the Covid-19 pandemic? Early stages of the pandemic in Spain. *Psicothema, 32*(4), 490–500. https://doi.org/10.7334/psicothema2020.168

Lemieux, T., Milligan, K., Schirle, T., & Skuterud, M. (2020). Initial impacts of the Covid-19 pandemic on the canadian labour market. *Canadian Public Policy, 46*(S1), S55–S65. https://doi.org/10.3138/cpp.2020-049

Matias, C., Popovic, A., Lebel, A. (2021, August 18). *Projected financial impact of the Covid-19 pandemic on canadian universities for the 2020/21 academic year.* Statistics Canada. https://www150.statcan.gc.ca/n1/pub/81-595-m/81-595-m2021002-eng.htm

Mimoun, E., Ben Ari, A., & Margalit, D. (2020). Psychological aspects of employment instability during the Covid-19 pandemic. *Psychological Trauma: Theory, Research, Practice, and Policy*, *12*(S1), S183–S185. https://doi.org/10.1037/tra0000769

Mortimer, J. T. (2010). The benefits and risks of adolescent employment. *The Prevention Researcher, 17*(2), 8-11.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (Covid-19): A review. *International Journal of Surgery, 78,* 185-193. https://doi.org/10.1016/j.ijsu.2020.04.018

Parks, C. A., Nugent, N. B., Fleischhacker, S. E., & Yaroch, A. L. (2020). Food system workers are the unexpected but under protected covid heroes. *The Journal of Nutrition, 150*(8), 2006-2008. https://doi.org/10.1093/jn/nxaa173

Patterson, Z. R., Gabrys, R. L., Prowse, R. K., Abizaid, A. B., Hellemans, K. G. C., & McQuaid, R. J. (2021). The influence of Covid-19 on stress, substance use, and mental health among postsecondary students. *Emerging Adulthood,* 1-15. https://doi.org/10.1177/21676968211014080

Rusticus, S. A. (2014). Impact of sample size and variability on the power and type 1 error rates of equivalence tests: A simulation study. *Practical Assessment, Research and Evaluation, 19*(11), 1-11. https://doi.org/10.7275/4s9m-4e81

Ruth, N., López, T., Wodtke, G. (2010). College residence and academic performance: Who benefits from living on campus? *Urban Education, 45*(4), 506-532. https://journals.sagepub.com/doi/10.1177/0042085910372351

Stan, E. (2013, January 16). The role of grades in motivating students to learn. *Procedia Social and Behavioral Sciences, 69*(2012), 1998-2003. https://www.sciencedirect.com/science/article/pii/S1877042812056236.

Statistics Canada. (2021, July 12). *Unemployment rate, participation rate, and employment rate by type of student during school months, monthly, unadjusted for seasonality.* https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410002101

Statistics Canada. (2020, May 12). *Impacts of the Covid-19 pandemic on postsecondary students.* https://www150.statcan.gc.ca/n1/daily-quotidien/200512/dq200512a-eng.htm

Statistics Canada. (2021, September 27). *Impacts of the Covid-19 pandemic on postsecondary students study documentation.* https://1drv.ms/b/s!Alq5O6JfvYsDgsd6XedAJzKQGHgV-g?e=HwEwx5

a. Statistics Canada. (2020). Impacts of the Covid-19 pandemic on postsecondary students. Retrieved from https://www150.statcan.gc.ca/n1/daily-quotidien/200512/dq200512a-eng.htm

b. Statistics Canada. (2020). Covid-19 in Canada: A Six-month Update on Social and Economic Impacts. Retrieved from: https://www150.statcan.gc.ca/n1/pub/11-631-x/11-631-x2020003-eng.htm

c. Statistics Canada. (2020, May 14). *Covid-19 Pandemic: Academic impacts on postsecondary students in Canada.* https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00015-eng.htm

Xu, T. (2021). Psychological Distress of International Students during the Covid-19 Pandemic in China: Multidimensional Effects of External Environment, Individuals' Behavior, and Their Values. *International Journal of Environmental Research and Public Health*, *18*(18), 1-18. https://doi.org/10.3390/ijerph18189758

Associations between combined marijuana and e-cigarette use with tobacco cigarette smoking status

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INTRODUCTION

Effects of tobacco cigarettes and factors leading to initiation

Smoking is the leading cause of premature death in Canada. It has a negative impact on health status and life expectancy, with smoking removing approximately ten years of life expectancy (Payne, 2013). Smoking tobacco also increases the likelihood of developing fatal diseases such as cancer and irregular heart rhythms. Most individuals who begin smoking tobacco cigarettes start in their teenage or young adulthood years (Coleman et al., 2020). During those years, the initiation of the smoker status is driven by external and internal factors. External factors may be present in the form of peer pressure or through the modeling of a relative's behavior to smoke. It is also argued that individuals begin smoking as a coping mechanism for stress and other mental conflicts (Coleman et al., 2020).

Effects of e-cigarette use

The use of e-cigarettes among this age group is also a particular concern of interest. This is evident by a statistics done by singlecare, which concluded that 20% of people aged eighteen to twenty nine use e-cigarette (Team, S. C., 2021). Given the limited data that explores adverse effects over long periods of time due to the novelty of e-cigarettes, it is difficult to say what everlasting impacts there may be. Previous research suggests that the use of e-cigarettes leads to the development of nicotine addiction (Kandel et al., 2014). In addition, epidemiological studies have linked nicotine with an increased likelihood of consuming marijuana and other drugs such as cocaine and opium (n.d., 2021). Research exploring the effect of nicotine on mice has found that the consumption of nicotine intensified the effect of drugs such as cocaine. The study concluded that this effect may also be present in humans, evident by an increased rate of cocaine dependence after having been exposed to nicotine (n.d., 2021).

Effects of marijuana use

Similarly to tobacco cigarettes, marijuana consumption between the ages eighteen to twenty four is also an area of concern, as its prevalence is the highest of all age groups, with 70% of respondents reporting the use of the drug previously (Health Canada, 2021). The rise of marijuana users among this age can be explained by a) external and internal factors similar to the use of tobacco cigarettes b) recent legalization of marijuana across Canada several years ago. Research previously done on marijuana described it as a “gateway drug”, given the strong correlations between marijuana consumption and the use of other drugs. More specifically, research focused on the influence of marijuana consumption on other drugs concluded that the use of marijuana likely precedes the use of other illicit drugs (n.d., 2021). This was evident when a longitudinal study concluded that young adults that reported the use of marijuana, were more likely to report increased alcohol consumption within three years (Coleman et al., 2020). Moreover, marijuana use was linked with nicotine addiction as well as other various substance disorders (Coleman et al., 2020) The increased vulnerability to the development of addictions of other substances may be explained by the effect of cannabinoids on the brain. Rats that were exposed to cannabinoids in their adolescence were later observed to have ever-lasting tolerance to morphine, cocaine, and amphetamine (Pistis, 2004). This possibly suggests that cannabinoids decrease the reward centers of the brain thus increasing the vulnerability of the individual to be dependent on other substances upon exposure (Rioux et al., 2018). The amount of THC extracted in the process of marijuana consumption can vary depending on the method of consumption.

Depending on the method, cannabinoids can be transported through the bloodstream via the respiratory system or the digestive system.

Missing knowledge

While numerous studies investigated the individual impact of marijuana consumption and e-cigarette use on other substances, there is limited research analyzing their concurrent impact on smoking status. e-cigarettes today are becoming what cigarettes became in the 19th century. Its popularity has surged and given the limited information regarding its long-term effects, it is hard to say the impact it may have on our young adults one day. In addition, marijuana use among young adults ages (18-24) has also grown popular following its legalization in Canada in 2018. There is limited research done on how the methods of cannabis consumption may lead to the use of other substances, specifically e-cigarettes.

Study purpose

Understanding this relationship may provide the necessary guidelines to help young adults formulate better decisions regarding their smoking habits, and how they go upon consuming marijuana. The purpose of this study is to investigate the difference between smoking status among Canadians in Ontario aged 19-24 who use marijuana and e-cigarettes as compared to Canadians in Ontario aged 19-24 who do not use marijuana and e-cigarettes. In addition, the method of marijuana consumption and its role in cigarette smoking status among Canadians in Ontario aged 19-24 who use marijuana and e-cigarettes will also be explored.

METHODOLOGY

Study design and database

The design of our study is observational and cross-sectional, analyzing data from participants across Canada between February 1, 2017 to December 31, 2017. The information was collected using a two-phase stratified random sampling of telephone numbers designed to increase representation of people from the 15-19 and 20-24 age group. Participants then answered questions on a structured questionnaire that collected participant responses using a computer assisted telephone interview (CATI) that uses universal modules designed for any type of survey. The Canadian Tobacco, Alcohol and Drugs survey (CTADS) is used to monitor and compare the usage of substances with addictive properties. The CTADS merges core Tobacco content from Canadian Tobacco use monitoring survey (CTUMS) and core drug and alcohol content from Canadian Alcohol and Drug use monitoring survey (CADUMS) to provide a more efficient collection of data.

Study participants

The study participants we chose to include in our study were both male and females aged 19-24 that reside in Ontario. Based on this criteria, two groups of participants were selected, those who both use e-cigarettes and consume marijuana compared to those who do not use e-cigarettes and do not consume marijuana. As a result, data that was collected in the study but excluded from our research were participants aged under 19 or over 24 in Ontario, participants that do not reside in Ontario and 19-24 year old Ontarians that only either use e-cigarettes or consume marijuana. Respondents that only used either e-cigarettes or marijuana were excluded as we wanted to identify whether use of both substances have an effect on cigarette smoking. Additionally, the

CTADS excluded residents from Yukon, Northwest Territories and Nunavut as well as full-time residents of institutions and permanent residents without phones.

Study outcomes

The primary outcome in our research question is smoking status type, when considering use of both marijuana and e-cigarettes. Participants were asked to provide a traditional smoking status, where they chose from the options current smoker, former smoker, never smoked, valid skip/don't know/refusal/not stated. This was chosen over other variables related to cigarette smoking included in the dataset such as number of cigarettes consumed or frequency of smoking over a period of time, as the aim of the study was to analyze the impact of marijuana and e-cigarette use on current and former cigarette smoking habits rather than current usage. This was done in line with current research on smoking patterns on young adults, as many findings demonstrate an established smoking pattern to be present by the age of young adulthood (19-25) (Hair et al., 2017). The secondary outcome in our research question was also smoking status, when considering methods of cannabis consumption among the e-cigarette use and marijuana consumption group. Participants that reported consuming marijuana were asked about which method of marijuana consumption they have used including: dabbed, smoked, vaporized, drink, eaten within a time period of 12 months and chose from the options: yes, no, valid skip/don't know/refusal/not stated. Reasons for these particular variables being used for the outcome was because they were determined to be the best suited, as they contained the closest data to what was required for the analysis. All variables were collected as part of the CTADS telephone questionnaire.

Additional data collection

Additional variables collected in our database include age of participants as well as the province of the selected respondent, used to describe the study population. The 2 questions regarding marijuana use and e-cigarette use (choices being yes, no, valid skip) were recoded into a new variable combining responses of “yes” to both use of marijuana and e-cigarette within lifetime and “no” to both. This new dichotomous variable discerning between use of both marijuana and e-cigarettes opposed to none at all was used for testing between group differences and correlations. Smoking status type was recoded into a new dichotomous variable combining “current smokers” and “former smokers” into one value and “never smoked” remained unchanged, as current and former smokers were not compared in this study. This was also done to allow for between group differences and correlations. Missing data or participants that answered valid skip/don’t know/refusal/not stated were filtered out of the dataset.

Statistical analysis

As the age of the selected respondents was the only continuous variable within our data set, the Shapiro-Wilks Normality test was performed to analyze distribution. Data in Table 1 was summarized as median and interquartile range for age of selected respondents, and frequencies followed by valid percent were reported for smoking status as well as methods of marijuana consumption. Three main statistical analyses were conducted to answer the research question. For the primary outcome, a Chi-squared test was used to test for a difference in the proportion of current/former smokers and non-smokers between groups of respondents using both marijuana and e-cigarettes and those who have never used either. Furthermore, the Spearman-Rho’s correlation was computed to assess the relationship between use of both marijuana and e-cigarettes and cigarette smoking status. A Chi-Squared test was performed to determine whether there were between-group differences in methods of marijuana consumption and smoking status. P-value for significance used was ≤ 0.05. Anything less than or equal to a P-value of 0.05 was deemed statistically significant and any P-value greater than 0.05 was deemed statistically insignificant. All statistical analyses were performed using SPSS software.

RESULTS

Table 1. Smoking status of Ontarians aged 19-24, Canada 2017

Characteristics	Have used marijuana and e-cigarettes N=257	Have never used marijuana and e-cigarettes N=677	p-value
Age (median)(IQR))	22(6)	21(6)	<0.001
Smoking status type 1 - traditional definition			
Current smoker	89 (34.6%)	19 (2.8%)	
Former smoker	20 (7.8%)	6 (0.9%)	
Never smoked	148 (57.6%)	652 (96.3%)	
Type of marijuana consumption - 12 mo			
Dabbed			
Yes	46 (24.5%)		
No	142 (75.5%)		
Smoked			
Yes	184 (97.9%)		
No	4 (2.1%)		
Vaporized			
Yes	100 (53.2%)		
No	88 (46.8%)		
Drink			
Yes	21 (11.2%)		
No	167 (88.8%)		
Eaten			
Yes	118 (62.8%)		
No	70 (37.2%)		

Table 1. Smoking status of Ontarians aged 19-24 between those who have used marijuana and e-cigarettes and those who have never used marijuana and e-cigarettes. All values are reported as frequencies and valid percentage (adjusted for missing values) unless stated otherwise. N= 934.

Prevalence of marijuana and e-cigarette use

Of the young adults aged 19-24 (934) in this study, approximately 27.5% (257) reported having used both marijuana and e-cigarettes; 72.5% (677) reported having never used marijuana and e-cigarettes.

Smoking status by marijuana and e-cigarette use

Among the 27.5% (257) of young adults in this study that reported having used both marijuana and e-cigarettes, 34.6% (89) reported being current smokers, 7.8% (20) reported being former smokers and 57.6% (148) reported never having smoked. Of the 72.5% (677) that reported to have never used both marijuana and e-cigarettes, 2.8% (19) were current smokers, 0.9% (6) were former smokers, and 96.3% (652) were never smokers.

Type of marijuana consumption within 12 months

Among the 27.5% (257) of young adults in this study that reported having used both marijuana and e-cigarettes, 24.5% (46) reported to have used marijuana via dab, 97.9% (184) reported trying marijuana by smoking, 53.2% (100) reported trying marijuana by vaporization, 11.2% (21) reported trying marijuana by drinking, and 62.8% (118) reported trying marijuana by eating, all within 12 months.

Between group differences, by smoking status

There was a significant difference in cigarette smoking status between those who used marijuana and e-cigarettes when and those who did not use them (Pearson Chi-square, asymptotic 2-sided significance <0.001*).

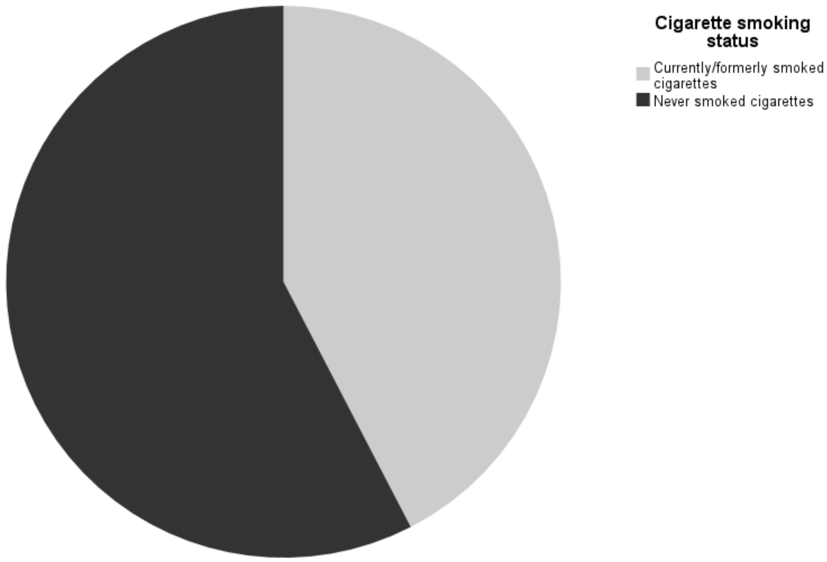

Figure 1. Comparison of smoking status of Ontarians aged 19-24 that use both marijuana and e-cigarettes*

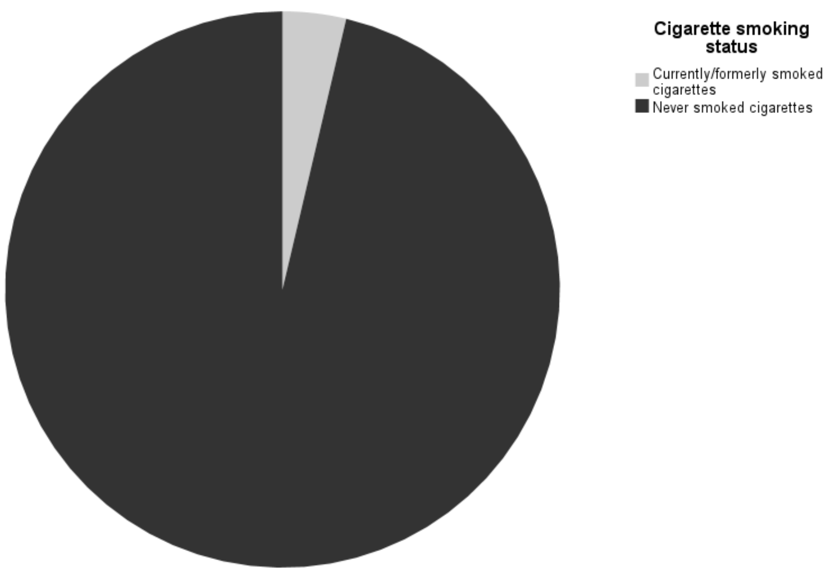

Figure 2. Comparison of smoking status of Ontarians aged 19-24 that do not use marijuana and e-cigarettes*

Correlations between marijuana and e-cigarette use with smoking status

There was a significant, positive association between the variables of marijuana and e-cigarette use and cigarette smoking status (Spearman's rho Correlation Coefficient = 0.493*, 2 tailed significance value of <0.001*).

Between group differences of types of marijuana by smoking status

There was a significant difference in smoking status between those who used marijuana via dab and those who did not use it (Pearson Chi-square, asymptotic 2-sided significance = 0.008*). There was no significant difference in smoking status between those who used marijuana by smoking, vaporizing, drinking, eating, and those who did not use it (Pearson Chi-square, asymptotic 2-sided significance = 0.128, 0.559, 0.287, 0.478, respectively).

