DATING APPS, SEXUALLY TRANSMITTED INFECTIONS AND RISKY SEXUAL BEHAVIOUR

THE ASSOCIATION BETWEEN MOBILE DATING APPS USE, SEXUALLY TRANSMITTED INFECTIONS AND RISKY SEXUAL BEHAVIOUR IN ONTARIO UNIVERSITY STUDENTS

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TITLE: The Association Between Mobile Dating Apps Use, Sexually Transmitted Infections and Risky Sexual Behaviour in Ontario University Students

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Lay Abstract

This study investigated whether students who use mobile dating apps are more or less likely to engage in risky sexual behavior, and to have been tested for and diagnosed with a sexually transmitted infection (STI) in the previous 12 months, compared to students who do not use mobile dating apps. An anonymous online survey was used to collect data on sexual behaviour and STI history from Ontario university students. I found that Ontario university students who used dating apps in the previous 12 months were more likely to have a greater number of sexual partners in the previous year, have multiple concurrent sexual partners, use alcohol and cannabis in combination with sexual activity, and get tested for STIs more frequently than non-dating app users. However, mobile dating app users were not more likely to have been diagnosed with an STI in the previous 12 months compared to non-dating app users.

Abstract

Over the last decade, the incidence rates of many sexually transmitted infections (STI) have been on the rise, especially amongst young adults. Popular Canadian media outlets have speculated that the reason behind these increases is the use of mobile dating applications which foster romantic and sexual connections. This cross-sectional study assesses whether students who use mobile dating apps are more or less likely to have been diagnosed with an STI in the previous 12 months and engage in risky sexual behaviour, compared to students who did not use mobile dating apps in the previous 12 months. An anonymous online questionnaire was used to collect data from 965 study participants currently enrolled at an Ontario university. The survey required participants to self-report STI testing behaviour and diagnoses, as well as sexual behaviours, including number of sexual partners, relationship type, condom use, substance use and sex work. I found that Ontario university students who used dating apps in the previous 12 months were more likely to have a greater number of sexual partners in the previous year ($p<0.05$), have multiple concurrent sexual partners (OR=10.72, 95% CI: 6.10-18.84), frequently use alcohol (OR=3.94, 95% CI:2.17-7.14) and cannabis (OR=3.36, 95% CI:1.45-7.78) in combination with sexual activity, and were more likely to have been tested for STIs in the previous 12 months (OR=2.25, 95% CI: 1.73-2.94) compared to non-dating app users. However, mobile dating app users were not more likely to have been diagnosed with an STI in the previous 12 months compared to non-dating app users.

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Thank you.

List of Figures and Tables

List of Abbreviations and Symbols

aOR   Adjusted Odds Ratio

BMSM   Black men who have sex with men

CI   Confidence Interval

CCHS   Canadian Community Health Survey

GPS   Global Positioning System

GSN   Gay Social Networking

HIV   Human Immunodeficiency Virus

HPV   Human Papillomavirus

LGBTQ+   Lesbian, Gay, Bisexual, Transgender, Queer and related communities

MARS   Scarborough/Multimedia Audience Research System

MSM   Men who have sex with men

OR   Odds Ratio

OSAP   Ontario Student Assistance Program

PR   Prevalence Ratio

SD   Standard Deviation

STI   Sexually Transmitted Infection(s)

Academic Declaration

I, Alanna Miller, declare this thesis work to be my own. I created the study design, collected the data, performed the statistical analysis, and wrote this thesis document.

My supervisor, Dr. Marshall, assisted with the creation of the study design and provided detailed guidance and feedback throughout the process. Along with my thesis committee members, Dr. Mbuagbaw and Dr. Hopkins, all three members provided feedback regarding the study design, data analysis and editing of the thesis.

Table of Contents

CHAPTER 1: INTRODUCTION

The Problem

Sexually transmitted infections (STIs) include the viral, bacterial, fungal and parasitic diseases that are spread from human to human during sexual contact. Annually, over two million STIs are reported across Canada[1]. However, often STIs go undiagnosed due to the absence or minimal impact of symptoms, inaccessibility of health care, and reluctance of individuals to be tested. Therefore, the actual prevalence of STIs in Canada is likely much greater[1]. Though most STIs are easily treated with anti-microbial drugs, if left untreated, many STIs can pose a serious health threat, resulting in permanent damage to reproductive organs, systemic infection, or even death[1]. Many STIs can also be transmitted to infants during pregnancy and childbirth, and those such as Human Papillomavirus (HPV) can cause cancer[1]. Another growing concern regarding STIs is the increasing occurrence of antimicrobial resistance. Though historically STIs, such as gonorrhea, have been easily cured with antibiotics, a surge of resistant strains have been reported worldwide[2]. Across Canada in 2014, over 50% of tested gonorrhea samples were resistant to at least one antibiotic, and there were two reported cases of completely-drug-resistant gonorrhea infections[2].