Fig. 3

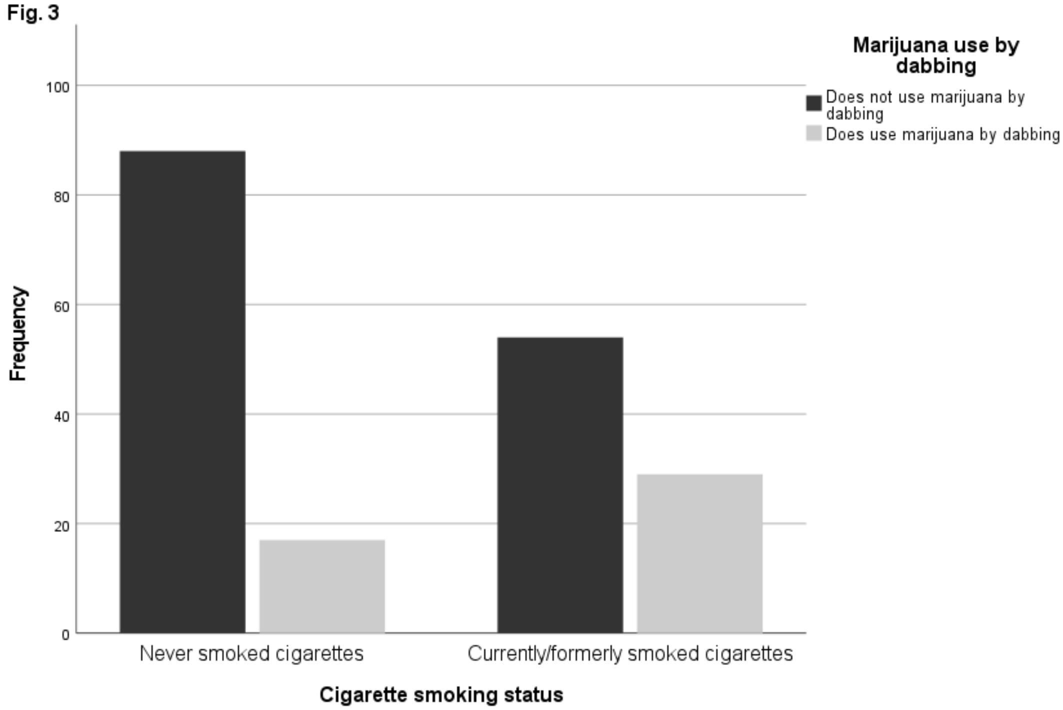

Figure 3. Prevalence of marijuana use via dabbing by smoking status, Ontarians aged 19-24 that use both marijuana and e-cigarettes*

DISCUSSION

The data presented here suggests that tobacco cigarette smoking status of individuals aged 19-24 in Ontario differs between those who have used both marijuana and e-cigarettes and those who have not used either. Furthermore, the data also suggests that use of marijuana via dabbing may play a significant role in cigarette smoking status among Ontarians aged 19-24 that have used both marijuana and e-cigarettes. Methods of marijuana consumption via smoking, drinking, eating, and vaporization did not show significant differences in cigarette smoking status.

In relation to previous studies

These findings are consistent with existing research , with evidence supporting that e-cigarette and marijuana use alone increases susceptibility to cigarette use later on. The possibility of adolescent e-cigarette use leading to tobacco cigarette use has been supported in previous research, including longitudinal studies exploring the relationship temporally (Soneji, 2018). In a study by Sonenji et al. (2018), a meta-analysis of nine studies that supported this relationship suggested that there was a combined odds ratio for tobacco cigarette initiation almost four times greater for individuals that have ever used e-cigarettes versus never. Furthermore, a longitudinal study by Spindle et. al. (2016) assessed the association between e-cigarette use and the onset of cigarette smoking. Results showed that college students who had never smoked before, were more likely to initiate cigarette use, after having tried e-cigarettes. Although it still remains unclear to what extent increased marijuana use impacts risk of tobacco cigarette initiation, recent studies have demonstrated that there may be an association, while also suggesting progression to nicotine dependence (Patton et al., 2005). Furthermore, marijuana and tobacco users share similar socio demographic profiles (Patton et al., 2005). Prevalence of occasional marijuana use is now more common than tobacco cigarette use among young adults in Canada (Tjepkema, 2004), along with the popularity and accessibility of e-cigarettes in Canada increasing at an even higher rate (Richmond et al., 2018). Coupled with new evidence that young adulthood is a critical period in the progression of tobacco cigarette use (Hammond, 2005), the urgency for analysis between the 3 variables among this at-risk population is increasing. The findings from our study give further insight into potential relationships between combined use of marijuana and e-cigarettes and cigarette smoking status that can possibly be compared to research surrounding the influence of only marijuana or e-cigarettes.

Limitations

Although there is sufficient evidence to establish that differences exist between cigarette smoking status in relation to e-cigarette and marijuana use compared to non-users, limitations of this study still remain, some common to survey research. Despite relatively high response rates and filters to account for lack of response, the findings in our study are still subject to sample bias. The study included only 934 participants aged 19-24 in Ontario and may have generalizability issues. The population is fairly small, in a tight age group and localized only to Ontario residents which may affect the overall generalizability of the study results to residents outside of the age group or do not reside in Ontario. The data collected was cross-sectional and only represents behavior of participants in 2017—behaviors and substance use may change over time and the results that we have concluded may not be applicable to later years. Furthermore, participants responded to a questionnaire over the telephone which presents possibilities of response bias like self-report bias and social desirability bias that affect the validity of responses.

Participants may have chosen options that are not truly representative of themselves and instead opted for responses more socially acceptable to appear more presentable. It should be noted that a logistic regression analysis was determined to be the initial test to explore the secondary outcome. Although there was a significant correlation between the predictor variables and the dependent variable, all Spearman-Rho's correlations between predictors were above the threshold value of 0.3. Thus, the logistic regression analysis could not continue.

Conclusion and future directions

Overall, this study illustrates significant differences in smoking status when comparing between participants who used marijuana and e-cigarettes as opposed to those who used neither. Additionally, there was a significant difference in the smoking status for those who consumed marijuana via dabbing alongside marijuana and e-cigarettes compared to those who did not. There were no significant differences for any of the other consumption methods of marijuana. In terms of real world implications, these results may be useful to government officials when creating policy regulations regarding the selling of nicotine-products. Furthermore, legislators could use these findings in aid of creating regulatory policies towards e-cigarette and marijuana usage and its implications as gateway drugs in young adults. As the study database used followed a cross-sectional design, the implementation of longitudinal study in future research may provide additional context to paint a bigger picture. Longitudinal studies would provide data over prolonged periods of time, which would provide more adequate results pertaining to the everlasting effects of consuming both marijuana and e-cigarettes. This could aid in keeping results relevant as new patterns and tendencies arise. Additionally, the implementation of a broader group of participants such as individuals from other countries in the data set, would allow for the rest to be generalized to all populations, not just specific to individuals in Ontario. Although further generalization and a need for longitudinal studies surrounding the subject matter of this study is needed for deeper understanding, it is a step in the right direction. Exploring the impact of combined marijuana and e-cigarette use on cigarette smoking in a time of increasing prevalence within young adults in Canada is essential to assess possible new risk factors as new trends emerge.

REFERENCES

Coleman, M., Donaldson, C. D., Crano, W. D., Pike, J. R., & Stacy, A. W. (2020). Associations between family and peer e-cigarette use with adolescent tobacco and marijuana usage: A longitudinal path analytic approach. *Nicotine & Tobacco Research, 23*(5), 849–855. https://doi.org/10.1093/ntr/ntaa204

Hair, E., Bennett, M., Williams, V., Johnson, A., Rath, J., Cantrell, J., Villanti, A., Enders, C., & Vallone, D. (2017). Progression to established patterns of cigarette smoking among young adults. *Drug and Alcohol Dependence*, *177*, 77–83. https://doi.org/10.1016/j.drugalcdep.2017.03.040

Health Canada. (2021, August 12). *Government of Canada*. Canada.ca. Retrieved December 10, 2021, from https://www.canada.ca/en/health-canada/services/drugs-medication/cannabis/research-data/canadian-cannabis-survey-2020-summary.html.

Hammond, D. (2005). Smoking behaviour among young adults: beyond youth prevention. *Tobacco Control*, *14*(3), 181–185. https://doi.org/10.1136/tc.2004.009621

Patton, G. C., Coffey, C., Carlin, J. B., Sawyer, S. M., & Lynskey, M. (2005). Reverse gateways? Frequent cannabis use as a predictor of tobacco initiation and nicotine dependence. *Addiction*, *100*(10), 1518–1525. https://doi.org/10.1111/j.1360-0443.2005.01220.x

Pistis, M., Perra, S., Pillolla, G., Melis, M., Muntoni, A. L., & Gessa, G. L. (2004). Adolescent exposure to cannabinoids induces long-lasting changes in the response to drugs of abuse of rat midbrain dopamine neurons. *Biological Psychiatry, 56*(2), 86–94. https://doi.org/10.1016/j.biopsych.2004.05.006

Kandel, E. R., & Kandel, D. B. (2014). A Molecular Basis for Nicotine as a Gateway Drug. *New England Journal of Medicine*, *371*(10), 932–943. https://doi.org/10.1056/nejmsa1405092

N.d (2021, May 24). *Is marijuana a gateway drug?* National Institute on Drug Abuse. Retrieved December 10, 2021, from https://www.drugabuse.gov/publications/research-reports/marijuana/marijuana-gateway-drug

N.d (2021, June 7). *Marijuana drug facts*. National Institute on Drug Abuse. Retrieved December 10, 2021, from https://www.drugabuse.gov/publications/drugfacts/marijuana.

Richmond, S. A., Pike, I., Maguire, J. L., & Macpherson, A. (2018). E-cigarettes: A new hazard for children and adolescents. *Paediatrics & Child Health*, *23*(4), 255–259. https://doi.org/10.1093/pch/pxx204

Rioux, C., Castellanos-Ryan, N., Parent, S., Vitaro, F., Tremblay, R. E., & Séguin, J. R. (2018). Age of cannabis use onset and adult drug abuse symptoms: A prospective study of common risk factors and indirect effects. *The Canadian Journal of Psychiatry, 63*(7), 457–464. https://doi.org/10.1177/0706743718760289

Soneji, S. (2018). Errors in Data Input in Meta-analysis on Association Between Initial Use of e-Cigarettes and Subsequent Cigarette Smoking Among Adolescents and Young Adults. *JAMA Pediatrics*, *172*(1), 92. https://doi.org/10.1001/jamapediatrics.2017.4200

Spindle, T. R., Hiler, M. M., Cooke, M. E., Eissenberg, T., Kendler, K. S., & Dick, D. M. (2016, April). *Electronic cigarette use and uptake of cigarette smoking: A longitudinal examination of U.S. college students*. Addictive behaviors. Retrieved December 1, 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5250543/.

Team, S. C. (2021, January 21). *E-cigarette and Vaping Statistics 2020*. The Checkup. Retrieved November 28, 2021, from https://www.singlecare.com/blog/news/vaping-statistics/.

Tjepkema, M. (2004). *Use of cannabis and other illicit drugs*. HEALTH STATISTICS CANADA.

https://publications.gc.ca/Collection-R/Statcan/82-003-XIE/0040382-003-XIE.pdf

Assessing how Covid-19 has Impacted Single Mothers Compared to Mothers in a Co-parent Relationship in Ontario

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Introduction

The World Health Organization declared COVID-19 a pandemic in late March of 2020, resulting in the temporary closure of many societal institutions, businesses, and borders. While the virus was distributed globally, the health and societal impacts were felt hardest among marginalized communities.

Gender, different from sex, is a social determinant of health (Connor et al., 2020). Before the pandemic struck, women reported more unhealthy days per year than men; despite using more preventative care services (Connor et al., 2020). Women are also nearly twice as likely to suffer from mental illness compared to men (Yu, 2018). Moreover, the pandemic has exacerbated gender inequality across domains – from divisions of labour to economic stability; and gender inequality is associated with worse mental health outcomes for women (Fisher & Ryan, 2021; Yu, 2018).

In Canada, women make up the majority of healthcare workers, accounting for over 80% of all healthcare workers in 2020 (Statistics Canada, 2021). Expectedly, healthcare workers have an increased risk of contracting COVID-19, compared to other occupations, due to close contact with infected patients (Connor et al., 2020). And despite the severity of COVID-19 being higher in men, women reported greater stress and psychological distress during lockdowns (Fisher & Ryan, 2021). Economically, women are worse off during the pandemic than men. Women have suffered an 11% unemployment rate, compared to just 4% for men. The higher unemployment can mean more women are forced into part-time work, potentially balancing multiple jobs, and decreasing work-life balance.

The closure of schools, along with a decreased access to childcare services has inevitably increased parents' burden of childcare (Yamamura & Tsustsui, 2021). Unfortunately, the burden of childcare disproportionately falls upon women, and this inequality has also been exacerbated during the pandemic (Yamamura & Tsustsui, 2021). To take care of their children, mothers are more likely to skip work/work from home compared to fathers during the pandemic (Yamamura & Tsustsui, 2021; Fisher & Ryan, 2021). The increased childcare burden along with greater economic instability is especially detrimental in low-income families. Instability in childcare arrangements can increase mothers' physical and psychological aggression, and neglectful behaviour (Ha et al., 2015). A Statistics Canada study found that single parents were the most likely to use childcare services – approximately 7 in 10 (Zhang et al., 2021). With the lockdowns during the pandemic, many childcare services were temporarily shut down, making this no longer an option for many single parents. Regrettably, child maltreatment related to childcare burden is more significant for single mothers. Shutting down schools and childcare centers also increases the unemployment rate of mothers, further increasing financial burdens and stress (Russell & Sun, 2020).

Living in the pandemic has undoubtedly been difficult for parents all around the world. Yet, women are disproportionately bearing the brunt of the psycho-social damage the pandemic has caused. However, it is unclear if single mothers are impacted significantly more than their coupled counterparts. A study on the Health risks and outcomes that disproportionately affect women during the pandemic has highlighted some of the outcomes seen in women, some who are caregivers. This study reports that female caregivers have an increased risk of contracting covid-19 and that gender-informed policies are required to help solve health issues during a pandemic (Connor, 2021). While this study does not analyze the mental health of single or partnered mothers, it raises the need for further research, as one might wonder if having increased risk of covid-19 for female caregivers affects their mental health. Research has not yet addressed the differences in mental health outcomes for single mothers compared to mothers that have a partner. In this study, we analyze the general feelings of anxiety felt by working single mothers in Canada compared to working mothers that have a partner. This study should help to identify any gaps in current knowledge about determinants of mental health, and ultimately inform mental health and childcare policies. Further, it can back up the aforementioned study's highlighted outcome, on the need for gender-based policies to help solve health issues during the pandemic. This study answers the question: is the mental health impact of COVID-19 greater on single mothers compared to mothers with partners in Ontario.

Materials and methods

Study Design and Database

This study was designed as a retrospective, cross sectional study. The objective was to produce results that included the impacts of COVID-19 on mental health of individuals. Data collection occurred in 2020 from May 4th to May 10th, and was produced on Odesi as a dataset. The desired database was found under the Canadian Perspective Survey Series 2 (CPSS2): Monitoring the Effects of COVID-19. This database was authorized by the Affiliation Statistics Canada, located in Ottawa, Ontario. It was distributed by the Data Liberation Initiative. Participants who were part of a subset from the impact of COVID-19 crowdsource collection were invited to participate. The CPSS Sign-up randomly selected people aged 15 years and over. The mode of data collection was by the CPSS Sign-Up survey which created Statistic Canada’s probability panel. A letter was sent out to the selected sample explaining CPSS and the CPSS2, 2020. Participants were then asked to go online and sign up using a given Secure Access Code. A standard approach used for many StatCan surveys was used. Participation was voluntary and information would be confidential. Participants were sent the survey through email. The survey was open for 6 days, and reminder emails were sent each day. The CPSS2 was intended to collect data on the knowledge and behaviour of residents in 10 Canadian Provinces. A further motive of achieving this database was for informing policy makers on a national level on emerging data needs (CPSS, 2020).

Study Participants

The initial target population for data collection were residents, 15 years of age or older, of the 10 Canadian Provinces. Of the 4600 participants originally included in the database, data for this study was extracted from only 342 participants. This study required information for the two categories, single mothers and mothers with a partner, both located in Ontario. To minimize unwanted influences on data outcomes, data kept included females born in Canada, aged 25 to 54, each with a child under 18, and residing in urban dwellings.

Study Outcomes

Data collected for all variables in this study was through an online survey sent through email of selected participants. For each variable, participants were required to select a category for each question. All variables were dependent and the measurement scale was nominal.

The primary outcomes of this study were perceived mental health and severity of generalized anxiety For perceived mental health, there were nine categories to choose from, however this was transformed to having two categories to examine for the purpose of our study. The two categories were excellent or good and fair or poor to better organize the data. For the general anxiety of participants, a cutoff point from the GAD-7 test was used to assess the severity participants had. We selected these outcomes because we believed that these were the two most significant in determining the impact of mental health on the two groups of women.

Additional data collection

The variables that our group included into our additional data collection included the age group of respondents, which was broken down into three separate categories; ages 25-34 years old, 35-44 years old and 45-55 years old. We also included the highest level of education completed, which was organized into four groups; below high school, high school diploma, college/trade/university diploma or certificate and bachelor's degree or higher. Marital status was taken into account, in order to include only single mothers. These categories are organized into four groups; married, living common-law, widowed/separated/divorced and single, never married. We included household size, ranging from one to four or more, as well as the type of dwelling, a single detached house, low-rise apartment, high-rise apartment and other. Finally, we included the employment status of the mothers, either employed and at work at least part of the reference week, and employed but absent from work due to COVID-19, as well as the respondents telework status, with the options being a work location changed from outside the home, to at home, a work location that remains at home, a work location that remains outside of the home, absent from work as well as an option of not stated. All of the above data was expressed in percentages, and household size does not include any children under the age of 18.

Statistical analysis

In order to answer our research question, we completed chi-square tests on groups we believed would show significant results. This was done through the software SPSS, and we used a P value of 0.05 to test for the significance. The chi-square tests completed involved the cross-tabulation of feeling lonely or not paired with each variable listed above, to find correlation amongst variables. The same test was also done to distinguish any independent variables that may affect the outcomes of this experiment.

Results

Table 1. Characteristics of single mothers and mothers with a partner.

Variables	Single mothers (n = 84)	Partnered mothers (n = 258)
Age group of respondents		p = 0.758
25 to 34 years old	23 (27.4)	61 (23.6)
35 to 44 years old	40 (47.6)	133 (51.6)
45 to 55 years old	21 (25.0)	64 (24.8)
Highest Level of Education Completed		**p = <0.001**
High school or below	22 (26.2)	27 (10.5)
Above high school	62 (73.8)	231 (89.5)
Marital Status		
Married	-	183 (70.9)
Living common-law	-	75 (29.1)
Widowed/Separated/Divorced	39 (46.4)	-
Single, never married	45 (53.6)	-
Household size		p = 0.468
3 or less	82 (97.6)	245 (95.0)
4 or more	2 (2.4)	13 (5.0)
Type of dwelling		**p = <0.001**
Single detached	40 (47.6)	217 (84.1)
Apartment	13 (15.5)	12 (4.7)
Other	31 (36.9)	29 (11.2)
Employment status		p = 0.634
Employed	66 (78.6)	210 (81.4)
Not employed	18 (21.4)	47 (18.2)
Missing	-	1 (0.4)
Employed but absent from work due to COVID-19 (n = 66)		**p = 0.015**
Yes	15 (23.4)	26 (12.4)
No	2 (3.0)	25 (11.9)
Telework status		p = 0.951
Work location changed from outside the home to at home	20 (23.8)	69 (26.7)
Work location remains at home	13 (15.5)	36 (14.0)
Work location remains outside the home	16 (19.0)	53 (20.5)
Absent from work	17 (20.2)	51 (19.8)
Missing	18 (21.4)	49 (19.0)

The data is presented as the number (%) of participants unless stated otherwise. Household size does not include children under 18.