Over the last decade, the incidence rates of many STIs have been on the rise. In Ontario, the incidence of the bacterial infection, *Chlamydia trachomatis* ('chlamydia'), rose from 255.1 cases per 100,000 in 2010, to 331.7 cases per 100,000 in 2018, depicting a 30% increase[3]. The incidence of another bacterial infection, *Neisseria gonorrhoeae* ('gonorrhea'), increased in Ontario from 30.2 cases per 100,000 in 2010, to 72.2 cases per

100,000 in 2018, depicting an 139% increase[3]. Regarding infectious syphilis, the Ontario incidence increased from 5.9 cases per 100,000 in 2010, to 13.1 caser per 100,000 in 2018, depicting an 122% increase[3]. These incidence rates are even higher for young adults. The 2018 Ontario incidence of infectious syphilis in young adults aged 20-24 was 18.1 cases per 100,000 in 2018[3]. The 2018 Ontario incidence of gonorrhea in young adults aged 20-24 was 231.9 cases per 100,000[3]. The Ontario 2018 incidence of chlamydia in young adults aged 20-24 was 1714.79 cases per 100,000[3]. National or provincial estimates of the incidences of anogenital warts caused by the human papillomavirus (HPV) and genital herpes are not available. However results from a 2013 systematic review estimates the global annual incidence rate of anogenital warts between 160 to 289 cases per 100,000[4] and a longitudinal study estimates the Canadian annual incidence of genital herpes between 261.2 and 386.6 cases per 100,000[5]. Popular Canadian media outlets, including Global News, Huffington Post Canada and CBC News, have published news stories speculating the reason behind these increases and have postulated a link between the rising incidence of STIs and the use of mobile dating applications (apps)[6–8].

Mobile Dating Apps

Mobile dating apps, including applications such as Tinder™, Bumble™ and Grindr™, use Global Positioning System (GPS) technology to facilitate the meeting of individuals for dating purposes. Opposed to traditional dating methods, mobile dating apps allow users to meet a large number of individuals within a small geographic area, in

a relatively short time period. Mobile dating apps such as Tinder™ can be used by anyone, whereas apps such as Grindr™ and HER™ are tailored towards LGBTQ+ populations, and Minder™ and Tantan™ are tailored towards specific cultural communities (A list of the mobile dating apps used in this study and their intended audiences is provided in Appendix A). Though many distinct mobile dating apps exist, they all allow for the exchange of messages and facilitate the meeting of individuals for romantic or sexual purposes. Since the release of Grindr™ in 2009, dating apps have become increasingly popular, with Tinder™'s official website boasting app usage in over 190 countries and their responsibility for facilitating the occurrence of over one million dates every week[9].

The use of mobile dating apps by young adults is common, however the estimated prevalence varies. Studies have consistently demonstrated that mobile dating app use is higher in younger populations than older populations. A 2016 cross-sectional study conducted in the United States using data from the Scarborough/Multimedia Audience Research System (MARS) Healthcare module reported that 6.2% of respondents used dating apps in the previous 30 days and that rates of dating app use declined with age; 11.4% of respondents aged 18-24 reported using dating apps in the past month and 1.5% of respondents over 65 years old reported similar usage[10]. In another study, survey data were collected from 20,091 respondents belonging to the general population of Australia between the ages of 16 and 69[11]. Results indicated that 12.09% of respondents had searched for partners online, 2.98% of respondents met someone they had met online in person, and 1.95% of all respondents had sex with someone they had met online[11]. These behaviours were all highest amongst those age 16-29 years old, and lowest amongst those

60-69 years old[11]. Additionally, a 2018 cross-sectional study conducted in the United States with 415 participants with a median age of 31 found that 78% of their sample had met a sexual partner online or through a smartphone application in the previous 12 months[12]. The majority (71%) of men who met partners online also reported using on average 2.3 different online venues for finding sexual partners[12].

Though geared towards adults, mobile dating apps are also used by emerging adolescents and young adults. A 2019 mixed-methods study conducted in the United States examined the current behaviours and attitudes of youth aged 13-24 (average age 19.7) regarding online dating[13]. Survey data was collected from 1500 individuals, and focus groups were conducted with 66 participants[13]. The results indicated that 34% of survey respondents had used mobile dating apps and/or websites before[13]. Overall, Tinder™ was the most popular app, and the majority (51.8%) of those over 18 had used the mobile application[13]. Eighty percent of those who reported having used a dating website or app had also met with someone they met online in person[13]. With regards to the intentions of the youth using these platforms, 33.1% of male app users used them for 'hooking up', or engaging in casual sexual encounters (comparable to 17.9% of female users), and 27% of transgender users employed these platforms for 'hooking up'[13]. Despite the fairly high usage of internet-based dating websites and mobile applications, the qualitative analysis revealed that youth across all ages feared dating violence and cyber abuse as an outcome of using these platforms[13].

Dating app use is also high amongst men who have sex with men (MSM). A 2018 cross-sectional study conducted with 580 MSM in France reported that the majority of the

sample, 89.5%, had used a smartphone application to meet sexual partners in the previous three months[14]. Specifically, among HIV-positive men, 86.2% reported having used an app to meet sexual partners[14]. A 2015 cross-sectional study conducted in the United Kingdom with 702 participants, examined the use of dating apps and assessed the sexual behaviours of MSM[15]. The results indicated that 60.4% of respondents reported using gay social networking (GSN) apps and reasons for using dating apps included: "killing time", meeting guys for sex and swapping naked photos[15]. A 2018 cross sectional study conducted in China with 403 MSM reported that 66% of respondents reported dating app usage in the previous 6 months[16]. Regarding those who reported using dating apps, 13.5% reported using apps specifically to find sex partners[16].

The estimated use of dating apps varies across populations. However, it is evident that mobile phone-based dating methods have become commonplace, and the use of such applications is likely to increase as younger generations who have grown-up using mobile-based technology enter the dating scene and more dating apps geared towards specific populations become available.

Risky Sexual Behaviour

Risky sexual behaviour is characterized by a series of behaviours that can increase a person's risk of making poor decisions regarding their sexual health. Such behaviours include not using a form of barrier protection during sexual contact (ex. Condom, internal condom, dental dam, etc.), having multiple concurrent sexual partners, consuming drugs or alcohol during sexual encounters and engaging in sex work. Though using a dating

app, or more generally the Internet, to meet sexual partners isn't a risky behaviour in itself, several studies have demonstrated an association between app use and engagement in several risky sexual behaviours[11,14,17–21].

Condom Use

Condoms offer an effective barrier protection against the transmission of STIs. Despite their effectiveness, there are many factors that inhibit their use, and unprotected consensual sex is a common occurrence. The rate of condom use during sex varies across studies, and amongst the sexual acts being performed (i.e. vaginal vs. anal vs. oral sex). A 2016 cross-sectional study conducted in Hong Kong with 666 university students used self-reported data to assess the association between using dating apps and exhibiting risky sexual behaviour, including condomless sex[17]. The findings indicated that among respondents, the odds of having used a dating app for longer than 12 months was 13.56 times greater (aOR=13.56, $p<0.05$) amongst those that had not used a condom in their last sexual encounter in comparison to those who had[17].

Similar patterns of inconsistent condom use are also observed in some, but not all studies involving MSM. A 2015 cross-sectional study conducted in New Zealand with 1912 participants over the age of 16 investigated the factors predicting recent non-condom use with casual sex partners amongst MSM[18]. The study reported that after adjusting for demographic factors, infrequent condom use with a casual partner was independently predicted by recruiting partners from Internet dating sites[18]. Additionally, a 2016 cross-sectional study conducted in the United States with 271 Black MSM (BMSM)

investigated the association between substance use, STI diagnosis, risky sexual behaviour and online partner meeting with being HIV positive[19]. Regarding participants' sexual behaviour within the previous three months, 38% of respondents reported engaging in condomless anal sex with a partner they had met online[19]. Conversely, after examining condom use and predictors of condom use amongst 213 MSM in China, 39.8% of the sample reported consistent condom use during recent anal sex encounters with regular partners, and 54.2% reported consistent condom use during recent anal sex encounters with casual partners[20]. However, respondents who reported a higher frequency of using the apps Jack'd™ and Grindr™ demonstrated a reduced odds of inconsistent condom use (aOR=0.62)[20], suggesting that app-users were more likely to exhibit safer sex practices than non-app users.

Number of Sexual Partners & Concurrent Sexual Relationships

Engaging in sexual activity with a greater number of individuals, and concurrently with multiple individuals, are considered high-risk sexual behaviours. Because dating apps can facilitate the meeting of many individuals in a small geographic radius, they offer the potential for individuals to meet more sexual partners than typically expected. Many studies have reported that individuals who use dating apps are more likely to have a higher number of sexual partners and engage in sexual practices concurrently with multiple partners[11,14,21].

A 2018 cross-sectional study conducted in Australia investigated the proportion of people who have had sex with someone they had met on a dating website or mobile

dating app within the previous 12 months[11]. Survey data was collected from 20,091 respondents belonging to the general population of Australia between the ages of 16 and 69 years old[11]. The strongest correlate of having had sex with someone met using the internet was having a higher number of sexual partners in the previous year[11]. When adjusted for age and income, the odds ratio (OR) of having had sex with someone met through the internet was 32.01 (95%CI, 13.17-77.78) for respondents reporting two to three sexual partners in the previous year, and 75.08 (95%CI, 32.75-181.43) for respondents reporting over 5 partners in the previous year, in comparison to those with one sexual partner in the previous year[11].

Again, similar patterns are exhibited in MSM. A 2018 cross-sectional study conducted in the United States performed an exploratory analysis of dating app use among MSM[21]. Dating app use was measured using a Likert scale ranging from 'never' to 'daily'[21]. Frequent use was considered as '2-5 times a week' or 'daily'[21]. The results indicated that 55.7% of the sample frequently used dating apps, and another 22.5% reported some use. This was similar across racial groups[21]. Respondents who frequently used apps were more likely to have casual sex partners (66.7%). When looking specifically at users of Grindr™ (n=3105), Grindr™ users reported having more sexual partners in the past 12 months (Mdn=5) compared to never users (Mdn=2, p<0.001)[21]. A 2018 cross-sectional study conducted with 580 MSM in France sought to explore whether meeting sexual partners at public, cruising or online venues was associated with risky sexual behaviour[14]. In the multivariate analysis, engaging in group sex (three or more sexual partners during a single sexual encounter) was the only behaviour associated with

using a smartphone application to meet sexual partners [aOR=1.47(1.10-1.96), p<0.001][14].

Sexually Transmitted Infections

Engaging in risky sexual behaviour ultimately places individuals at an increased risk of contracting an STI. Often, STIs go undiagnosed due to the absence of symptoms and the reluctance of individuals to be tested. Though there appears to be a clear association between the use of mobile dating apps and engagement in risky sexual behaviour, the findings regarding dating app use and incidence of STIs is less consistent.