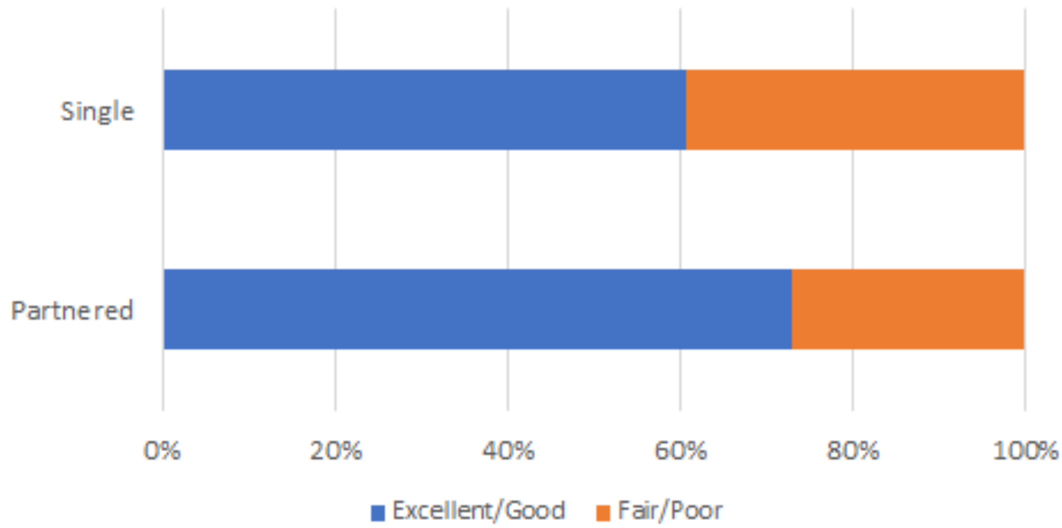

Figure 1. Self-perceived mental health of single versus partnered women. Results are presented in a 100% stacked bar-graph.

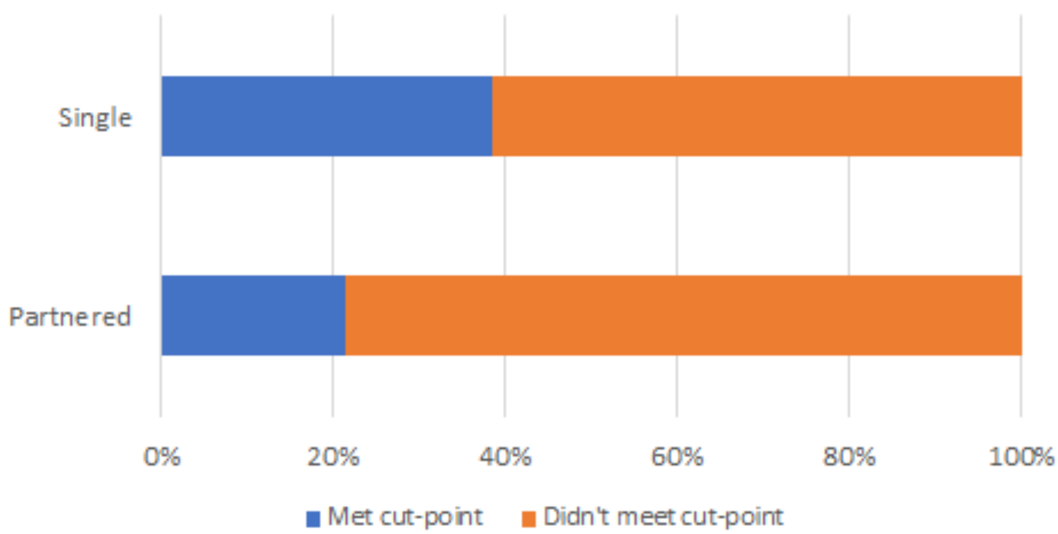

Figure 2. Percentage of women that met the GAD-7 cut-point. Cut-point was set at a score of 10 or higher on the GAD-7 survey indicating moderate to severe symptoms of anxiety. Results are presented in a 100% stacked bar-graph.

39% of single mothers reported fair/poor mental health compared to only 27% of partnered mothers. A chi-squared test revealed that self-perceived mental health scores were significantly worse for single women compared to partnered women (X^2 (1, N = 342) = 3.889, p = 0.049). 38% of single mothers met the cut-point for moderate/severe anxiety symptoms compared to only 21% of partnered mothers. Similarly, single women were significantly more likely to have a GAD-7 score of 10 or higher (X^2 (1, N = 339) = 8.699, p = 0.003.).

Table 2. Ability to meet financial obligations and likelihood of losing employment in the next four weeks.

COVID-19 Impacts ability to meet financial/essential obligations		p = 0.339
Major/Moderate impact	20 (23.8)	49
Minor/No impact or Too soon to tell	64 (	209
I might lose my job in the next 4 weeks		p = 0.798
Strongly agree/Agree	7	18
Neutral/Disagree/Strongly Disagree	59	192
Missing	18	48

Single mothers and mothers with partners were not significantly different in their ability to meet their financial/essential obligations, and their likelihood of losing their jobs.

Discussion

Overall, in this study we found that single mothers had worse mental health scores compared to partnered mothers. Self-perceived mental health was consistent with GAD-7 scores for single mothers, but was slightly inconsistent for partnered mothers. 39% of single mothers reported their mental health as fair/poor and 38% met the GAD-7 cut-point for moderate to severe anxiety symptoms, compared to 27% and 21% of partnered mothers, respectively. This is likely due to the fact that anxiety is only one aspect of overall mental health. However, Regardless, both self-perceived mental health and GAD-7 scores were significantly worse for single mothers compared to partnered mothers.

Our study suggests a few reasons as to why this might be the case. Firstly, single mothers were much more likely to have a lower level of education completed compared to partnered mothers which is associated with higher levels of anxiety and depression (Bjelland et al. 2008). Moreover, partnered mothers tend to reside in larger homes which is likely an indicator of better financial stability, potentially due to a second income stream from their partners. Lastly, single mothers were more likely to have been absent from work due to COVID-19, which would impact their income stream, leaving them vulnerable to economic insecurity. Nevertheless, single mothers and partnered mothers were not significantly different in their ability to meet their financial obligations. Furthermore, both single and partnered mothers were equally likely to maintain/lose their employment in the next four weeks. However, this survey was conducted in 2020 and the situation for single mothers might have deteriorated significantly due to the ongoing pandemic and many lockdown restrictions since then.

The mental health of Ontarians was significantly impacted during the pandemic (Shilington et al. 2021). Conner et al. (2020) found that women disproportionately burden the negative health and economic impacts during the pandemic. Furthermore, due to limited access to mental health support, anxiety among parents has quadrupled and overall mental health has deteriorated (Dozois, 2021). The combination of these risk factors leaves single mothers at a greater risk for mental health difficulties, the consequences of which can be observed in our data.

There are some limitations to our study. First, the CPSS survey was produced in June of 2020. More recent data collections would likely affect the results of this study due to the ongoing implications of the COVID-19 pandemic. Furthermore, since this was a longitudinal study it is impossible to determine how mental health scores shift over time and what factors are causally related to mental health outcomes. That is why it would be beneficial to do a second survey so we can compare the results to findings in our study and hopefully gain a better understanding of specific mental health risk factors for single mothers. Secondly, while the CPSS asked for employment status, it did not account for income which is much more important. According to the U.S. census bureau, single women are 3 times more likely to work a minimum wage job (United States Census Bureau, 2015). In our study, single mothers were significantly more likely to be absent from work due to COVID-19. This could be an indicator of single mothers working in non-essential service industries which are more likely to be minimum wage jobs. A third limitation is that the surveys were sent in by mail and are subject to self-report bias. Because of this, it is difficult to determine if the discrepancy between self-perceived mental health and GAD-7 scores in partnered women is due to some factor not accounted for in the CPSS, or a result of self-report bias. A fourth limitation was that previous research showed that mental health scores in single mothers versus partnered mothers was age dependent, however we did not examine that here https://pubmed.ncbi.nlm.nih.gov/15022043/. However, this study was done in 2004 so it is unclear how relevant the results are today.

To our knowledge this is the only study comparing mental health outcomes among single mothers to mothers with partners. We hope this research brings more attention to the needs of single mothers in Ontario. The increased child care burden, compounded with the impacts of the pandemic have left single mothers in an especially vulnerable position. Consequently, this might lead to child neglect and maltreatment. Policies should look to reduce the child care burden on mothers. One option is to subsidize third party child care services such as daycare, or providing a tax credit for using babysitting services. Future research should focus on how single mothers have coped since the time this survey was conducted, and the factors that impact mental health in single mothers the most.

References

Connor, J., Madhavan, S., Mokashi, M., Amanuel, H., Johnson, N. R., Pace, L. E., & Bartz, D. (2020). *Health risks and outcomes that disproportionately affect women during the Covid-19 pandemic*. ScienceDirect: A review. Retrieved October 8, 2021, from https://doi.org/10.1016/j.socscimed.2020.113364

Dozois, D. J. A. (2021). *Apa PsycNet*. Anxiety and depression in Canada during the COVID-19 pandemic: A national survey. Retrieved December 10, 2021, from https://doi.org/10.1037/cap0000251

Ha, Y., Collins, M. E., & Martino, D. (2015). Child care burden and the risk of child maltreatment among low-income working families. *Children and Youth Services Review*, *59*, 19–27. https://doi.org/10.1016/j.childyouth.2015.10.008

Russell, L., & Sun, C. (2020, November 23). *The Effect of Mandatory Child Care Center Closures on Women's Labor Market Outcomes During the COVID-19 Pandemic*. Retrieved October 9, 2021, from https://cpb-us-w2.wpmucdn.com/web.sas.upenn.edu/dist/0/610/files/2020/11/PaperDraft_COVIDChildcareClosures-3.pdf.

Shillington, K. J., Vanderloo, L. M., Burke, S. M., Ng, V., Tucker, P., & Irwin, J. D. (2021, September 15). *Ontario adults' health behaviors, mental health, and overall well-being during the COVID-19 pandemic*. BMC Public Health. Retrieved October 8, 2021, from https://doi.org/10.1186/s12889-021-11732-6.

Yamamura, E., & Tsustsui, Y. (2021). The impact of closing schools on working from home during the COVID-19 pandemic: evidence using panel data from Japan. *Review of Economics of the Household*, *19*(1), 41–60. https://doi.org/10.1007/s11150-020-09536-5

Zhang, S., Garner, R., Heidinger, L., & Findlay, L. (2021, July 22). Parents' use of child care services and differences in use by mothers' employment status. Retrieved October 9, 2021, from https://www150.statcan.gc.ca/n1/pub/75-006-x/2021001/article/00007-eng.htm

https://journals.sagepub.com/doi/full/10.1177/1559827620981014 - lifestyle

US Census Bureau. (2015, September). Current Population Survey, , 2015 Annual Social and Economic (ASEC) Supplement. Retrieved December 5, 2021, from https://www2.census.gov/programs-surveys/cps/techdocs/cpsmar15.pdf.

Bjelland, I., Krokstad, S., Mykletun, A., Dahl, A. A., Tell, G. S., & Tambs, K. (2008). Does a higher educational level protect against anxiety and depression? The hunt study. *Social Science & Medicine*, *66*(6), 1334–1345. https://doi.org/10.1016/j.socscimed.2007.12.019

Investigating the Effect of Alcohol Consumption on LDL Cholesterol Serum Concentration in Healthy Men Between the Ages of 45 and 65

Abdalla El-Komy, Abood Qadri

Group 26

Introduction

Alcohol is one of the oldest recreational drugs in history, being consumed by people from different eras. It's produced primarily by fermenting and distilling various fruits and vegetables, such as grapes. Alcohol, which is also referred to by its chemical name ethanol, is the main active drug in drinks such as beer and wine and is consumed for many reasons, depending on the religious and cultural environment. Alcohol consumption can result in a multitude of effects, many of which are due to multiple biochemical mechanisms in the body. Alcohol primarily increases the effects of a neurotransmitter called y-aminobutyric acid, or GABA. The increased effects of this neurotransmitter results in what characterizes alcohol as a depressant, which is the suppression of the central nervous system. Alcohol also affects other neurotransmitters, such as dopamine, which results in the euphoric feeling many people experience after its consumption.

Cholesterol is a fat like substance that can be found in cell membranes (Grundy, 2002) to reduce fluidity and permeability. It travels in the blood in recognizable parts containing both lipids and proteins, hence the category lipoproteins (Grundy, 2002). It aids in the production of sex hormones, it acts as a building block for cells, and it aids in bile production in the liver which is beneficial to digestion (Schaefer, 2020). Like many other biochemical assemblies, the body is able to produce much of the cholesterol it needs but it does rely on outside sources such as diet to obtain cholesterol. It can be taken from many sources like milk, cheese, meat, and eggs. Although cholesterol is needed to maintain necessary bodily functions and to stay healthy, it comes in a good and bad form. The bad form otherwise known as low-density lipoprotein flows throughout the bloodstream, clumps artery walls and can cause a condition known as atherosclerosis if it becomes chronically high. The plaque that forms on the artery walls is generally tough and causes long term narrowing of the arteries and restricts blood flow. On the other hand there is good cholesterol or high-density lipoprotein which helps remove cholesterol from the body keeping overall cholesterol levels low ("LDL and HDL," 2020). High-density lipoprotein does this by absorbing cholesterol and carrying it to the liver. The liver then flushes it out of the body ("LDL and HDL," 2020). This is beneficial since high levels of HDL can lower the risk of heart disease and strokes.

Alcohol consumption and its effect on health markers have been researched intensively, especially in recent years, but the specific relationship between alcohol consumption and its effect on LDL cholesterol have not been investigated as much as the relationship between alcohol and other health markers, such as liver values. The main studies that discuss the relationship between the two were completed by Perisinotto et al. and Corella et al., respectively. Perisinotto et al. investigated the effects of alcohol consumption on cardiovascular risk factors in older lifelong wine drinkers. The study concluded that moderate consumption of wine in the elderly results in a net benefit of multiple health markers, but the effects of the alcohol consumption negatively impacted LDL levels in the participants of the study. Whilst the study was not performed on the target demographic we focus on, it does shed some light on the potential effects of alcohol consumption on LDL cholesterol values. In the study done by Corella et al., the effect of alcohol consumption on LDL cholesterol values was investigated but with more focus placed on whether variation at the apolipoprotein E gene (ALOE) locus impacts the way alcohol consumption affects LDL values. The study concluded that variation in the ALOE locus does in fact partially impact the extent to which alcohol consumption affects LDL values in healthy men, which is closer to our target demographic than the participants in the study performed by Perisinotto et al. The lack of direct research done on the impact of alcohol consumption on LDL cholesterol serum concentration is an issue that needs to be addressed if there is hope to understand the effects of this drug on something that could potentially be harmful, such as an increase in LDL cholesterol. With a slight idea on how alcohol could potentially impact the LDL cholesterol serum concentration, we aimed to investigate how they are correlated, if at all. We hypothesize that there is a positive correlation between alcohol consumption and LDL cholesterol serum concentration.

Methods

The design of the study was cross-sectional and observational since no interventions were implemented and the sample used was only surveyed at one point in time. The data used in this study was taken from the Canadian Heart Health Database (CHHD) from the years 1986 to 1992. The CHHD is an assembly of data collected from multiple surveys conducted by several provincial departments of health, including The Heart and Stroke Foundation of Canada and Health Canada. The CHHD primarily focuses on cardiovascular disease prevention, including but not limited to, the prevalence of risk factors, consequences of cardiovascular disease, and the associated lifestyle behaviors.

The original database included too many variables that were deemed unnecessary by the inclusion criteria of this paper. The inclusion criteria meant only men were chosen as valid participants and women were excluded. Anyone between the ages of 45 to 65 were included. Participants who have high or low blood pressure, are on a specific diet, take prescription medication for their heart or cholesterol, have preexisting health conditions, are sedentary, and have an abnormal BMI (less than 19 and greater than 25) were also excluded. The criteria for these exclusions were chosen to make sure that as many variables were controlled and that the only thing impacting the LDL cholesterol values was the alcohol consumption. Just like any other study that attempts to classify the relationship between two real-world variables, not 100%

of the variables will be accounted for which is why other statistical tests will be required, such as analysis of covariance.

The objective of this study was to investigate the impact of alcohol consumption on LDL cholesterol values in young and healthy men. The primary outcome would be an increase in LDL values due to increased alcohol consumption. The data used in this study was collected through 10 different surveys. A sample large enough was used to generate 2000 responses. Participants were visited in their homes where information was collected about them, such as demographic data, CVD risk factors, blood pressure readings. and their opinions on issues pertaining to heart health. The same participants were then asked to come into a clinic for the second and final visit to collect anthropometric measurements, a blood sample and two more blood pressure readings. Considering the different categories of data collected, different methods of acquiring the data were utilized. The first category of data was the demographic data. This data was acquired by surveying the participants and asking them questions related to their household, income, age, sex, etc. The second category of data was information pertaining to the participants' blood pressure. This data was acquired by taking two different blood pressure readings throughout the first visit and by surveying the participants. The third category of data were personal measurements. These were taken at the clinic by a nurse and through surveying the participants. The fourth and final category of data collected were the cholesterol levels. These were collected through the blood sample collected during the visit to the clinic. The rationale behind including all these categories of data is similar to that of other studies referenced earlier, such as the one by Perisinotto et al. and Corella et al. Variables such as LDL cholesterol values can be influenced by a multitude of factors, so ensuring that a large amount of data is recorded will help ensure that as many variables are accounted for when looking for a relationship between alcohol consumption and LDL cholesterol. Accounting for all these variables and ensuring they're controlled helps with the validity of the results. Without accounting for them, there could be multiple variables influencing the results without the researchers' knowledge.

Aside from the primary outcomes, most other variables have the potential to influence the results. These variables are the ones included in Table 1, such as age and BMI. Other variables that were not included in Table 1 since they were categorical and could not be tested for normality include current smoking status, exercise frequency and duration, and hypertensive status. These variables will be used as covariates in an ancova model.

The statistical tests used were the shapiro-wilk tests of normality for the continuous variables. The data summarized from the statistical test stated the variable, its significance value, whether it was normal or not and the measure of central tendency to be reported. Other statistical tests include the Pearson correlation test to determine whether there is a significant correlation between alcohol consumption and LDL cholesterol values. SPSS software was used to conduct all statistical tests and a p-value of 0.05 was chosen as the significance value.

Results

Table 1. Descriptive Statistics of the 1986 to 1992 Population Surveyed by the Canadian Heart Health Database. Different statistical calculations were performed on the continuous variables deemed appropriate for the study, such as the mean, standard deviation, variance, and the number of participants who provided a response for the prompt (dictated by "N").