Regarding sexual health testing behaviours, some studies report a greater likelihood of dating app users to seek STI testing. A 2016 cross-sectional study analyzed the HIV testing and STI testing behaviours of 199,308 individuals over the age 18 residing in the United States[10]. The study reported that 6.5% of dating app users had been tested for STIs in the past year compared to 4% of non-users, yielding a prevalence ratio (PR) of 1.64. However in dating app users 18-24 years old, HIV testing was less common in users (PR=0.875)[10]. The authors concluded that older dating app-users were more likely to seek STI testing than non app users, however this may not be the case for younger app users.

A 2015 cross-sectional study reported that meeting recent male sex partners on the internet was not associated with oncogenic HPV infection in young adult women. Researchers collected self-obtained vaginal swabs from 282 women, aged 18-24, who used the internet to find a partner in the previous 12 months. The results indicated that

35% of respondents reported having met a sexual partner on the internet in the past 6 months. Regarding condom use, 80% of the sample reported always using condoms with male sex partners within the previous six months. The prevalence of oncogenic HPV in participants was 36.5%. This prevalence was comparable to the prevalence in the general population of 20-24-year-old women, which is 43%. Therefore, researchers concluded that meeting recent male sex partners on the internet was not associated ($p > 0.1$) with oncogenic HPV infection in this sample.

However, the majority of the literature suggests an association between using dating apps to meet sexual or romantic partners and contracting an STI, including syphilis, gonorrhea, chlamydia, and HIV. A case study from the United Kingdom described an outbreak of infectious syphilis in rural North Wales that occurred between 2013 and 2014[22]. Between 2003 and 2012, the average incidence rate of infectious syphilis in this region was 1 case per 100,000 individuals[22]. In 2013-2014, the incidence increased to 4 cases per 100,000[22]. During the outbreak investigation, it was revealed that 40% of MSM cases reported using an app to find sexual partners, and overall, amongst the cases, use of 10 different dating apps was reported[22]. In 2003, 9% of syphilis cases in the United Kingdom reported finding partners online, whereas 55% of all cases did in 2013[22].

A large cross-sectional study conducted in Los Angeles analyzed the association between dating app use and STI and HIV outcomes in MSM[23]. Out of the 7184 study participants, 36% had reported having had met sexual partners through dating apps[23]. Those who were under 40 years old, identified as Caucasian or Asian, were college

graduates or above, reported using dating apps in greater proportions[23]. App use was also higher amongst men who reported higher ecstasy and cocaine use[23]. In the multivariate analysis, those who used dating apps had a greater odds of testing positive for gonorrhea (aOR=1.25, 95%CI 1.06-1.48) and chlamydia (aOR=1.37, 95%CI 1.13-1.65)[23].

Building upon the previously mentioned cross-sectional study conducted by Beymer et al[23], another large cross-sectional study conducted in Los Angeles analyzed the association between dating app use and STI outcomes in 9,499 MSM[24]. The results indicated that 47% of the sample reported having had met a sexual partner through an app in the previous 3 months, and 15% had reported meeting their most recent partner through an app[24]. Out of the respondents who reported having used a dating app in the past 3 months, 27% of respondents tested positive for any STI compared to 23% of those who did not use apps (p<0.0001)[24]. App users were more likely to have been diagnosed with gonorrhea (p=0.0007), chlamydia (p=0.001) and syphilis (p=0.03), but not HIV[24]. However, when controlling for the number of sexual partners in the past 3 months, only a diagnosis of gonorrhea was statistically associated with app use[24].

A 2016 cross-sectional study conducted in the United States with 271 Black MSM (BMSM) examined the extent to which BMSM meet sex partners online, assessed the HIV prevalence within this population, and investigated the association between substance use, STI diagnosis, risky sexual behaviour and online partner meeting with being HIV positive[19]. Participants who tested positive for HIV were more likely to report using dating apps to meet partners (OR=2.2, 95%CI 1.11-4.37), and the use of dating

apps remained significantly associated with HIV after adjusting for other factors

(aOR=2.15, 95%CI 1.06-4.36)[19].

A 2018 cross-sectional study conducted in the United States with 415 participants

examined the associations between using hook-up sites and testing positive for STIs

amongst MSM[12]. When analyzing each online venue independently, Scruff™ was the only

site found to be associated with testing positive for an STI (aOR=2.16, p<0.05)[12]. Thirty-

four percent of Scruff™ users tested positive for any STI[12]. Though use of Grindr™ was

not independently associated with testing positive for any STI, 100% of those diagnosed

with gonorrhea (n=51) had used Grindr™ to meet sexual partners[12]. Other behaviours

associated with STI diagnosis (p<0.05) included higher frequency of alcohol consumption

(aOR=2.87) methamphetamine use (aOR=4.49) and lower frequency of condom use

(aOR 2.3-3.67)[12].

Conclusion

Across Ontario, the incidence rates of STIs have been increasing over the last

decade, especially amongst young adult populations[3]. The incidence rates of chlamydia,

gonorrhea and syphilis in young adults age 20-24 were 416.9%, 221.2% and 38.2%

higher than that of the general population[3]. Despite this increase, certain aspects of sexual

activity in young Canadian adults haven't changed. According to the most recent analysis

of the Canadian Community Health Survey (CCHS), between 2003 and 2010, similar

proportions of Canadian adults aged 20-24 reported engaging in sexual activity (85% in

2003; 86% in 2010)[25]. Additionally, according to the CCHS, in 2003, 29% of 20-24-year-

olds reported having multiple partners in the previous year, compared to 30% in 2010, a statistically insignificant difference[25]. Between 2003 and 2010, a change in the reported use of condoms during last sexual intercourse was reported, with an observed increase in the use of condoms (56.4% in 2003, 62.8% in 2010, $p<0.05$)[25]. Conversely, over this same time period, society has witnessed a change in the way people meet sexual partners, specifically the introduction of Internet dating and mobile dating applications has altered the practice of dating, especially for young people. Estimated rates of mobile dating app use are very diverse, ranging from 6.3% to 89.5%[10–16]. These same dating apps have also been placed at blame by many popular media outlets for the rise of STIs[6–8]. To support these claims, evidence from many international studies have alluded to an association between the use of mobile dating applications, inconsistent condom use[17–20], engaging in sexual activity with multiple partners[11,14,21], and STI diagnosis[12,19,22–24], however no studies were found pertaining to post-secondary students in the Canadian context.

CHAPTER 2: METHODS

Research Question

Are Ontario university students who use mobile dating apps for casual sex or romantic relationships at an increased risk of contracting an STI compared to those who do not use mobile dating apps?

Objectives

1. Determine if students who use mobile dating apps are more or less likely to have been diagnosed with an STI in the previous 12 months compared to students who did not use mobile dating apps in the previous 12 months.

2. Determine if students who use mobile dating apps are more or less likely to engage in risky sexual behaviour, including: not using a condom during sexual encounters, having more sexual partners, engaging in non-monogamous sexual relationships (having multiple concurrent sexual partners) and using alcohol or drugs during sexual encounters, compared to students who did not use mobile dating apps.

Hypotheses

Based on a review of the literature, it was hypothesized that university students who use mobile dating apps to meet romantic and/or sexual partners will have an increased odds of having been diagnosed with an STI, and be more likely to engage in risky sexual behaviour, compared to students who did not use mobile dating apps.

Study Design

A cross-sectional study design was selected because previous research evaluating the association between mobile dating app use, STIs and risky sexual behaviour in Ontario university students has not been conducted. Cross-sectional study designs are beneficial when establishing preliminary distribution of a disease by population characteristics, which is necessary in this circumstance, as well as for generating hypotheses for subsequent observational studies. Due to the relatively recent debut of mobile-dating apps, existing surveillance data has yet to capture mobile dating app use in relation to the prevalence of STIs and risky sexual behaviour. No existing database exists which would allow for the linkage of app use with health outcomes, warranting the use of primary data collection. Therefore, a cross-sectional study design, using primary data collection was used to answer the research question.

Sampling & Recruitment

The target population of this study was Ontario university students. Inclusion criteria included current full or part-time enrollment in an undergraduate or graduate program at an Ontario university. Only individuals who were not current university students were excluded from participating in this study. Survey recruitment was done primarily though social media. Advertisements recruiting participants were posted on personal Instagram and Twitter accounts, in addition to student-run university Facebook pages. Advertisements were posted to 15 Facebook pages, belonging to 12 different Ontario universities: McMaster University, the University of Toronto, Carleton

University, the University of Ottawa, Wilfrid Laurier University, Nipissing University, Brock University, Western University, the University of Waterloo, the University of Windsor, the University of Guelph and Ryerson University. The survey was open to all Ontario university students and completion of the anonymous survey was done on a volunteer basis. Any responses completed by individuals who reported that they were not enrolled as a student at an Ontario university were excluded from participating.

Sample Size Calculation

Prior to data collection, sample size calculations were completed using G*Power 3.1 software. Sample size calculations were completed for the primary binary outcome of STI incidence, for a Chi-square goodness of fit statistical test for contingency tables (1 degree of freedom), where $\alpha=0.05$ and $\beta=0.95$. A sample size of 208 study participants was calculated to detect an exposure effect of 25%. In this circumstance, a 25% effect size indicates that the minimal clinically important difference in STI incidence between dating app users and non-users in this sample must be equal to or greater than 25%.

Data Collection & Measurement

An anonymous online questionnaire was used to collect data from study participants. The survey was only offered in English. The questionnaire consisted of 33 questions in total pertaining to four categories: mobile dating app-use, sexual behaviour, history of STIs and sociodemographic characteristics. The full survey is provided in Appendix B.

Mobile Dating App-Use

Three multiple-choice questions addressed participants' use of mobile dating apps. Specifically, participants were asked if they had used mobile dating apps in the previous 12 months, as well as their frequency (never, once a year, once every few months, 1-3 times per month, 3-5 times per week or daily) and primary reasons (to meet partners for casual sex, to meet partners for romantic relationships or to meet individuals for friendships) for specifically using Tinder™, Grindr™, Bumble™, HER™ and Hinge™.

Sexual Behaviour

Eighteen questions addressed participants' sexual behaviour, including three questions requiring numerical input responses, one question requiring an open-ended response and 14 multiple choice questions. Participants were asked to report their lifetime number of sexual partners, their number of sexual partners in the previous 12 months and their number of sexual partners met through mobile dating apps. Barrier use during vaginal, anal and oral sex was measured by the frequency of use over the previous 12 months (always, usually, sometimes, rarely, never) as well as during the participants' last sexual encounter. Participants were also asked to report any engagement in sex work as well as their frequency of substance use during sexual encounters.