	N	Mean	Std. Deviation	Variance
[AGE] AGE IN YEARS	2218	55.187	6.410	41.094
[BMI] BODY MASS INDEX	2010	27.315	3.965	15.718
[WGTC] CLINIC: WEIGHT IN KILOGRAMS	2000	83.134	13.164	173.293
[HGTC] CLINIC: HEIGHT IN CENTIMETRES	2001	174.288	7.038	49.531
[TCHOL] TOTAL PLASMA CHOLESTEROL (MMOL/L)	1971	5.544	.978	.956
[LDL] LOW DENSITY LIPOPROTEINS (MMOL/L)	1880	3.499	.840	.706
[CIG_DAY] NUMBER CIGARETTES PER DAY, ALL SUBJECTS	2202	6.333	11.730	137.604
[ALCMTH] MONTHLY FREQ OF ALC DRINKS IN PAST YEAR	632	10.123	9.193	84.504
Valid N (listwise)	539			

Table 2. A Shapiro-Wilk statistical test performed to determine normality. The Shapiro-Wilk test was used on the same continuous variables from Table 1 to determine which variables, if any, were normal. A P-value of 0.05 was used as the significance value. Only the LDL and HGT variables were considered not-normal according to the Shapiro-Wilk test.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
[AGE] AGE IN YEARS	.115	81	.010	.936	81	<.001
[BMI] BODY MASS INDEX	.065	81	.200*	.987	81	.607
[LDL] LOW DENSITY LIPOPROTEINS (MMOL/L)	.075	81	.200*	.984	81	.386
[ALCMTH] MONTHLY FREQ OF ALC DRINKS IN PAST YEAR	.295	81	<.001	.727	81	<.001
[HGT] HEIGHT IN CENTIMETRES	.093	81	.081	.971	81	.063
[WGT] WEIGHT IN KILOGRAMS	.121	81	.005	.942	81	.001
[ALCNUM] AVERAGE DAILY ALCOHOL CONSUMPTION	.311	81	<.001	.530	81	<.001

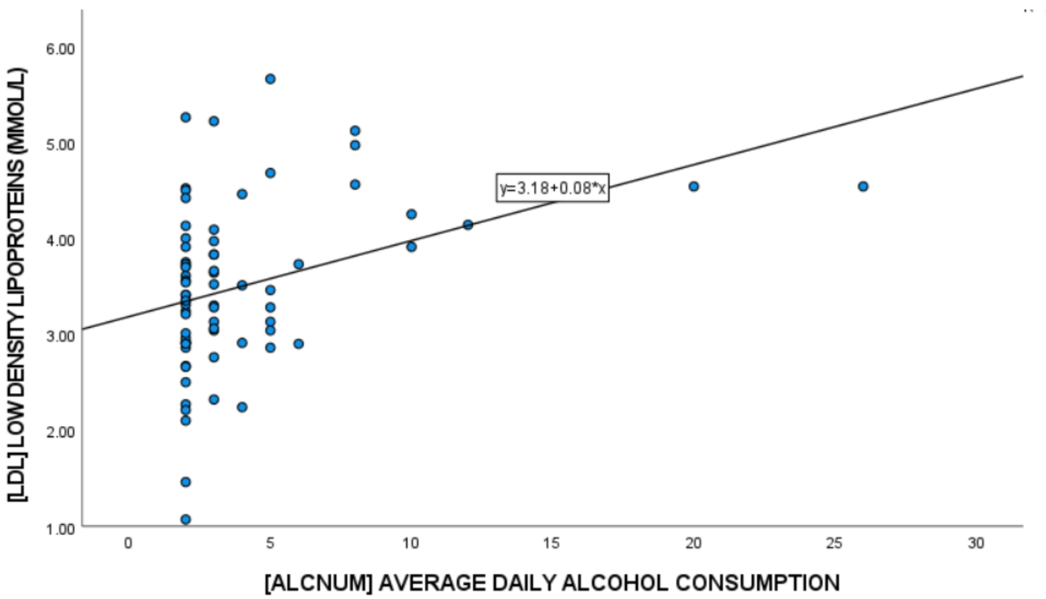

Figure 1: Scatter plot of [LDL] low density lipoproteins (MMOL/L) by [ALCNUM] Average daily Alcohol consumption. The scatter plot shows each individual's average daily consumption of alcohol and their LDL levels. As can be seen by the line of best fit there is moderate positive correlation between the 2 variables suggesting that higher alcohol consumption increases LDL levels in serum.

Table 3. Spearman's Rho test to determine significance of correlation between average daily alcohol consumption and LDL cholesterol. Using a P-value of 0.05 to determine significance, the Spearman's Rho test concluded that there is a significant correlation between Low Density Lipoproteins and Average Daily Alcohol Consumption with a correlation coefficient of 0.337. The correlation coefficient is considered weak.

			[LDL] LOW DENSITY LIPOPROTEINS (MMOL/L)	[ALCNUM] AVERAGE DAILY ALCOHOL CONSUMPTION
Spearman's rho	[LDL] LOW DENSITY LIPOPROTEINS (MMOL/L)	Correlation Coefficient	1.000	.337**
		Sig. (2-tailed)	.	.004
		N	72	72
	[ALCNUM] AVERAGE DAILY ALCOHOL CONSUMPTION	Correlation Coefficient	.337**	1.000
		Sig. (2-tailed)	.004	.
		N	72	79

Discussion

SPSS software was used to produce descriptive statistics of the population, significance tests for normality and correlation, and a scatter plot to visualize the correlation between LDL cholesterol in men aged 45 to 65 years of age and their alcohol consumption levels. It is important to note from table 1, the average BMI of this population was 27.315 kg/m^2. This is above the ideal BMI for most adults which is between 18.5 kg/m^2 to 24.9 kg/m^2 and anything above that range would be considered overweight to obese ("NHS," n.d.). Also, the average total cholesterol was higher than desired at 5.544 mmol/l. The desired total cholesterol was less than 5.18 mol/l as 5.18 to 6.18 mmol/L was considered borderline high (Mayo Foundation, 2021). Furthermore the average number of cigarettes smoked per day across all participants was 6.333. Ideally none of the subjects would have been smokers because according to Freeman et al, LDL cholesterol and plasma triglycerides were found to be significantly increased while HDL was significantly decreased in smokers. This was shown by a substantially higher LDL/HDL ratio in smokers (2.89) than in non smokers (2.38), (Freeman, 1993). The purpose of the study was to research the impact of LDL cholesterol serum concentrations in generally healthy men aged 45 to 65, but the results could've been affected since BMI, total cholesterol and smoking status were outside of the normal 'healthy' ranges.

Table 2 shows a shapiro wilks test that was used to determine normality and it was found that LDL cholesterol was not normally distributed. Determining normality is crucial in deciding which statistical analysis is appropriate for the variables being tested for correlation. Figure 1 shows the relationship between each individual's average daily alcohol consumption and their LDL levels. As shown by the line of best fit there is a moderate positive correlation between the 2 variables which suggests that as alcohol consumption increases LDL increases. The results obtained here are different from another study by Kiechl et al where they noted a J shaped graph. This meant that no alcohol consumption and heavy alcohol consumption had higher levels of LDL and a higher risk of atherosclerosis, while light to moderate drinkers had lower LDL levels and some protection from atherosclerosis due to antithrombotic effects. This means that light alcohol consumption was able to counteract plaque thrombosis in arteries. Kiechl et al is different from this study as figure 1 didn't have a J shape, it had a positive linear shape. In addition to this another study found similar results to Kiechl et al. They found that coronary artery disease increased with alcohol use, with a J shaped relation (Foerster, 2009). It was concluded that the protective risk of alcohol consumption disappeared in very high drinkers, because the beneficial increase in HDL cholesterol was offset by the increases in blood pressure (Foerster, 2009).

To determine if the correlation between LDL and average daily alcohol consumption was significant a spearman's rho test using a P-value of 0.05 was conducted (Table 3). The test showed that there is a significant correlation between LDL and average daily alcohol consumption with a correlation coefficient of 0.337. The correlation coefficient is considered weak. The covariables like increased BMI, total cholesterol, and smoking may have skewed the results causing the shape of the curve to be straight and for the correlation in the spearman's rho test to be weaker than anticipated.

One of the main issues encountered was the small sample size used in this study. Out of the 2,218 participants who met our criteria, only 539 provided us with all the data necessary to conduct the study. The small sample size could have potentially skewed the results. Another issue encountered were variables that might have not been accounted for. For example, the design of the study was cross-sectional and observational, so it could be that alcohol and LDL cholesterol are correlated due to a variable that actually has an impact on LDL which wasn't accounted for. Other issues would be misreporting of answers; a participant could claim that they consume 60 drinks a month but in reality, they could be consuming 100 drinks a month and misremembering it. Controlling for all the possible variables that could affect the outcome is also very difficult in a study of this sort; observational studies do not allow the researchers the opportunity to actively choose which variables are controlled and which are not.

Moving on, more studies should be conducted regarding this topic as it is severely understudied and the potential risks of knowing so little about this topic could potentially be harmful. Studies should ideally be done in an experimental manner where the researchers implement an active intervention to account for as many confounding variables and to avoid issues such as misreporting answers.

Citations

Centers for Disease Control and Prevention. (2020, January 31). *LDL and HDL Cholesterol: "Bad" and "Good" Cholesterol*. Centers for Disease Control and Prevention. Retrieved December 7, 2021, from https://www.cdc.gov/cholesterol/ldl_hdl.htm.

Corella, D., Tucker, K., Lahoz, C., Coltell, O., Cupples, L. A., Wilson, P. W., ... & Ordovas, J. M. (2001). Alcohol drinking determines the effect of the APOE locus on LDL-cholesterol concentrations in men: the Framingham Offspring Study. *The American journal of clinical nutrition*, *73*(4), 736-745.

Foerster, M., Marques-Vidal, P., Gmel, G., Daeppen, J.-B., Cornuz, J., Hayoz, D., Pécoud, A., Mooser, V., Waeber, G., Vollenweider, P., Paccaud, F., & Rodondi, N. (2009). Alcohol drinking and cardiovascular risk in a population with high mean alcohol consumption. *The American Journal of Cardiology*, *103*(3), 361–368. https://doi.org/10.1016/j.amjcard.2008.09.089

Freeman, D. J., Griffin, B. A., Murray, E., Lindsay, G. M., Gaffney, D., Packard, C. J., & Sheperd, J. (1993). Smoking and plasma lipoproteins in man: Effects on low density lipoprotein cholesterol levels and high density lipoprotein subfraction distribution. *European Journal of Clinical Investigation*, *23*(10), 630–640. https://doi.org/10.1111/j.1365-2362.1993.tb00724.x

Grundy, S. M., Clark, L. T., & Cooper, R. S. (2002). Rationale for Intervention. In D. Becker (Ed.), *Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III)NIG* (pp. II-1). essay, NIH Publication.

Kiechl, S., Willeit, J., Rungger, G., Egger, G., Oberhollenzer, F., & Bonora, E. (1998). Alcohol consumption and atherosclerosis: What is the relation? *Stroke*, *29*(5), 900–907. https://doi.org/10.1161/01.str.29.5.900

Mayo Foundation for Medical Education and Research. (2021, May 15). *Cholesterol test*. Mayo Clinic. Retrieved December 9, 2021, from https://www.mayoclinic.org/tests-procedures/cholesterol-test/about/pac-20384601.

NHS. (n.d.). *What is the body mass index (BMI)?* NHS choices. Retrieved December 8, 2021, from https://www.nhs.uk/common-health-questions/lifestyle/what-is-the-body-mass-index-bmi/.

Perissinotto, E., Buja, A., Maggi, S., Enzi, G., Manzato, E., Scafato, E., ... & ILSA Working Group. (2010). Alcohol consumption and cardiovascular risk factors in older lifelong wine drinkers: the Italian Longitudinal Study on Aging. *Nutrition, Metabolism and Cardiovascular Diseases*, *20*(9), 647-655.

Schaefer, A. (2020, March 29). *Why is cholesterol needed by the body?* Healthline. Retrieved December 7, 2021, from https://www.healthline.com/health/high-cholesterol/why-is-cholesterol-needed.

Data to Manuscript: No Observed Effect from Income Adequacy on Stroke Prevalence Dependent on Marital Status in Adult Canadian Men

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Stroke simultaneously affected 405,000 Canadians in 2013, and is expected to simultaneously affect at least 650,000 Canadians by 2038 (Krueger et al., 2015). Each patient costs C$17,000 to C$57,000 annually in direct medical costs, and upwards of C$1,900 annually per patient in indirect medical costs such as caregiving expenses (Goeree et al., 2008). There are many studies linking specific traits and behaviours to stroke prevalence, such as: age, weight, cigarette use, salt consumption, and stress (Boehme et al., 2017). However, there are few notable studies linking the prevalence of stroke from specific behaviours depending on the individuals' specific traits, particularly between marriage and income adequacy.

Boysen et al., (1998) had found that individuals with lower household income are more likely to experience a stroke relative to individuals with higher household income. Individuals with lower income may experience a lower quality of life due to missed opportunities from insufficient financial resources (Kuruvilla & Jacob, 2007), which can increase stress levels and increase stroke prevalence (Boehme et al., 2017). Individuals with higher income will have more opportunities available; which can increase their quality of life, and decrease their stress relative stroke prevalence. However, income beyond a certain amount could have diminishing returns, and an asymptotic effect on decreasing stress, as individuals will already have access to sufficient opportunities; and would reflect the findings of Boysen et al. (1998), who had found no significant change in stroke prevalence between middle and high income earners. Simons et al. (1998) had found that women who are married have reduced stroke prevalence, while men are unaffected. Simons et al. (1998) rationalised their findings with women typically having better social support to reduce their stress, to which men may not have as-readily available access. This will not necessarily affect men's stress levels; but may decrease women's stress levels (Mumtaz et al., 2018), and therefore their stroke prevalence (Boehme et al., 2017). While Boysen et al.

(1998) and Simons et al. (1998) had conclusive results for this study's purpose, their works were published over two decades ago, and were based on different populations, so their findings may not be applicable. This study can verify if a relationship between income and marital status on stroke prevalence such as theirs exists in a Canadian population.

Stroke typically affects older individuals more than younger individuals, with at least 14.0% of at least-80 year olds experiencing strokes compared to up to 6.1% of under-80 year olds (Mozaffarian et al., 2015); but its prevalence in younger individuals has increased (Kamal et al., 2015; Tong et al., 2020). Individuals who have strokes at younger ages (e.g. under 50) have up to a 1-in-8 chance to not be able to live independently even beyond 10 years (Synhaeve et al., 2014). During this time, these individuals may require ongoing professional care which can cost upwards of C$1,900 a year (Goeree et al., 2008); and may prevent them from living a full life (e.g. marriage, raising children), which can further decrease their quality of life. Additionally, the requirement for ongoing care means the loss of economic contributors (Kamal et al., 2015), as well as decreased medical attention for other patients (Romani et al., 2021). Therefore, any reduction in stroke prevalence across the population can greatly reduce medical costs and maintain individuals' quality of life. The age range of 35-64 inclusive was chosen to build on previous research done by Tong et al. (2020) on the same age range to contribute to a more-holistic model of stroke prevalence factors.

Katsiki et al. (2011) had found that men have higher stroke prevalence than women for most ages, except for the elderly. Katsiki et al. (2011) rationalised this through men exhibiting stroke-related behaviours, such as smoking and alcohol consumption, more often than women. Although women typically have worse post-stroke outcomes than men (Katsiki et al., 2011), reducing the overall number of strokes can reduce the medical staff and resources occupied which allows them to focus on other patients (Romani et al., 2021).

All of these specific variables of interest have been studied, but no notable studies combine all of them into a unified study. This study will use the database, *Canada Heart Health Database 1986-1992* by Statistics Canada (1997), to determine if there is sufficient evidence to indicate a relationship between income adequacy and marital status on stroke prevalence. Specifically, this study will determine if income adequacy disproportionately increases stroke prevalence in married Canadian men aged 35-64 inclusive compared to unmarried Canadian men aged 35-64 inclusive.

Methods

This study used data from the database, *Canada Heart Health Database 1986-1992* (Statistics Canada, 1997). It was created using data from a questionnaire-based observational and cross-sectional study performed by Health Canada and the Heart and Stroke Foundation of Canada on Canadian men and women aged 18-74 inclusive from the 10 provinces (Statistics Canada, 1997). The study gathered a large selection of data regarding stroke-contributing factors, and the data relevant to this study is summarised in table 1 (results section). All analyses and data modifications were performed in SPSS.

Any participant who had missing data in any of the relevant data (e.g. refused to answer, did not know) had their entire entry removed to simplify the analyses. This study only included participants from the database who were males 35-64 years of age inclusive who knew and shared their income status, marital status, and stroke history. Participants were not included if they were female, younger than 35, older than 64; and/or did not know - or did not share - at least one of their income status, marital history, and stroke history. Participants' age and sex were filtered to ensure that they are relevant to the study's research question. Participants' income adequacy and marital status are used for the categorical independent variables. Participants' stroke history is used for the categorical dependent variable. There were no normality tests performed as no continuous variables were used.

Participants' marital statuses were amalgamated to simplify the analyses. Statistics Canada (1997) amalgamated participants who were married and participants who had a common law partner; but distinguished unmarried participants according to if they were never married, divorced, or widowed/widowered. This study kept married and common law participants amalgamated, but also amalgamated unmarried participants regardless of the cause. The remaining participants were then split into 12 subpopulations - depending on permutations of their income adequacy, marital status, and stroke history - for three separate 2x2 Chi-squared tests.

Each Chi-squared test was performed on subpopulations according to their income adequacy, and then compared the frequencies of strokes between married and unmarried men of the same income adequacy. The first test was done on men who had low income adequacy; the second, medium; and the third, high. There were no other distinctions made between the participants (e.g. by age).

A binary logistic regression analysis was performed on the entire study population to determine the chances of an individual experiencing a stroke given their income adequacy and marital status. All variables used were categorical, and the independent variables had "First" reference categories. Wald tests were performed by SPSS to measure each variable's contributions to the holistic model for stroke prevalence.

Results

The summary of the variables of interest and applicable population counts from the database, Canada Heart Health Database 1986-1992 (Statistics Canada, 1997), are summarised in table 1 (see below). The database initially had 23,129 participants (Statistics Canada, 1997). After applying the inclusion and exclusion criteria, 19,789 participants were removed and 3,340 participants remained. Some variables resulted in uneven sample distributions (e.g. CURMAR, EVRSTR), but this was unavoidable within this database.

Descriptive Variable	Value: Category	Participant Count
SEX	1: Male	3,340
GPAGE	2: 35-64	3,340
INCADEQ	1: Low	609
	2: Middle	1,464
	3: High	1,267
CURMAR	0: Not currently married and no current common-law partner (e.g. never married, divorced, separated, widowed or widower)	438
	1: Currently married and/or Current common-law partner	2,902
EVERSTR	0: No	57

	1: Yes	3,283

Table 1. Descriptive characteristics relevant to the study's participants (n = 3,340). All data was taken from *Canada Heart Health Database 1986-1992* (Statistics Canada, 1997). This table includes the number of participants in each category/trait of each relevant descriptive variable. Participants in the database were excluded from the study if they had any missing data (e.g. refused to answer) for any of the analysed variables.