History of Sexually Transmitted Infections

Five questions addressed participants' history of sexually transmitted infections, including four multiple choice questions and one question requiring an open-ended

response. The survey questions specifically asked patients to report if they had been tested for STIs, excluding HIV, in the previous 12 months, and whether or not they had been diagnosed with an STI, excluding HIV, in the previous 12 months. Due to the complexity in the nature of HIV transmission, participants were not asked to disclose their HIV status, as HIV infection may not derive from sexual contact.

Sociodemographic Characteristics

Seven questions addressed participants' sociodemographic characteristics, including age, sexual orientation, race, gender and socioeconomic status. One question required a numerical response, and the remaining six questions were multiple choice.

The questionnaire was operated through LimeSurvey. LimeSurvey is a McMaster University ethics-compliant data collection service with secure data storage on a Canadian server and ensures participant response anonymity as IP addresses are not collected. Questions were not mandatory, allowing participants to skip any question they were uncomfortable answering. Additionally, the survey used pathways, ensuring participants need only to respond to questions relevant to their previous responses.

Statistical Analyses

All statistical analyses were conducted using SPSS 26 with all p-values two-tailed with p< 0.05 indicating statistical significance.

Descriptive Statistics

Measures of central tendency, including, mean, median and minimum and maximum values were used to characterize continuous variables. For all categorical variables, proportions were calculated.

Univariate Analysis

Chi-square analysis was used to compare categorical variables, and odds ratios were determined. For continuous variables, normalcy was tested using the Shapiro Wilks test. When variables were found not to be normally distributed, the non-parametric independent samples median test was used to compare dating app users and non-users. For all normally distributed continuous variables, independent samples t-tests were conducted to compare subpopulations.

Logistic Regression Analysis

Binary logistic regression was used to generate predictive models for **1)** having had an STI test in the previous 12 months and **2)** having been diagnosed with an STI in the previous 12 months. The models were developed in forward-step fashion, with the first step looking at mobile dating app use in the previous 12 months. The second step examined the number of sexual partners in the previous 12 months, sexuality (heterosexual vs. non-heterosexual), frequency of alcohol consumption in combination with sexual activity, frequency of cannabis consumption in combination with sexual activity, and average condom use (average condom use was determined by averaging the

individual Likert responses for the frequency of condom use during vaginal sex, receptive anal sex and penetrative anal sex over the previous 12 months). The third step incorporated demographic variables into the model, including age, gender, race and employment.

Ethical Considerations

This study was approved by the Hamilton Integrated Research Ethics Board. Before the participants began the survey, each participant was asked to read a notice explaining the purpose and objectives of the study, and participants were asked to click an agreement box indicating informed consent. Though this study collected sensitive information from its participants, all questionnaires were completed on a volunteer basis and were submitted anonymously. We did not collect any personal information that would allow us to identify participants, including name, date of birth and location of residence. Additionally, LimeSurvey is a McMaster ethics-compliant data collection service that ensures participant response anonymity since IP addresses are not collected. Following study completion, collected data will be stored on MacDrive, which is a privately hosted, secure, cloud storage solution. Only the custodian of the data (Dr. Tara Marshall) will have access to any data stored on MacDrive following study completion.

CHAPTER 3: RESULTS

Descriptive Results

<u>Survey Response</u>

The *Mobile Dating Apps, Sexual Behaviour and Sexually Transmitted Infections Survey* ran from February 6, 2020 through March 5, 2020 for a total of four weeks. The online survey was administered via LimeSurvey. The survey was accessed by 2008 unique individuals, and completed surveys were received from 965 respondents, generating a response rate of 48%.

<u>Demographic Characteristics</u>

Age

Age data were collected from 964 respondents. The mean age of respondents was 20.48 years with a standard deviation (SD) of 2.33 years.

Race

Race data were collected from all 965 respondents. The majority of respondents identified as Caucasian (n=612, 63.4%), followed by East Asian (n=102, 10.6%) and South Asian (n=101, 10.2%). The descriptive analysis for the survey respondents' race is summarized in Table 1 provided in Appendix C.

Gender

Data regarding gender were collected from all 965 respondents. The vast majority of respondents identified as cis-gender female (n=808, 83.7%). One-hundred thirty-eight respondents identified as cis-gender male (14.3%), eight respondents identified as non-binary (0.8%), another eight respondents identified as an 'other' gender. One respondent identified as trans-gender female (0.1%), and two respondents identified as trans-gender male (0.2%). The descriptive analysis for the survey respondents' gender are summarized in Table 1 provided in Appendix C.

Sexuality

Data regarding sexuality were collected from all 965 respondents. Seven hundred thirty-four respondents identified as heterosexual (76.1%), 171 respondents identified as bisexual (17.7%), 34 respondents identified as homosexual (3.5%) and 25 respondents (2.6%) identified as an 'other' sexuality. The descriptive analysis results for the survey respondents' sexuality is summarized in Table 1 provided in Appendix C.

Income & Employment

Use of the Ontario Student Assistance Program (OSAP) was collected from all 965 respondents. Five hundred fifteen (53.4%) respondents reported currently accessing the program, 436 (45.3%) respondents reported not accessing the program, and 14 respondents (1.5%) were unsure if they had accessed OSAP funding.