All Chi-squared tests were 2x2, and had a degree of freedom of 1. The first Chi-squared test compared frequencies of men with stroke and men without stroke, between married and unmarried men with low income adequacy; the second test, medium income adequacy; and the third test, high income adequacy. All three Chi-square tests were statistically insignificant for an alpha of 0.05, but also had one of four cells with an expected value of less than five. The Chi-squared and p values are in table 2 (see below). The more-specific counts and proportions of each subpopulation are in table 3 (see underneath). A visual comparison of the proportions is in figure 1 (see further below).

Income Adequacy	Low	Medium	High
X^2	2.779	0.178	0.480
df	1	1	1
p	0.096	0.673	0.489
$E_{ij}>5$, $E_{ij}\leq5$	3, 1	3, 1	3, 1

Min Eij	3.28	2.64	1.88

Table 2. Chi-squared test results for stroke proportions in married and unmarried men, separated by income adequacy (n = 3,340). The Chi-squared tests compared the observed stroke proportions between different marital statuses for each income adequacy level to the expected proportions. Each proportion was not statistically different, but each Chi-squared test had one cell with an expected value of less than five, so the conclusion may be invalid.

Income Adequacy		Unmarried	Married
Low	n total	100	509
	n stroke	6	14
	n no stroke	94	495
	p stroke	0.0600	0.0275
Medium	n total	168	1,296
	n stroke	2	21
	n no stroke	166	1,275
	p stroke	0.0119	0.01620
High	n total	170	1,097
	n stroke	1	13

	n no stroke	169	1,084
	p stroke	0.00588	0.01185

Table 3. Stroke and no-stroke frequencies and proportions table for unmarried and married individuals, separated by income adequacy (n = 3,340). Unmarried men with low income adequacy have higher stroke prevalence than married men; whereas in medium and high income adequacies, married men have higher stroke prevalence than unmarried men. However, none of these observed differences in proportions are statistically significant.

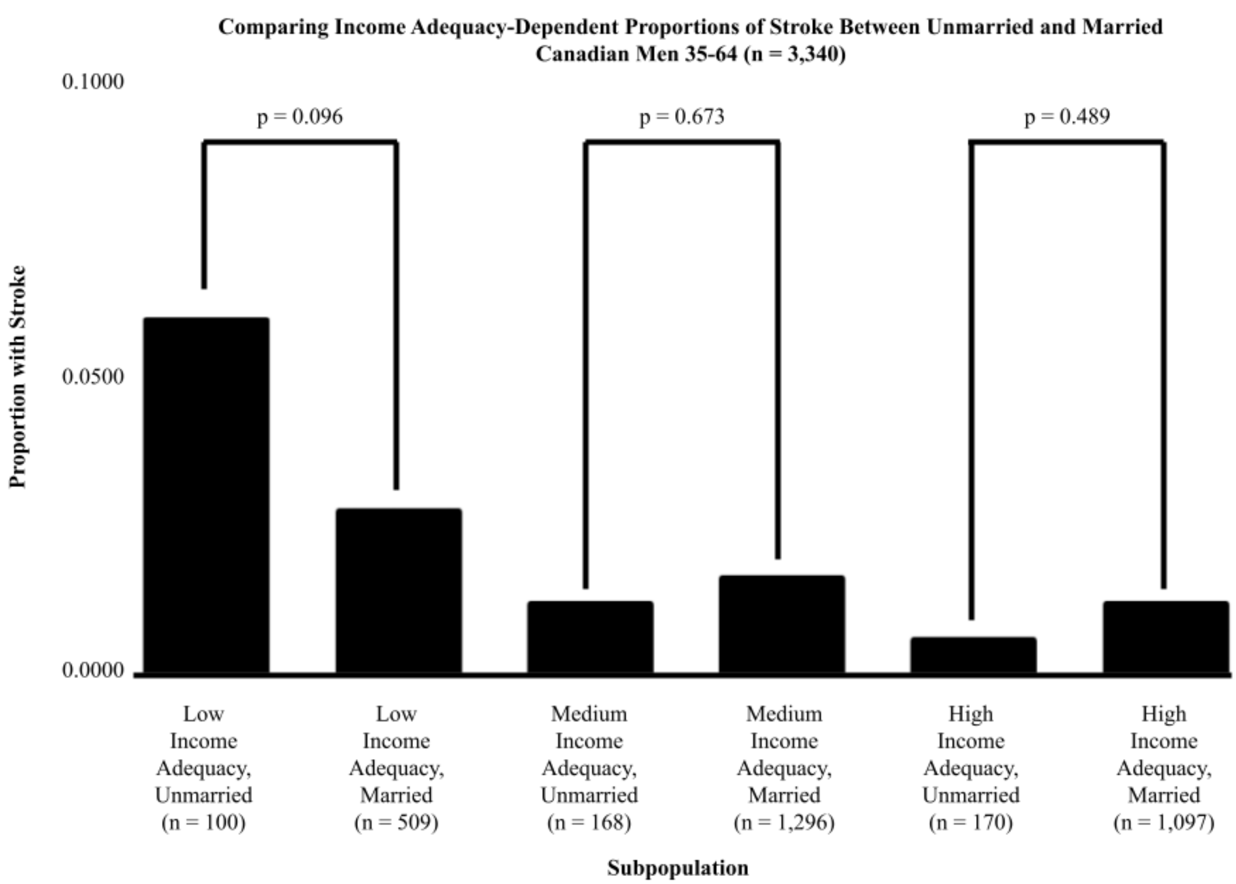

Figure 1. Visually comparing proportions of stroke between the study's subpopulations (n = 3,340). Chi-squared p values link each pair of proportions, between marital statuses, within an

income adequacy level. Unmarried men with low income adequacy have the highest prevalence of stroke, whereas unmarried men with high income adequacy have the lowest prevalence of stroke. While marital status within income adequacies has no statistically significant effect on stroke prevalence, the graph shows a possible trend of decreasing stroke prevalence with increased income which reflects the findings of Boysen et al. (1998).

The binary logistic regression analysis assumed that the baseline individual was an unmarried man with low income adequacy, and predicted that increasing income adequacy and/or marrying resulted in higher probabilities of stroke. The Wald tests indicated that income adequacy statistically significantly affects the model, whereas marital status does not; for an alpha of 0.05. The percent accuracy correct was 98.3. The B, Wald tests', and p values are in table 4 (see below). The classification table is in table 5 (see underneath).

Variable	B	Wald	p	exp(B)
Income Adequacy (Low)	N/A	10.935	0.004	N/A
Income Adequacy (Medium)	0.746	5.779	0.016	2.108
Income Adequacy (High)	1.106	9.862	0.002	3.023
Marriage	0.172	0.218	0.640	1.188

Table 4. Variables in the binary logistic regression model. All income adequacy-related variables in the model have a statistically significant effect on the model, whereas the marriage variable did not, for an alpha of 0.05. This model predicts that increasing income adequacy and/or marrying increases the individual's risk of stroke.

Observed Strokes	Predicted Strokes		
	Yes	No	Percentage Correct
Yes	0	57	0.0
No	0	3,283	100.0
Overall Percentage			98.3

Table 5. Binary logistic regression classification table. The predicted counts of individuals with and without stroke are compared to the observed counts of individuals with and without stroke to determine the model's percentage accuracy correct.

Discussion

The Chi-square statistical analyses indicate that the database, Canada Heart Health Database 1986-1992 (Statistics Canada, 1997), does not contain strong evidence that income adequacy disproportionately increases stroke prevalence in married Canadian men aged 35-64 inclusive compared to unmarried Canadian men aged 35-64 inclusive; given equal income adequacy, married men have a statistically equal chance of experiencing a stroke as an unmarried but otherwise-identical man. The proportion of unmarried men with low income adequacy who experienced strokes is higher than that of married men; whereas with medium and high income adequacies, married men have higher stroke prevalence than unmarried men. However, none of the differences in proportions is statistically significant, although the statistical conclusions may be invalid because not all of the statistical analysis' requirements were satisfied. This suggests that male marital status has no effect on stroke prevalence, which reflects the findings of Simons et al. (1998).

The binary logistic regression analysis indicates that database, *Canada Heart Health Database 1986-1992* (Statistics Canada, 1997), contains strong evidence that income adequacy disproportionately increases, but that marriage has no effect on, stroke prevalence Canadian men aged 35-64 inclusive compared; given equal income adequacy, married men have a statistically equal chance of experiencing a stroke as an unmarried but otherwise-identical man. All predicted B values were greater than zero, which predicts that increasing income adequacy and/or marrying results in higher probabilities of stroke. Income adequacy had a statistically significant effect on the model for all levels of income adequacy, but the addition of marital status had no significant effect. The statistically significant increase in stroke prevalence with higher income adequacy contradicts the findings of Boysen et al. (1998), while the statistical insignificance of marriage on male stroke prevalence confirms the findings of Simons et al. (1998). Because there were no female participants analysed, this study cannot confirm nor deny any relationship between female marital status and stroke prevalence.

Despite the results' general statistical insignificance, there may be clinically significant implications. As visually alluded to in figure 1, and statistically supported in table 4, income adequacy alone is able to explain the differences in stroke prevalence between the study participants. While the original hypothesis had no strong supporting evidence, this finding confirms those of Boysen et al. (1998) which suggests that it can be used to determine other comorbid factors of stroke, the results of which can be used to reduce stroke prevalence. As previously mentioned, reducing stroke incidents will reduce direct and indirect medical costs, and will allow the finite amount of medical attention and resources to focus on other medical incidents

This study had limitations which may have contributed to the results' statistical insignificance and affected their validity. The most prominent limitation is the data's age. The database was published in 1997, over 20 years ago. Advances in medical knowledge and changes in lifestyles may lead to a different dataset, which may lead to different results even with the exact same procedure. The most statistically influential limitation is the dataset's population distribution. An example of this is the total number of participants who had strokes - disregarding income adequacy and marital status - was 57 of 3,340, or ~1.7%. When accounting for income adequacy and marital status, the number of participants with stroke was up to 21, and the number of unmarried participants with stroke was up to 6 (see table 3). These low frequencies led to 2x2 Chi-square expected values of less than 5 for unmarried men with stroke of every income adequacy level, which reduces the Chi-square tests' results' validity; the Chi-square tests' conclusions may be incorrect, and there may actually be a different in stroke prevalence between married and unmarried men dependent on income adequacy, but it is hidden by the population being too small to make those differences statistically significant. The binary logistic regression also suffers from this, which can be seen in table 5. The model has a high percentage accuracy correct, but the model predicted that every individual does not experience stroke. Because such a high proportion of individuals do not experience strokes, this model appears to be very accurate when it may completely overlook factors which do contribute to stroke prevalence. A more-subtle limitation is the participant variables; such as their smoking, drinking, exercising, and dietary habits. While the database includes information regarding these participant variables, they may not have been surveyed to the desired level of detail, and multiple stroke-related behaviours and/or traits may be comorbid which may be the actual cause between differences in stroke prevalence (Liao et al., 2009). Additionally, including these variables in the analyses would have further lowered the subpopulations, and excessively complicated the statistical analyses.

All of the limitations could be remediated by creating a new database. The first limitation would be remediated by the new database's recency; the data would be from a more-modern population, so its hypothetical results would be more applicable to the current population. The second limitation could be remediated by sampling a larger number of participants to increase the subpopulations to, and well beyond, the Chi-square test's requirements for minimum expected frequencies of five. The binary logistic regression classification table would also have more participants; which would result in either the model predicting participants with stroke, or possibly having a larger proportion of incorrect predictions which would lower its percentage accuracy correct and better-reflect its ignorance of stroke-contributing factors. The third limitation could be partially remediated through creating a new database with information which better-suits the new study's analyses, and by having a longer time frame for the analyses to be planned out.

Despite the results' statistical insignificance, the possible clinical significance may justify followup studies in which this study's procedure is performed on a larger and more-recent database - which reduces limitations 1 and 2 - to more conclusively determine the presence or absence of any effects of income adequacy and marital status on stroke prevalence. Followup studies may also serve as an opportunity to collect other data regarding stroke-related behaviours and conditions to analyse other possible correlations between specific behaviours and/or conditions to determine if they have any statistically significant effect on stroke prevalence.

These findings can be used to design governmental and societal policies in order to decrease stroke prevalence, and its associated financial and physiological costs.

Unfortunately, this database does not suggest that income adequacy disproportionately affects stroke prevalence between married and unmarried Canadian men aged 35-64 inclusive. However, the clinical applications of this research may justify creating another database to perform more-conclusive analyses.

Author Disclosure Statements

All of the data used in the analyses were taken from Canada Heart Health Database 1986-1992 by Statistics Canada (1997). The analyses and conclusions drawn are my own, and do not reflect those of Statistics Canada.

References

Boehme, A. K., Esenwa, C., & Elkind, M. S. V. (2017). Stroke risk factors, genetics, and prevention. *Circulation Research, 120*(3), 472-593. https://doi.org/10.1161/CIRCRESAHA.116.308398

Boysen, G., Nyboe, J., Appleyard, M., Sørensen, P. S., Boas, J., Somnier, F., Jensen, G., & Schnohr, P. (1998). Stroke incidence and risk factors for stroke in Copenhagen, Denmark. *Stroke, 19*(11), 1345-1353. https://doi.org/10.1161/01.STR.19.11.1345

Goeree, R., Blackhouse, G., Petrovic, R., & Salama, S. (2005). Cost of stroke in Canada: A 1-year prospective study. *Journal of Medical Economics, 8*(1-4), 146-167. https://doi.org/10.3111/200508147167

Kamal, N., Lindsay, M., Côté, R., Fang, J., Kapral, M., & Hill, M. (2015). Ten-year trends in stroke admissions and outcomes in Canada. *Canadian Journal of Neurological Sciences, 42*(3), 168-175. https://doi.org/10.1017/cjn.2015.20

Katsiki, N., Ntaios, G., & Vemmos, K. (2011). Stroke, obesity, and gender: A review of the literature. *Maturitas, 69*(3), 239-243. https://doi.org/10.1016/j.maturitas.2011.04.010

Krueger, H., Koot, J., Hall, R. E., O'Callaghan, C., Bayley, M., & Corbett, D. (2015). Prevalence of individuals experiencing the effects of stroke in Canada. *Stroke, 46*(8), 2226-2231. https://doi.org/10.1161/STROKEAHA.115.009616

Kuruvilla, A., & Jacob, K. S. (2007). Poverty, social stress & mental health. *Indian Journal of Medical Research, 126*, 273-278

Liao, Y., Greenlund, K. J., Croft, J. B., Keenan, N. L., & Giles, W. H. (2009). Factors explaining excess stroke prevalence in the US stroke belt. *Stroke, 40*(10), 3336-3341. https://doi.org/10.1161/STROKEAHA.109.561688

Mozaffarian, D., Banjamin, E. J., Go, A. S., Arnett, D. K., Blaha, M. J., Cushma, M., de Ferranti, S., Després, J.-P., Fullerton, H. J., Howard, V. J., Huffman, M. D., Judd, S. E., Kissela, B. M., Lackland, D. T., Lichtman, J. H., Lisabeth, L. D., Liu, S., Mackey., R. H., Matchar, D. B., ... American Heart Association Statistics Committee and Strokes Statistics Subcommittee. (2015). Heart disease and stroke statistics--2015 update: A report from the American Heart Association. *Circulation, 131*(4), 29-322. https://doi.org/10.1161/CIR.0000000000000152

Mumtaz, F., Khan, M. I., Zubair, M., & Dehpour, A. R. (2018). Neurobiology and consequences of social isolation stress in animal model—A comprehensive review. Biomedicine & *Pharmacotherapy, 105*, 1205-1222. https://doi.org/10.1016/j.biopha.2018.05.086

Romani, G., Dal Mas, F., Massaro, M., Cobianchi, L., Modenese, M., Barcellini, A., Ricciardi, W., Barach, P., Lucà, R., & Ferrara, M. (2021). Population health strategies to support hospital and intensive care unit resiliency during the COVID-19 pandemic: The Italian experience. *Population Health Management, 24*(2), 174-181. https://doi.org/10.1089/pop.2020.0255

Simons, L. A., McCallum. J., Friedlander, Y., & Simons, J. (1998). Risk factors for ischemic stroke. *Stroke, 29*(7), 1341-1346. https://doi.org/10.1161/01.STR.29.7.1341

Statistics Canada. (1997). *Canada Heart Health Database 1986-1992*.

Synhaeve, N. E., Arntz, . M., Maaijwee, N. A. M., Rutten-Jacobs, L. C. A., Schoonderwaldt, H. C., Dorresteijn, L. D. A,. dr Kort, P. L. M., van Dijk, E. J., & de Leeuw, F.-E. (2014). Poor long-term functional outcome after stroke among adults aged 18 to 50 years. *Stroke, 45*(4), 115-1160. https://doi.org/10.1161/STROKEAHA.113.004411

Tong, X., Yang, Q., George, M. G., Gillespie, C., & Merritt, R. K. (2020). Trends of risk profile among middle-aged adults hospitalized for acute ischemic stroke in United States 2006–2017. *International Journal of Stroke, 16*(7), 1-8. https://doi.org/10.1177/1747493020979379

The Relationship Between Smoking E-cigarettes with Nicotine in the Last 30 Days and Disrupted Sleep Patterns of Canadian Female Students in Grades 7 to12

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December 13, 2021

Introduction:

Adequate sleep quality is crucial for a young student's physical health, mental health, as well as academic success. Adolescents require approximately 9.2 hours of undisturbed sleep to maintain a healthy sleep schedule (Wolfson et al., 2007). There are various factors that may disturb an individual's sleep pattern. This may be due to an unhealthy diet, genetics, or an overall unhealthy lifestyle. In recent years, there has been a rapid incline in the use of electronic cigarettes (e-cigarettes) as a source of nicotine, with a prevalence rate of 4% in North America (Zvolensky et al., 2019). With the onset of the recent electronic cigarette trend, more students have succumbed to partaking in this kind of smoking. This has proven to be very harmful to their health. Multiple studies found a link between smoking electronic cigarettes and inadequate sleep quality (Kianersi et al., 2020). The intake of nicotine results in delayed sleep via its impacts on the endocrine system; there is an increase in heart rate, blood pressure, and blood glucose levels (Wiener et al., 2020). In a research study conducted by Hirostu et al., the severe use of nicotine has been connected to the reduction of slow-wave and rapid eye movement (REM) sleep in individuals that do not smoke (Hirotsu et al., 2018). An alternate study conducted by Park et al. (2019) determined a p-value of lesser than 0.05, indicating that there is a statistical significance for the connection between the use of e-cigarettes and sleep deprivation. It is important to assess this association for the Canadian population.

There are various studies that investigate the relationship between e-cigarette use and disturbed sleep patterns, yet, these consequences have not been surveyed in female Canadian students in grades 7 to 12. It is important to analyze the data for the association of smoking and sleep patterns as there is limited knowledge for this specific Canadian population. As an example, a study conducted by Liao et al. (2019) demonstrates the difference in sleep patterns of smokers and nonsmokers of a general population in China. A multi-stage sampling method was used to obtain the study's participants, with the population's age ranging from 12 to 99 years old and an average age of 38 years old. Several alternative studies also explore this association, however, none target our particular demographic. Hence why it is important to assess this association for the young Canadian student population.

This study's research question is whether there is a relationship between smoking e-cigarettes containing nicotine in the last 30 days and the disruptive sleep patterns of Canadian females from grades 7 to 12. The goal of this study is to close the gaps in knowledge and present prophylactic efforts to schools so that they may implement them in their respective curriculums to control smoking in the preadolescent and adolescent populations. As a result, the aim of the study is also to ensure that the public is knowledgeable of these impacts and aid students to make healthy decisions. The hypothesis is that the frequent use of e-cigarettes will contaminate the sleep patterns of the participants. It is anticipated that the participants who use e-cigarettes will have a more challenging time going to sleep, which results in a decrease in focus related to academics. Variables such as province of residence and sort of community (urban or rural areas) are analyzed to search for any secondary associations to smoking habits.

Students who receive less than an adequate amount of sleep (an average of 9.2 hours) will see an influence on their academic performance, in fact, most perform poorly due to inadequate sleep (Tobore et al., 2019). This study aims to understand the impacts of smoking e-cigarettes on a young Canadian population and to provide a basis for further academic exploration.

Methods:

This study database titled, "Canadian Student Tobacco, Alcohol, and Drugs Survey (CSTADS), 2018-2019" involves looking at data from a population at one specific point in time, which means that the study design is cross-sectional. The database used in this paper was obtained from Ontario Data Documentation, Extraction Service and Infrastructure (ODESI). This web collection enables access to millions of various databases, questions, and aids in basic calculation analysis. Access to such datasets by university libraries and government collaboration aids researchers and students in advancing the knowledge. One of the key features of Odesi is that it allows an individual to download the dataset and its compatibility allows it to transfer directly into statistical software format, which makes it easier for the researchers to conduct analysis and interpret the results. The survey utilized in our study aided in learning about smoking patterns and discrepancies in sleeping patterns of the Canadian youth from grades 7 to 12. This dataset is known to be collected every two years since 2004. This large-scale survey collection was only possible due to coordinated efforts by the Propel Centre for Population Health Impact at the University of Waterloo and Health Canada.

This research paper includes Canadian youth females (n = 31066). As the database was shrunk, the inclusion criteria involves Canadian residents from grades 7-12, who are attending private, public and catholic schools. The exclusion criteria involve individuals going to schools of Yukon, Northwest Territories and Nunavut and students attending special schools (e.g. schools for visually impaired, schools for hearing-impaired, special needs, first nation reserve schools, virtual schools, military-based schools, international schools). Furthermore, to minimize the cost for data collection, individuals from schools who do not have a minimum of 20 students enrolled in at least one grade were also excluded. Moreover, male survey participants (n=31784) were excluded as well to focus on the research question.

In this research study, the primary outcome which is examined is the frequency of the participants struggling to fall asleep, based on the frequency of using an electronic cigarette containing nicotine. This measure was accomplished through a questionnaire that was divided into categories based on the following: Every day/night, several times, twice, once, never and not stated. Overall, when comparing those who smoke and their sleep irregularities, the most selected answer was found to be “daily” and “several”, with 4531 females and 7978 females respectively (Figure 3).

To evaluate the primary outcome of the study, this survey question was analyzed, since it reveals the possibility of a relationship between disturbed sleeping patterns alongside the smoking behaviour that participants may have. Based on the survey data, this question has clinical relevance as it allows the participants to accurately and systematically categorize their sleep patterns by picking between five different options. With the question giving a lot of clarity and insights, it also generates a question of whether any confounding variables (e.g. school stress or uneasy family environment) can play a role in varying sleep patterns among female students. Thus, more exploration and analysis are needed. Since the question asks female participants if they have had trouble falling asleep in the past two weeks instead of a general and vague question, it makes the survey question explanatory and can directly showcase the negative effects of smoking on sleep quality.

On the other hand, the secondary outcome that was measured involves participants being asked in the past two weeks, how often they struggled to stay awake while reading, studying and doing homework. While the most popular choice was "never", the second most popular selected option was "several times," with 9588 females and 7681 females respectively (Figure 2). This research paper selected this survey question to assess the secondary outcome, which describes how smoking status may influence how well a student focuses in class and how hard it is for the student to stay awake while studying. A question such as this has clinical implications since it allows us to analyze students' focus levels much accurately. Additionally, it gives enough clarity to assess focus in their study routine since academics play an integral part in a student's life. While there may be confounding variables (e.g. not a studious student, taking prescribed medications, has other important responsibilities) that influence this question, it can still be used to assess the secondary outcome since it can be related to the student's smoking behaviour and well-being.

To assess the results and answer the research question, statistical analyses such as Spearman Rho and Chi-Square tests were used, as well as a p-value of 0.05 was used as a cut-off for significance. The SPSS computer software was used to run the statistical tests. Any missing data for the primary variables were deleted (e-cigarette smoking, sleep, focus), for a clear understanding of the data and to provide more accurate results. Since the secondary variables (grade level, sex, province of residence, and participants' school region) did not have any missing data, none was deleted. The Spearman Rho test was used to determine the strength of the relationship of specific variables to the dependent variable. The relationships tested were gender v/s smoking, smoking v/s grade, gender v/s sleep, smoking v/s focus, grade v/s focus, sleep v/s focus, smoking v/s province, smoking v/s school region, grade v/s sleep, smoking v/s sleep. The Chi-Square test was used to view proportions of participants who fall into categories and then transfer the values to a table, text of results or create a figure for the manuscript. The variables tested were gender v/s smoking, smoking v/s grade, gender v/s sleep, smoking v/s focus, grade v/s focus, sleep v/s focus, smoking v/s province, smoking v/s school region, grade v/s sleep, and smoking v/s sleep. The Chi-square test was appropriate to use since there were nominal variables recorded in the dataset used, and it highlights the statistical significance.

We chose these tests because we wanted to explore the correlation between smoking and sleep patterns in female participants, but also examine secondary variables' relation to the participants' smoking behaviour. Furthermore, given that this study design was qualitative and in the form of a questionnaire with most of the data being categorical, most of the analysis could not have been run such as normality tests, Pearson correlation, ANCOVA, and logistic regression. Pearson correlation coefficient values were unable to be calculated as none of the variables are continuous.

Table I demonstrates the descriptive characteristics of Canadian female students from grades 7-12 who smoke e-cigarettes containing nicotine. Table I summarizes the data in such a way that allows us to view the relationships between certain variables. For instance, there are separate sections in the table, giving insights into the data about each variable. Excel was used to transfer data from SPSS software to generate tables and graphs to find significant relationships between variables of interest.

Results:

The final number of participants excluding the missing data and male data points was 31066 female individuals. In total, out of 62580 participants, 31784 total cases were deleted including 8224, being the total missing data points. Firstly, in terms of the focus variable (Frequency of inability to stay awake while reading, studying and doing homework in the last two weeks), 2902 missing data points were deleted. Secondly, for the sleep variable (Frequency of inability to fall asleep in the last two weeks), 3348 total data points were deleted. Lastly, for the smoking variable (Frequency of participant’s e-cigarette with nicotine use in the last 30 days), 1974 total data points were deleted.

Table I. Descriptive Characteristics of Canadian female students from grades 7-12 (n=31066) who smoke e-cigarettes with nicotine. Reported the frequencies and percentages corresponding to various characteristics. Data was obtained from a data portal known as Ontario Data Documentation, Extraction Service and Infrastructure (ODESI). The participants included those who are attending private, public and catholic schools in provinces across Canada (excluding Yukon, Northwest Territories and Nunavut).

Characteristics	Female (n=31066)
Grade	
7 8 9 10 11 12	6333(20.4) 6099 (19.6) 5661 18.2) 5481 (17.6) 4701 (15.1) 2790 (9.0)
Frequency of inability to stay awake while reading, studying and doing homework in the last two weeks	
Every day/night Several times Twice Once Never Not stated	2358 (7.6) 7953 (25.6) 4398 (14.2) 4620 (14.9) 10839 (34.9) 2902 (2.9)
Frequency of inability to fall asleep in the last two weeks	
Every day/night Several times Twice Once Never Not stated	4653 (15.0) 8166 (26.3) 5248 (16.9) 5092 (16.4) 6508 (20.9) 3348 (4.5)

Frequency of participant’s e-cigarette with nicotine use in the last 30 days	
Daily or almost daily Daily, but at least once a week Weekly, but at least once in the last 30 days Tried, but not in the last 30 days Never tried Not stated	1699 (5.5) 1411 (4.5) 2159 (6.9) 3435 (11.1) 21564 (69.4) 1974 (2.6)
Participant's school region	
Urban Rural	23820 (76.7) 7246 (23.3)
Province	
Newfoundland and labrador Prince Edward Island Nova Scotia New Brunswick Quebec Ontario Manitoba Saskatchewan Alberta British Columbia	2596 (8.4) 2443 (7.9) 3508 (11.3) 1740 (5.6) 7858 (25.3) 3152 (10.1) 1479 (4.8) 1888 (6.1) 3155 (10.2) 3247 (10.5)

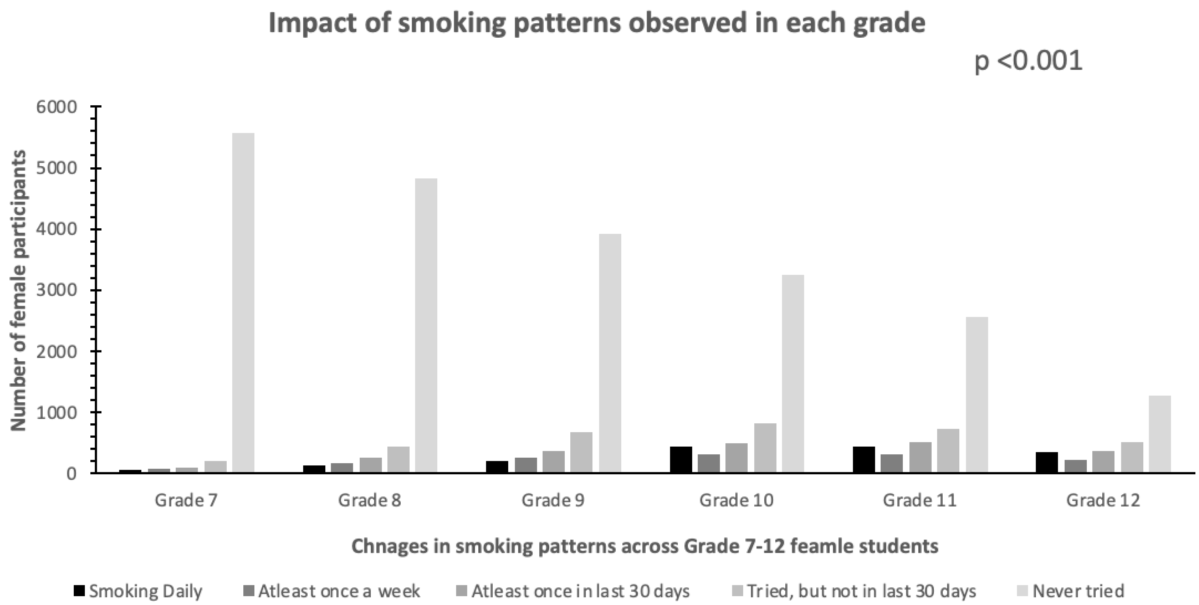

Figure 1. Clustered bar chart depicting the impact on smoking patterns observed in female youths by each grade (grade 7-12). A total of 5.47% (1647/30118) participants were observed to smoke daily in all grade levels. A total of 4.53% (1365/30118) participants were observed to smoke once a week in all grade levels combined. A total of 6.99% (2104/30118) participants were observed to smoke at least once in the last 30 days in all grade levels combined. Increased smoking patterns were experienced by grade 10 and grade 11 students when compared to other grade levels. For participants who never tried smoking, this pattern decreased showing that more students started smoking as grade levels went higher. The p-value is $p<0.001$ which was obtained by analyzing the data in SPSS software. This data was analyzed and generated on Microsoft Excel.

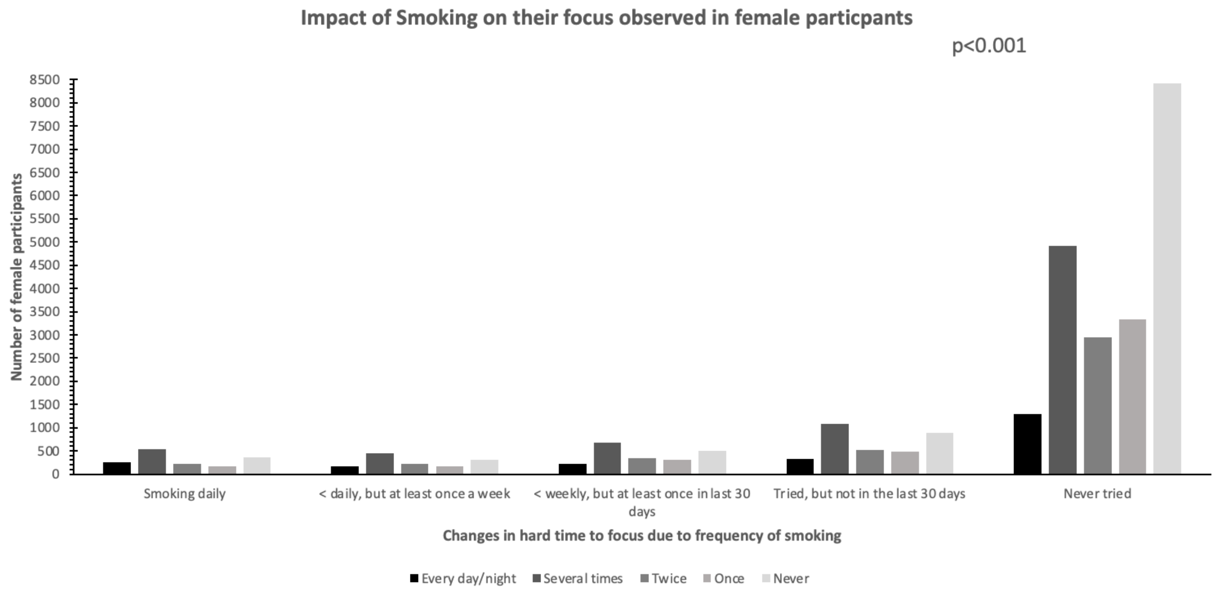

Figure 2. Clustered bar chart depicting the impact on focus by smoking in female participants. A total of 2.76% (806/29158) participants were observed to have a negative impact on their focus due to smoking daily. A total of 2.15% (628/29158) participants were observed to have a negative impact on their focus due to smoking once a week. A total of 4.85% (1413/29158) participants were observed to have a negative impact on their focus due to smoking once in 30 days. A total of 5.65% (1647/29158) participants were observed to have a negative impact on their focus due to trying to smoke before 30 days. The participants who smoked daily, once a week, once in 30 days, and tried to smoke, showed increasing patterns of impacted focus daily or several times. Overall, 21.26% (6199/29158) of female participants in Canada had issues in focus due to the effects of smoking. The p-value is p<0.001 which was obtained by analyzing the data in SPSS software. This data was analyzed and generated on Microsoft Excel.

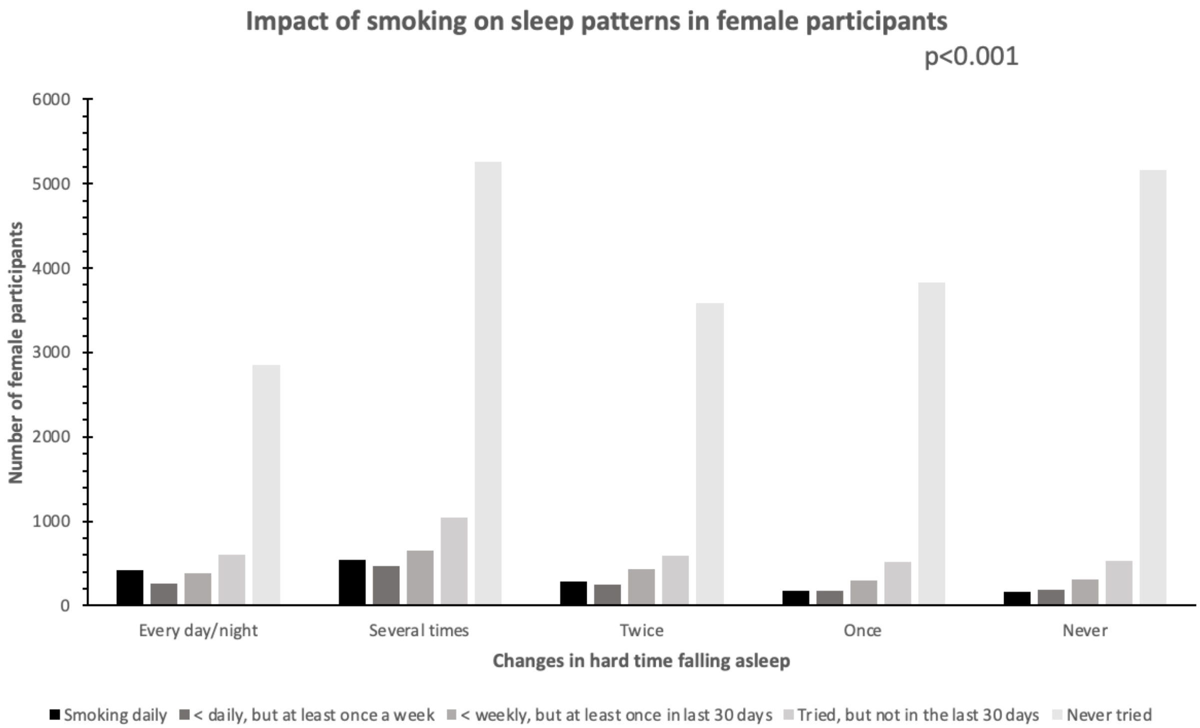

Figure 3. Clustered bar chart depicting the impact on sleep patterns by smoking. A total of 3.33% (967/29002) participants were observed to have disturbed sleep patterns due to smoking often. A total of 1.32% (383/29002) participants were observed to have disturbed sleep patterns due to smoking once in 30 days. A total of 2.09% (606/29002) participants were observed to have disturbed sleep patterns due to trying to smoke before 30 days. The participants who smoked daily, once a week, once in 30 days, and tried to smoke, showed an increase in trouble falling asleep daily or several times. Overall, 24.53% (7115/29002) of female participants in Canada had an irregularity in sleep patterns due to the effects of smoking. The p-value is $p<0.001$ which was obtained by analyzing the data in SPSS software. This data was analyzed and generated on Microsoft Excel.