Data regarding employment was collected from 960 respondents. Four-hundred ninety-five (51.6%) respondents reported being currently employed in some capacity, and 465 (48.4%) respondents reported that they are currently not working. Regarding the 495 respondents who reported employment, 490 of these respondents reported on the number of hours worked per week, which is summarized in Table 1 provided in Appendix C.

Mobile Dating App Use

Mobile dating apps usage was reported by 964 respondents, with 41.6% of respondents (n=401) reporting having used a mobile dating app in the previous 12 months, and 58.3% (n=563) of respondents reporting they had not. The descriptive analysis of the survey respondents' use of Tinder™, Bumble™, Grindr, ™ HER™, and Hinge™ and frequency of use of these mobile dating apps is provided in Appendix C in Table 2.

Tinder

Tinder™ was the most widely used app with 88.5% of app-users (n=355) reporting having used the app at least once within the previous 12 months (Table 2). Regarding the frequency that app users used Tinder™, 15.2% of Tinder™ users reported using the app once a year, 30.1% of users reported using the app once every few months, 22.3% of users reported using the app 1-3 times per month, 10.7% of users reported using the app 3-5 times per week, and 12.7% of users reported using the app daily (Table 2).

When asked their primary objective when using Tinder™, 41.1% of respondents noted finding partners for casual sex as their primary objective, 53.9% noted finding partners for romantic relationships and 5.1% noted finding partners for friendships as their primary objective for using Tinder™ (Table 3).

Bumble

Bumble™ was the second most widely used app with 50.4% of app-users (n=202) reporting having used the app at least once within the previous 12 months (Table 2). Regarding the frequency that app users used Bumble™, 25.3% of Bumble™ users reported using the app once a year, 29.2% of users reported using the app once every few months, 12.7% of users reported using the app 1-3 times per month, 15.4% of users reported using the app 3-5 times per week, and 7.9% of users reported using the app daily (Table 2).

When asked their primary objective when using Bumble™, 16.9% of respondents noted finding partners for casual sex as their primary objective, 71.6% noted finding partners for romantic relationships and 11.6% noted finding partners for friendships as their primary objective for using Bumble™ (Table 3).

Hinge

Hinge™ was the third most widely used app with 21.7% (n=87) of app users reporting having used the app at least once in the previous 12 months (Table 2). Regarding the frequency app users used Hinge™, 31.0% of Hinge™ users reported using the app once a year, 24.1% of users reported using the app once every few months, 19.5%

of users reported using the app 1-3 times per month, 19.5% of users reported using the app 3-5 times per week, and 5.6% of users reported using the app daily (Table 2).

When asked their primary objective when using Hinge™, 23.4% of respondents noted finding partners for casual sex as their primary objective, 66.1% noted finding partners for romantic relationships and 10.5% noted finding partners for friendships as their primary objective for using Hinge™ (Table 3).

HER

HER™ was the second most infrequently used app with 8.5% (n=34) of app users reporting having used the app at least once in the previous 12 months (Table 2)(however, when excluding those who identified as female, HER was the most infrequently used app). Regarding the frequency app users used HER™, 29.4% of HER™ users reported using the app once a year, 38.2% of users reported using the app once every few months, 11.8% of users reported using the app 1-3 times per month, 20.6% of users reported using the app 3-5 times per week, and 0% of users reported using the app daily (Table 2).

When asked their primary objective for using HER™, 25.0% of respondents noted finding partners for casual sex as their primary objective, 56.4% noted finding partners for romantic relationships and 18.8% noted finding partners for friendships as their primary objective for using HER™ (Table 3).

Grindr

Grindr™ was the app used most infrequently with only 3.0% (n=12) of app users reporting having used the app at least once in the previous 12 months (Table 2) (however, when excluding those who identify as female, Grindr was the second most infrequently used app). Regarding the frequency that app users used Grindr™, 0% of Grindr™ users reported using the app once a year, 25.0% of users reported using the app once every few months, 16.7% of users reported using the app 1-3 times per month, 8.3% of users reported using the app 3-5 times per week, and 50.0% of users reported using the app daily (Table 2).

When asked their primary objective for using Grindr™, 43.8% of respondents noted finding partners for casual sex as their primary objective, 30.1% noted finding partners for romantic relationships and 26.0% noted finding partners for friendships as their primary objective for using Grindr™ (Table 3).

Sexual Activity

Data regarding sexual activity were collected from 964 respondents, with 79.5% (n=767) of respondents reporting engaging in any sexual activity in the previous 12 months.

Number of Sexual Partners

When analyzing those who reported engaging in sexual activity in the previous 12 months, the median number of life-time sexual partners was 3. The minimum number of

lifetime sexual partners reported was one, and the maximum was 200. When analyzing those who reported engaging in sexual activity in the previous 12 months, the median number of sexual partners in the previous 12 months was 1. The maximum number of sexual partners reported in the previous 12 months was 32. When analyzing those who reported engaging in sexual activity in the previous 12 months, the median number of sexual partners met through mobile dating apps in the previous 12 months was 0. The maximum number of sexual partners met through dating apps in the previous 12 months was 22.

Relationship Status

Data regarding participants' current relationship status were collected from all 965 respondents. The majority (50.9%) of respondents reported being in a monogamous romantic/sexual relationship, followed by 29.2% of respondents reported being single and not engaging in any sexual activity. The descriptive analysis for the survey respondents' current relationship status is provided in full in Appendix C in Table 1.