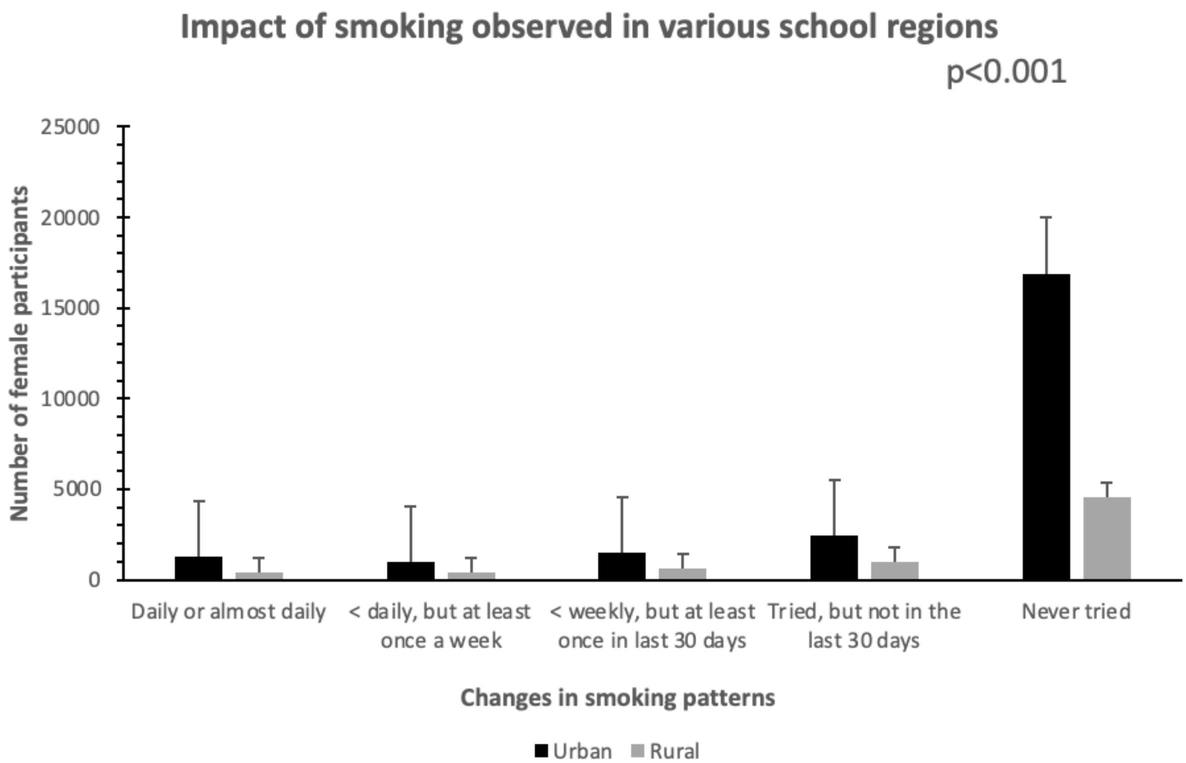

Figure 4. Bar Chart depicting the impact of smoking based on respondents from urban and rural areas. The graph portrays that there is a 38.9% increased number of female smokers who reside in urban areas when compared to rural areas. The p-value is $p<0.001$ which was obtained by analyzing the data in SPSS software. This data was analyzed and generated on Microsoft Excel.

Table II. Chi-Square and Spearman rho analysis was performed to analyze different primary and secondary variables. The relationships tested were gender v/s smoking, smoking v/s grade, gender v/s sleep, smoking v/s focus, grade v/s focus, sleep v/s focus, smoking v/s province, smoking v/s school region, grade v/s sleep, smoking v/s sleep. Spearman rho values are positive and negatively correlated. Values greater than 0.1 imply there is a relationship between the variables. A p-value less than 0.05 is statistically significant. This was obtained by analyzing the data in SPSS software and transferring it onto Microsoft Excel to create a table.

Variable	Chi square value	Spearman rho
Gender v/s smoke	<0.001	rho= -0.034 p-value <0.001
Smoke v/s grade	0.00	-0.350** p-value= 0.169
Gender v/s sleep	<0.001	0.176** p-value = 0.000
Smoke v/s focus	0.00	0.159** p-value = 0.000
Grade v/s focus	0.00	-0.331 p-value = 0.000
Sleep v/s focus	0.00	0.353** p-value = 0.000
Smoke v/s province	<0.001	0.004 p-value= 0.340
Smoke v/s school region	<0.001	0.073 p-value= <0.001
Grade v/s sleep	<0.001	-0.029 p-value= <0.001
Smoke v/s sleep	<0.001	-0.135 P-value = <0.001

Discussion:

The main findings from this paper supports the research question that smoking e-cigarette has a huge impact on sleep patterns in young females. The findings support the hypothesis. Conducting the Spearman rho and chi-square analysis revealed significant differences in variables, suggesting that there is a relationship between the variables. It is observed that there is an increased number of mainly grade 10 and 11 female students who smoke compared to other grade levels. Overall, 21.26% (6199/29158) of female participants in Canada had an irregularity in sleep patterns due to the effects of smoking. It is also seen that 21.26% of females attending school in Canada had issues in focus due to the effects of smoking. There is a 38.9% increased number of female smokers who reside in urban areas when compared to rural areas. Around 6119 female participants living in urban areas smoke, whereas only 2385 female participants in rural areas are found to smoke. Moreover, the number of female participants who smoke varies with the provinces across Canada. By looking at the survey data on SPSS, Quebec has the highest number of smokers, whereas New Brunswick has the lowest number of smokers.

Similar to this study, a cross-sectional study conducted by Boddu et al. (2019) determined that female smokers are more susceptible to sleep disturbances and have an increased risk of insomnia as a result of their nicotine intake. It was determined that women who consumed nicotine more frequently had higher PSQI (Pittsburgh Sleep Quality Index) scores, which indicate poor sleep quality. This aligns with the findings from figure 2, as an increased number of female participants who smoked e-cigarette daily or several times had issues with focusing and insomnia. According to the figure, around 75.1% of all the participants (6199/8254) who have smoked had a negative impact on their focusing ability and staying awake. In another study conducted by Kianersi et al. (2020), it was reported that out of the 19,701 participants who smoke and previously smoked e-cigarettes, respectively 47% and 35% of the participants self-reported sleep deprivation. This also aligns with our research findings from figure 3, as an increased number of female participants in grades 10 and 11 had irregular patterns in sleep due to smoking frequently. According to the figure, around 85.6% of all the participants (7115/8309) who have smoked resulted in poor sleep quality.

There are many limitations in the study which should be considered. Firstly, there were limitations in doing various statistical tests such as normality tests, Pearson correlation, ANCOVA, and logistic regression due to data not being continuous. This can hinder the study to provide improved evidence to support the research question. Secondly, the survey population was limited as many respondents (n=8824) did not answer the survey questions and 3 provinces were excluded from the original survey. This can lead to skewness, less accurate results, and not all results can be generalized. Thus, the sample may not have been sufficient to give significant outcomes. Thirdly, this study uses self-reported data through a survey done by Canadian female participants about their smoking habits, sleeping patterns, and focus ability, which can lead to participation bias. Moreover, the honesty of the reported data can be questioned.

The collected data and results can be affected due to many confounding variables which can contribute to changes in sleep patterns. According to figure 3, many respondents never got involved with smoking, but still experienced disturbed sleep patterns and had difficulty focusing on school work. This shows that there might be other factors other than smoking that can play a role in affecting sleep and focus. It was reported that around 60% of the students' sleep was impacted due to the frequent use of over-the-counter medication. Moreover, even caffeine has been shown to affect focus and sleep. The students' sleep was also affected due to environmental factors as their family members were involved in domestic violence and substance abuse. It's also stated that mental health illnesses have an association with adverse sleep patterns as well. Research has also found that the role of genes and distractions from electronic devices are also some sources of disturbances in sleep.

In terms of future implications and directions, youth accessibility to drugs such as nicotine should be limited. This will only happen when the government takes strict actions and collaborates with Canadian schools to educate and give access to various programs that can help youth quit smoking. In addition, smoking has been a global issue for many years, thus this research study will provide a foundation to further explore the relationship between the variables such as sleep, focus, and smoking. Moreover, future clinical studies can be performed in other countries to compare the data to see if the results are similar. This can explain how significant differences are there and give us a better understanding of the negative impacts e-cigarettes have on youth, especially females.

References

Ahrberg, K., Dresler, M., Niedermaier, S., Steiger, A., & Genzel, L. (2012). The interaction between sleep quality and academic performance. Journal of psychiatric research, 46(12), 1618-1622.

Hirotsu, C., Pedroni, M. N., Berro, L. F., Tufik, S., & Andersen, M. L. (2018). Nicotine and sleep deprivation: impact on pain sensitivity and immune modulation in rats. *Scientific reports*, *8*(1), 1-9.

Kianersi, S., Zhang, Y., Rosenberg, M., & Macy, J. T. (2021). Association between e-cigarette use and sleep deprivation in U.S. young adults: Results from the 2017 and 2018 behavioural risk factor surveillance system. *Addictive Behaviors*, *112*, 106646. https://doi.org/10.1016/j.addbeh.2020.106646

Liao, Y., Xie, L., Chen, X., Kelly, B. C., Qi, C., Pan, C., Yang, M., Hao, W., Liu, T., & Tang, J. (2019). Sleep quality in cigarette smokers and nonsmokers: findings from the general population in central China. BMC public health, 19(1), 808. https://doi.org/10.1186/s12889-019-6929-4

Boddu, S. A., Bojanowski, C. M., Lam, M. T., Advani, I. N., Scholten, E. L., Sun, X., ... & Alexander, L. E. C. (2019). Use of Electronic Cigarettes with conventional tobacco is associated with decreased sleep quality in women. American journal of respiratory and critical care medicine, 200(11), 1431-1434.

Park, E., Kwon, M., Gaughan, M. R., Livingston, J. A., & Chang, Y.-P. (2019). Listening to adolescents: Their perceptions and information sources about e-cigarettes. *Journal of Pediatric Nursing*, *48*, 82–91. https://doi.org/10.1016/j.pedn.2019.07.010

Tobore, T. O. (2019). On the potential harmful effects of E-Cigarettes (EC) on the developing brain: The relationship between vaping-induced oxidative stress and adolescent/young adults social maladjustment. Journal of adolescence, 76, 202-209.

Wiener, R. C., Waters, C., Bhandari, R., Trickett Shockey, A. K., & Alshaarawy, O. (2020). The association of sleep duration and the use of electronic cigarettes, NHANES, 2015-2016. *Sleep Disorders*, *2020*, 1–12. https://doi.org/10.1155/2020/8010923

Zvolensky, M. J., D'Souza, J., Garey, L., Alfano, C. A., Mayorga, N. A., Peraza, N., & Gallagher, M. W. (2020). Subjective sleep quality and electronic cigarette dependence, perceived risks of use, and perceptions about quitting electronic cigarettes. *Addictive behaviors*, *102*, 106199.

Investigating the Effect of Education on Cardiovascular Health in Canadian Males using Indicators for Cardiovascular Disease: A Cross-Sectional Study

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December 14, 2021

Introduction

Most of the recent literature suggests that education has an inverse correlation with the development of cardiovascular disease (CVD) in a general population (Dégano et al., 2017). While some studies have found that body mass index (BMI) and blood pressure are factors associated with both education and CVD, these studies have been unable to draw links between CVD and levels of education while accounting for the effects of frailty in a population (Dégano et al., 2017). Papers in this field have tended to generalize populations, sampling ages from 35 - 74 which may not be the most appropriate because frailty increases with age and susceptibility of CVD increase with frailty (Vitale et al., 2018). Other studies have shown that men seem to be more susceptible than women to CVD development (Bots et al., 2017). The knowledge gap that arises when frailty is not accounted for can be overcome by limiting the participant groups to young adults.

Blood pressure (BP) consists of two readings, the systolic and diastolic BP. Systolic BP measures the maximum pressure of the left ventricle wall of the heart during contraction (Information et al., 2019). Diastolic BP measures the force exerted on the cardiac walls during relaxation (Information et al., 2019). Education is inversely related to the development of CVD as well as BP (Dyer et al., 1976).

As mentioned earlier, BP generally increases with age. However, while systolic blood pressure increases progressively with age until 80, diastolic BP increases gradually up to about age 55, then decreases. Systolic BP is a superior predictor of the risk of cardiovascular disease compared to diastolic BP because systolic BP has become the leading cause of hypertension (Izzo et al., 2000). In a multifactor interventions program on coronary disease mortality called “Multiple Risk Factor Intervention Trial (MRFIT)”, it was found that populations with high systolic BP coupled with low diastolic BP had the worst prognosis (Neaton & Wentworth, 1992). A longitudinal follow-up study in France showed that men with increased systolic BP along with decreased diastolic BP had the greatest mortality rate (Benetos et al., 2000). These studies highlight the importance of considering the combined effect of systolic and diastolic BP on the risk of developing CVD.

In a much older study, in which the participants had levels of education ranging from high school to a graduate degree, it was found that mean systolic and diastolic BP decreases with increasing education (Dyer et al., 1976). An additional study found significantly lower systolic and diastolic BP readings in those with a graduate degree compared to those with a high school degree (Liu et al., 2011). This study also noted that the participants had a lower BMI and smoked fewer cigarettes per day.

BMI [kg/m^2] is a general indicator of overall obesity (Benson et al., 2018). In a representative US cohort study from age 14-22 in 1979 through age 47-55 in 2012, images as early as 18, differences in BMI scores can already be observed throughout different educational groups, such as less than high school diploma, high school diploma, and bachelor's degree (Benson et al., 2018). However, this study noted that education only predicted slight (10-30%) changes in BMI in women. It is also worth noting that this study was longitudinal and subject to the Hawthorne effect, which is an observer effect that alters participants' behaviours (Chen et al., 2015).

Another study looked at BMI and waist circumference (WC), which is a measure of central adiposity. This European cohort found an inverse association between higher BMI as well as higher WC and lower education level (Hermann et al., 2011). Both of these studies found that the association between education and BMI was stronger for women as the differences in BMI between the highest and lowest education groups were greater in women than in men. This study was also longitudinal and thus, subject to the Hawthorne effect that alters participants' behaviours, creating another gap in knowledge (Chen et al., 2015).

Having a higher than average BMI is a strong indicator of obesity, constituting an independent CVD risk factor (Akil & Ahmad, 2011). Individuals who are overweight, specifically with central deposition of adipose tissues, have been found to have an increased rate of CVD mortality and morbidity (Akil & Ahmad, 2011). After examining the associations between BMI and CVD, a positive relationship was found between CVD mortality and BMI. This evidence suggests that the likelihood of CVD increases with having a higher BMI score in the range of obesity.

With all of this research discovering these various relationships, my research question became the following: Is there a relationship between the attainment of a university degree in young Canadian adult males aged 25-34 and prevalent indicators for CVD compared to risk factors for prevalent CVD in young Canadian adult males aged 25-34 with a high school diploma?

Methods

This study used a database from the Social Science Data Centre at Queen's University. It was a cross-sectional study that took place from 1988-1989. The rationale for this database was to estimate CVD risk factors at the provincial level, provide insight as to participants' awareness about CVD causes, determine awareness about CBD consequences and risk factors, including lifestyle factors. All units of analysis were at the individual level. Previous literature implies that this database is a sufficient representation of the Canadian population and reliable for producing public health policies concerning cardiovascular health (CH) (Langille et al., 1999).

This database was designed by the Canadian Heart Health Database Centre (CHHD) at Memorial University of Newfoundland (MU). The design had inclusion criteria requiring the participants to be individuals aged 18-74 and Canadian citizens. The exclusion criteria justified by operational concerns excluded those who are full-time residents on military camps, Indian reserves, or in institutions.

Data collection took place in all 10 Canadian provinces. Sampling frames were established using health insurance agencies (Langille et al., 1999). Data collection consisted of primarily clinical visits and personal interviews. The initial stages of data collection aimed to collect demographic data, CVD risk factors, and data related to opinions of CH. Within these initial states, public health nurses were employed to visit the respondents at the dwellings. Additionally, participants were instructed to fast for a minimum of 8 hours before their first clinical visit.

Study participants in this survey included individuals that were surveyed from all ten provinces of Canada. Since our research aimed to limit the age range to young adults. I intentionally included people between the ages of 25 and 34. My data was comparing the BMI and prevalence of CVD indicators of individuals who had a high school education to those with a university education. Given these parameters, I made sure to only include those with an education level equivalent to University or Secondary education. My data was also looking at the BMI and prevalence of CVD indicators among males, so only those that identified as males were included. Any cases that did not meet the above criteria were not selected for and thus, deleted.

The primary outcome that is investigated in my research is observing the prevalence of CVD indicators. The level of education was measured as either secondary school completion or university degree and was obtained through surveying the participants. Additional outcomes of the study include the average systolic and diastolic blood pressure as well as BMI as both are associated with cardiovascular health. Sys/diastolic blood pressure, as well as BMI, were recorded as a numeric integer. In addition, descriptive variables such as participants' history of heart attacks were recorded categorically as “yes”, “no”, “not sure” and “not stated”. Information on the number of cigarettes smoked per day was also recorded. These outcomes were selected for this study as they are risk factors of cardiovascular health and disease.

In my database, I have included an additional three variables that serve as descriptive statistics which are important to control for in our population. This will limit confounding factors that will skew my results. The first additional variable is the age of the participants. This is very important to control for because, as mentioned earlier, systolic and diastolic BP increase with age. Therefore age must be controlled within a specific age group with an average blood pressure relative to everyone in that age group because both BPs are used as indicators for risk of CVD. The remaining two were included to provide insight into the correlation (or lack thereof) in my analysis. Looking at the number of cigarettes smoked per day and whether or not an individual heart disease was due to smoking allows for more insight on other potential reasons for a correlation (or lack thereof) observed. Because it is very unlikely that my R-value will be 1 (and my r^2 value less than 1 by default), this will assist in understanding other factors that indicate CVD.

The dataset was adjusted before it was used in this study. All tests were performed using SPSS version 28.0.0.0 (190). I then used the different variables to narrow down the database to those that fit my inclusion criteria. The EDUC variable for grouped education was used to select only those that had either “SECONDARY COMP” or “UNIVERSITY DEG”. The GPAGE2 variable was used to select only those who were 25-34 years of age. The SEX variable was used to select only those who were males. Missing cases, similar to all adjustments involving the deletion of data, were performed by using the select cases feature in SPSS with the "delete unselected cases" function under data and select cases. Missing data were deleted through a sort by ascending approach and a select by case approach. The ascending approach had data sorted by ascending and entries with "99999", "997", "998", "999", "7", or "9" were deleted using the select cases function. Select cases in these circumstances would make use of the "If" condition under "select cases" and specify an upper limit to the data within a certain variable i.e. BMI ≤ 998. After adjusting the database to align with the research question, the total sample size decreased to 2,828 which is approximately a 88% decrease in total data. Normality tests were performed for the relevant continuous variables and included in Table 1.

SPSS was used to perform the chi-squared test. A chi-squared test was used to observe the difference in proportion between university and high school educated groups in the cause of heart disease. The difference in education [EDUC] and cause of heart disease were examined for being overweight, excess fats, high blood cholesterol, smoking, high BP, arteriosclerosis, and stress/worry, and whether or not the participant has a history of a heart attack. [EDUC] was also computed with the cigarettes smoked per day [CIG_DAY]. The [CIG_DAY] variable was transformed into ordinal data from continuous data using the binning function in SPSS. There was one cutpoint, and the width was auto-calculated to be 50. The cutpoint was 0, as in 0 cigarettes smoked per day. Labels were assigned to each of the 2 groups with "No" representing 0 cigarettes smoked per day (CIG_DAY = 0), and "Yes" represented CIG_DAY > 0. This allows the proportions in the education level to be compared with the proportions of smokers versus non-smokers.

SPSS was also used to perform an Independent Samples T-test. The t-test was used to compare the means between two normally distributed groups, university education versus secondary school education on systolic BP, diastolic BP, and BMI.

Results

Table 1: Descriptive characteristics of Canadian Heart Health Database Centre study population [N=23,129].

Variable	Units of Measure	Normal or not Normal?	Shapiro-Wilk Significance Value	Central Tendency Mean (SD)
AGE	[years]	Normal	0.984[a, b]	40.78 (16.951)
HDART: Heart attack due to arteriosclerosis	[mentioned or not mentioned]	Not Normal (Categorical)	N/A	N/A
MSYS: Average Systolic Blood Pressure Value	[mmHg]	Normal	0.580[a, b]	123.87 (17.143)
MDIAS: Average Diastolic Blood Pressure Value	[mmHg]	Normal	0.447[a, b]	76.531 (9.734)
BMI: Body Mass Index	[kg/m^2]	Normal	0.565[a, b]	25.684 (4.673)
EVERHA: Ever had a heart attack?	[yes or no]	Not Normal (Categorical)	N/A	N/A
CIG_DAY: Number of cigarettes smoked per day (Binned)	[number of cigarettes]	Normal	0.802[a, b]	5.58 (10.142)

[a]*Data for this variable follows a normal distribution.* [b]*Mean (SD) are reported.*

Table 2.a. Chi-Square analysis output comparing proportions between Grouped Education and various Cardiovascular Disease Indicators.

		Condition				
Question	Group	Secondary Completed (N=2004)	University Degree (N=824)	Total	Chi-Square Value	P-value
[HDWGT] Cause of Heart Disease: Overweight	Mentioned	780	311	1091	0.295	0.581
	Not mentioned	1224	513	1737		
[HDFATS] Cause of Heart Disease: Excess fats	Mentioned	366	168	534	1.585	0.204
	Not mentioned	1638	656	2294		
[HDCHOLBD] Cause of Heart Disease: High Blood Cholesterol	Mentioned	686	294	980	0.479	0.46
	Not mentioned	1318	530	1848		
[HDSMOKE] Cause of Heart Disease: Smoking	Mentioned	1162	492	1654	0.646	0.401
	Not mentioned	842	332	1174		
[HDHBP] Cause of Heart Disease: High Blood Pressure	Mentioned	519	213	732	0	1
	Not mentioned	1485	611	2096		
[HDART] Cause of Heart Disease: Arteriosclerosis	Mentioned	138	93	231	14.491	<0.001*
	Not mentioned	1866	731	2597		

[HDSTRESS] Cause of Heart Disease: Stress/Worry	Mentioned	794	366	1160	5.357	0.021*
	Not mentioned	1210	458	1668		

Table 2.b. Chi-Square analysis output comparing proportions between Grouped education and Participant heart attack History.

		Condition				
Question	Group	Secondary Completed (N=1996)	University Degree (N=823)	Total	Chi-Square Value	P-value
Have you ever had a Heart Attack?	Yes	7	5	12	0.402	0.349
	No	1989	818	2807		

Table 2.c. Chi-Square analysis output comparing proportions between Grouped Education and Daily versus non-Daily Smokers.

		Condition				
Question	Group	Secondary Completed (N=1980)	University Degree (N=802)	Total	Chi-Square Value	P-value
Do you Smoke Cigarettes Daily?	Yes	1324	680	2004	90.096	<0.001*
	No	656	122	778		

Table 3.a. T-test output comparing the means between Grouped Education and Blood Pressure.

		Condition			
		Secondary Completed (N=2000)	University Degree (N=821)	T-test Value	P-value
[MSYS] Average Systolic Blood Pressure Value	Mean	122.961	121.798	0.06	0.008*
	Std. Deviation	10.596	10.595		
[MDIAS] Average Diastolic Blood Pressure Value	Mean	77.784	77.557	2.441	0.517
	Std. Deviation	8.584	8.018		

Table 3.b. T-test output comparing the means between Grouped Education and BMI.

		Condition			
		Secondary Completed (N=1729)	University Degree (N=711)	T-test Value	P-value
[BMI] Body Mass Index	Mean	25.694	25.156	3.361	<0.001*
	Std. Deviation	3.668	3.474		

The chi-square tests show that there is a statistically significant difference between the proportion of individuals who are smokers and individuals who are not smokers. Based on Table 2.a-c, the chi-square value ($X^2 = 90.096$) has a corresponding p-value of <0.001. Therefore, the conclusion becomes there is a significant difference between the proportions of high school versus university graduates when compared to smoking status and the null hypothesis which states that there is no significance, is rejected. It was also found that there was also a significant difference in the proportions between secondary versus university education levels for the cause of heart disease due to arteriosclerosis ($X^2 = 14.491$, $p < 0.001$), and the cause of heart disease due to stress or worry ($X^2 = 5.357$, $p <0.001$).

From the independent samples t-test, it can be concluded that there is a statistically significant difference between the means of the groups' BMI. The t-test has a T-value of 3.361 with a p-value of <0.001. This means that the null hypothesis can be rejected and the conclusion is that there is a significant difference between the means of secondary and higher education graduates when comparing BMI. It was also found that there was a significant difference in the means between secondary and university education levels for average systolic blood pressure (T-value = 0.060, p = 0.004).

Discussion

Main Findings

The variables [HDWGT], [HDFATS], [HDCHOLDBD], [HDSMOKE], [HDHBP], [HDART], [HDSTRESS], [EVERHA], and binned [CIG_DAY], were all selected for a chi-square analysis to determine whether or not there were between-group differences for each variable. Cholesterol in the blood can induce arteriosclerosis (Zhao et al., 2018), and increased intake of dietary fats may lead to obesity (Hohos & Skaznik-Wikiel, 2017). The previous studies both show that obesity and arteriosclerosis are prevalent indicators of CVD. As mentioned earlier, high BP is an indicator of CVD (Wu et al., 2015). Current studies have found a significant correlation between smoking cigarettes and heart failure in individuals over the age of 18 (Lee & Son, 2019). Previous studies have suggested that psydhosocial stress can indirectly be associated with CVD by contributing to the development of other factors, like obesity (Dar et al., 2019). Knowing the participant's heart attack history was also important because studies have found that those with lower education have a greater predisposition to adverse outcomes related to CVD (Kelli et al., 2019). The goal was to examine the differences in proportions of high school and university-educated groups in terms of causes of heart disease. For a Chi-square test, a p-value of less than 0.05 indicates that the differences in proportions are statistically significant. There was no significant difference in proportions between university and secondary school educated groups and the cause of heart disease (CHD) due to the participant being overweight($X^2 = 0.295$, $p = 0.581$), high blood cholesterol ($X^2 = 0.479$, $p = 0.460$), smoking ($X^2 = 0.646$, $p = 0.401$), high blood pressure ($X^2 = 0$, $p = 1.0$), or heart attack history ($X^2 = 0.402$, $p = 0.349$). There was a significant difference found in proportion between the university and secondary school educated groups and CHD due to arteriosclerosis ($X^2 = 14.491$, $p <0.001$), stress/worry ($X^2 = 5.357$, $p = 0.021$), and daily smokers versus non-smokers ($X^2 = 90.096$, $p <0.001$).

The independent samples T-test was performed to assess any statistical difference between the means of high school education and university education in MSYS, MDIAS, and BMI. Similar to the chi-square test a p-value of less than 0.05 indicates that the differences in means are statistically significant. The tests revealed that MSYS and BMI are statistically significant. The T-value for MSYS is 0.060 with a p-value of 0.004, and the T-value of BMI is 3.361 with a p-value of <0.001. This is evidence that there is a statistical difference in the average systolic BP and average BMI between high school and university graduates. This shows that the average university graduate has a lower BP than the average high school graduate.

Comparing these findings to other research

The results from the chi-square test suggest that the number of cigarettes smoked per day between the proportions of high school and university graduates may be attributed to education.

This is consistent with the findings by Gilman and colleagues where lower education was associated with increased smoking. This may be because while education may not have a direct impact on CVD risk, it can influence lifestyle choices which can heavily influence CVD risk (Finger et al., 2013).

The results from the independent samples T-test show that there is a statistically significant difference in the means of systolic BP and BMI between high school and university graduates. This is consistent with the results reported by Cohen and colleagues where they found that BMI is inversely related to educational attainment. This may be due to greater educated individuals being more likely to make more informed decisions about their diet (Finger et al., 2013).

Limitations

Like all studies, this one is not without its limitations. First, the variable EDUC, which was used for education level, is not very specific. For the study, I only used "SECONDARY COMP" or "UNIVERSITY DEG". Despite the fact that the database has the variable "SOME SECONDARY", there is no variable for "some university". This means that if an individual was in the process of completing their bachelor's degree, they would be put in the high school education category despite their most recent education being university level. The age group was set to 25-34 in an attempt to account for this since the average age of completing an undergraduate degree in Canada is 25 (Statistics Canada, 2019). However, this continues to remain a limitation because it does not account for individuals currently pursuing undergraduate studies. Having a separate section called "some university" would allow for more individuals to be grouped in the higher education group and more participants to be included in the study overall, thus increasing the study validity.

Another limitation of this study is the fact that the database used was from a study done approximately 33 years ago. Nation-wide surveys like these often reflect the trends of the time it was taken. Given that the late 1980s were a much different time from the early 2020s, and the various trends in obesity and education have changed, finding a newer more updated database would help solve this limitation.

This study was also limited by the method the database used to collect results, many of these results were taken through a survey (except variables such as BMI and BP), meaning it relies on the participant giving accurate information. While there is no reason to assume that participants would lie, an individual's opinion on their health may be different from the actual circumstances. A solution to this would be to have a more updated database that includes more clinical tests to receive a more medically accurate assessment of an individual's cardiovascular health.

Future Directions and Implications

This study has shed light on how there is a relationship between education and health and how differences in education may lead to an increased risk of CVD. This topic is important as obesity rates rise in Canada (Statistics Canada, 2018). Further education may give individuals the opportunity to live a healthier lifestyle as it will allow them to make healthier choices regarding diet. This study's findings may prove to be helpful in reviewing high school curriculums to encourage healthy lifestyle choices from an earlier age to prevent individuals from the risk of devloping risk factors for CVD, in the event that they choose not to pursue a higher education. The correlation between prevalent indicators of CVD and education shows potential for promising future research into rising obesity rates despite higher graduation rates.

References

Akil, L., & Ahmad, H. A. (2011). Relationships between Obesity and Cardiovascular Diseases in Four Southern States and Colorado. *Journal of Health Care for the Poor and Underserved*, *22*(4 Suppl), 61–72. https://doi.org/10.1353/hpu.2011.0166

Benetos, A., Zureik, M., Morcet, J., Thomas, F., Bean, K., Safar, M., Ducimetière, P., & Guize, L. (2000). A decrease in diastolic blood pressure combined with an increase in systolic blood pressure is associated with a higher cardiovascular mortality in men. *Journal of the American College of Cardiology*, *35*(3), 673–680. https://doi.org/10.1016/s0735-1097(99)00586-0

Benson, R., von Hippel, P. T., & Lynch, J. L. (2018). Does more education cause lower BMI, or do lower-BMI individuals become more educated? Evidence from the National Longitudinal Survey of Youth 1979. *Social Science & Medicine*, *211*, 370–377. https://doi.org/10.1016/j.socscimed.2017.03.042

Bots, S. H., Peters, S. A. E., & Woodward, M. (2017). Sex differences in coronary heart disease and stroke mortality: A global assessment of the effect of ageing between 1980 and 2010. *BMJ Global Health*, *2*(2), e000298. https://doi.org/10.1136/bmjgh-2017-000298

Canadian Heart Health Database Centre. 1997. Canadian Heart Health Database [public use microdata file]. St. John's, Newfoundland: Memorial University: Canadian Heart Health Database Centre [producer and distributor].

Chen, L. F., Vander Weg, M. W., Hofmann, D. A., & Reisinger, H. S. (2015). The Hawthorne Effect in Infection Prevention and Epidemiology. *Infection Control and Hospital Epidemiology*, *36*(12), 1444–1450. https://doi.org/10.1017/ice.2015.216

Cohen, A. K., Rai, M., Rehkopf, D. H., & Abrams, B. (2013). Educational attainment and obesity: A systematic review. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, *14*(12), 989–1005. https://doi.org/10.1111/obr.12062

Dar, T., Radfar, A., Abohashem, S., Pitman, R. K., Tawakol, A., & Osborne, M. T. (2019). Psychosocial Stress and Cardiovascular Disease. *Current Treatment Options in Cardiovascular Medicine*, *21*(5), 23. https://doi.org/10.1007/s11936-019-0724-5

Dégano, I. R., Marrugat, J., Grau, M., Salvador-González, B., Ramos, R., Zamora, A., Martí, R., & Elosua, R. (2017). The association between education and cardiovascular disease incidence is mediated by hypertension, diabetes, and body mass index. *Scientific Reports*, *7*(1), 12370. https://doi.org/10.1038/s41598-017-10775-3

Dyer, A. R., Stamler, J., Shekelle, R. B., & Schoenberger, J. (1976). The relationship of education to blood pressure: Findings on 40,000 employed Chicagoans. *Circulation*, *54*(6), 987–992. https://doi.org/10.1161/01.CIR.54.6.987

Finger, J. D., Tylleskär, T., Lampert, T., & Mensink, G. B. M. (2013). Dietary Behaviour and Socioeconomic Position: The Role of Physical Activity Patterns. *PLOS ONE*, *8*(11), e78390. https://doi.org/10.1371/journal.pone.0078390

Gilman, S. E., Martin, L. T., Abrams, D. B., Kawachi, I., Kubzansky, L., Loucks, E. B., Rende, R., Rudd, R., & Buka, S. L. (2008). Educational attainment and cigarette smoking: A causal association? *International Journal of Epidemiology*, *37*(3), 615–624. https://doi.org/10.1093/ije/dym250

Hermann, S., Rohrmann, S., Linseisen, J., May, A. M., Kunst, A., Besson, H., Romaguera, D., Travier, N., Tormo, M.-J., Molina, E., Dorronsoro, M., Barricarte, A., Rodríguez, L., Crowe, F. L., Khaw, K.-T., Wareham, N. J., van Boeckel, P. G., Bueno-de-Mesquita, H. B., Overvad, K., … Peeters, P. H. (2011). The association of education with body mass index and waist circumference in the EPIC-PANACEA study. *BMC Public Health*, *11*(1), 169. https://doi.org/10.1186/1471-2458-11-169

Hohos, N. M., & Skaznik-Wikiel, M. E. (2017). High-Fat Diet and Female Fertility. *Endocrinology*, *158*(8), 2407–2419. https://doi.org/10.1210/en.2017-00371

Information, N. C. for B., Pike, U. S. N. L. of M. 8600 R., MD, B., & Usa, 20894. (2019). What is blood pressure and how is it measured? In *InformedHealth.org [Internet]*. Institute for Quality and Efficiency in Health Care (IQWiG). https://www.ncbi.nlm.nih.gov/books/NBK279251/

Izzo, J. L., Levy, D., & Black, H. R. (2000). Importance of Systolic Blood Pressure in Older Americans. *Hypertension*, *35*(5), 1021–1024. https://doi.org/10.1161/01.HYP.35.5.1021

Kelli, H. M., Kim, J. H., Samman Tahhan, A., Liu, C., Ko, Y.-A., Hammadah, M., Sullivan, S., Sandesara, P., Alkhoder, A. A., Choudhary, F. K., Gafeer, M. M., Patel, K., Qadir, S., Lewis, T. T., Vaccarino, V., Sperling, L. S., & Quyyumi, A. A. (2019). Living in Food Deserts and Adverse Cardiovascular Outcomes in Patients With Cardiovascular Disease. *Journal of the American Heart Association*, *8*(4), e010694. https://doi.org/10.1161/JAHA.118.010694

Kirkland, S. A., MacLean, D. R., Langille, D. B., Joffres, M. R., MacPherson, K. M., & Andreou, P. (1999). Knowledge and awareness of risk factors for cardiovascular disease among Canadians 55 to 74 years of age: Results from the Canadian Heart Health Surveys, 1986-1992. *CMAJ: Canadian Medical Association Journal = Journal de l'Association Medicale Canadienne*, *161*(8 Suppl), S10-16.

Lee, H., & Son, Y.-J. (2019). Influence of Smoking Status on Risk of Incident Heart Failure: A Systematic Review and Meta-Analysis of Prospective Cohort Studies. *International Journal of Environmental Research and Public Health*, *16*(15), E2697. https://doi.org/10.3390/ijerph16152697

Liu, S. Y., Buka, S. L., Linkletter, C. D., Kawachi, I., Kubzansky, L., & Loucks, E. B. (2011). The association between blood pressure and years of schooling versus educational credentials: Test of the sheepskin effect. *Annals of Epidemiology*, *21*(2), 128–138. https://doi.org/10.1016/j.annepidem.2010.11.004

Neaton, J. D., & Wentworth, D. (1992). Serum cholesterol, blood pressure, cigarette smoking, and death from coronary heart disease. Overall findings and differences by age for 316,099 white men. Multiple Risk Factor Intervention Trial Research Group. *Archives of Internal Medicine*, *152*(1), 56–64.

O'Neill, M., Kornas, K., & Rosella, L. (2019). The future burden of obesity in Canada: A modelling study. *Canadian Journal of Public Health = Revue Canadienne de Santé Publique*, *110*(6), 768–778. https://doi.org/10.17269/s41997-019-00251-y

Statistics Canada. (2018). Overweight and obese adults, 2018. https://www150.statcan.gc.ca/n1/pub/82-625-x/2019001/article/00005-eng.pdf

Statistics Canada. (2019). Postsecondary graduates, by location of residence at interview and level of study, 2019. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710003001

Vitale, M., Masulli, M., Calabrese, I., Rivellese, A. A., Bonora, E., Signorini, S., Perriello, G., Squatrito, S., Buzzetti, R., Sartore, G., Babini, A. C., Gregori, G., Giordano, C., Clemente, G., Grioni, S., Dolce, P., Riccardi, G., & Vaccaro, O. (2018). Impact of a

Mediterranean Dietary Pattern and Its Components on Cardiovascular Risk Factors, Glucose Control, and Body Weight in People with Type 2 Diabetes: A Real-Life Study. *Nutrients*, *10*(8), 1067. https://doi.org/10.3390/nu10081067

Wu, C.-Y., Hu, H.-Y., Chou, Y.-J., Huang, N., Chou, Y.-C., & Li, C.-P. (2015). High Blood Pressure and All-Cause and Cardiovascular Disease Mortalities in Community-Dwelling Older Adults. *Medicine*, *94*(47), e2160. https://doi.org/10.1097/MD.0000000000002160

Zhao, Y., Xiang, L., Liu, Y., Niu, M., Yuan, J., & Chen, H. (2018). Atherosclerosis Induced by a High-Cholesterol and High-Fat Diet in the Inbred Strain of the Wuzhishan Miniature Pig. *Animal Biotechnology*, *29*(2), 110–118. https://doi.org/10.1080/10495398.2017.1322974