Barrier Use During Vaginal Sex

In total, 720 respondents reported engaging in vaginal sex in the previous 12 months. When asked how frequently respondents used some form of barrier protection during vaginal intercourse in the previous 12 months, 28.2% reported 'Always', 18.2% reported 'Usually', 13.1% reported 'Sometimes', 19.6% reported 'Rarely' and 21.0% reported never using barrier protection during vaginal sex. The descriptive analysis results

for the survey respondents' reported barrier use during vaginal intercourse are provided in Appendix C in Table 4.

When asked about their last sexual engagement involving vaginal sex, 43.5% of respondents reported using a form of barrier protection, and 56.5% reported not using barrier protection.

Barrier Use During Oral Sex

In total, 741 respondents reported engaging in oral sex in the previous 12 months. When asked how frequently respondents used some form of barrier protection during oral sex in the previous 12 months, 1.6% reported 'Always', 0.8% reported 'Usually', 0.5% reported 'Sometimes', 2.3% reported 'Rarely' and 94.7% reported never using barrier protection during oral sex. The descriptive analysis results for the survey respondents' reported barrier use during oral sex is provided in Appendix C in Table 4.

When asked about their last sexual engagement involving oral sex, 98.4% reported not using barrier protection.

Barrier Use During Anal Sex

In total, 160 respondents reported engaging in receptive anal sex in the previous 12 months. When asked how frequently respondents used some form of barrier protection during receptive anal sex in the previous 12 months, 18.5% reported 'Always', 9.9% reported 'Usually', 3.1% reported 'Sometimes', 8.0% reported 'Rarely' and 60.5% reported never using barrier protection during receptive anal sex. The descriptive analysis

results for the survey respondents' reported barrier use during receptive anal intercourse is provided in Appendix C in Table 4.

In total, 162 respondents reported engaging in penetrative anal sex in the previous 12 months. When asked how frequently respondents used some form of barrier protection during penetrative anal sex in the previous 12 months, 16.3% reported 'Always', 6.3% reported 'Usually', 1.9% reported 'Sometimes', 7.5% reported 'Rarely' and 68.1% reported never using barrier protection during penetrative anal sex. The descriptive analysis results for the survey respondents' reported barrier use during penetrative anal intercourse is provided in Appendix C in Table 4.

When asked about their last sexual engagement involving anal sex, 20.2% of respondents reported using a form of barrier protection, and 79.8% reported not using barrier protection.

Substance Use with Sexual Activity

Regarding those who reported engaging in any sexual activity in the previous 12 months (n=767), 2.5% of respondents reported 'Always' using alcohol when engaging in sex, 5.1% reported 'Usually' using alcohol, 21.8% reported 'Sometimes' using alcohol, 46.9% reported 'Rarely' using alcohol and 23.7% reported never using alcohol when engaging in sexual activities. The descriptive analysis results for the survey respondents' reported alcohol consumption during sexual activity is provided in Appendix C in Table 5.

Regarding those who reported engaging in any sexual activity in the previous 12 months (n=767), 1.2% of respondents reported 'Always' using cannabis when engaging in sex, 2.4% reported 'Usually' using cannabis, 7.8% reported 'Sometimes' using cannabis 24.8% reported 'Rarely' using cannabis and 63.9% reported never using cannabis when engaging in sexual activities. The descriptive analysis results for the survey respondents' reported cannabis consumption during sexual activity is provided in Appendix C in Table 5.

Regarding those who reported engaging in any sexual activity in the previous 12 months (n=767), zero respondents reported 'Always' or 'Usually' using illicit drugs when engaging in sex, 1.2% reported 'Sometimes' using illicit drugs, 4.6% reported 'Rarely' using illicit drugs and 94.4% reported never using illicit drugs when engaging in sexual activities. The descriptive analysis results for the survey respondents reported illicit drug consumption during sexual activity is provided in Appendix C in Table 5.

Sex Work

Participation in sex work was low amongst respondents; 1.1% of respondents who engaged in sex in the previous 12 months also performed sexual activities in return for money or other resources and 0.5% of respondents paid for sexual activity sometime within the previous 12 months.

Sexually Transmitted Infections

Regarding those who reported engaging in any sexual activity in the previous 12 months (n=767), 766 provided data on STI testing behaviour, and 49.6% (n=380) of respondents reported being tested for STIs in the previous 12 months. Twenty-nine respondents (7.4% of those tested in the previous 12 months) were diagnosed with an STI in the previous 12 months, and four respondents (1.1%) were unsure if they had received an STI diagnosis.

The 29 respondents accounted for 30 STI diagnoses in the previous 12 months: 24 cases of chlamydia, 4 cases of genital herpes and 2 cases of genital warts caused by HPV. There were no reported cases of gonorrhea, syphilis or trichomoniasis. The incidence rate of chlamydia in the sample was 3129 cases per 100,000 annually. The incidence rate of genital herpes in the sample was 521 cases per 100,000 annually. The incidence rate of genital warts in the sample was 260 cases per 100,000 annually.

Univariate Analysis Results

Demographic Characteristics

Age

The independent samples t-test was used to compare age between mobile dating app users and non-users, and there was no difference in age between these two groups. The mean age of mobile dating app users was 20.4 years (SD=2.26) and the mean age of non-users was 20.55 (SD=2.39).

Socioeconomic Status

Employment and OSAP enrollment were used to assess socioeconomic status. Chi-square analysis was used to compare access to OSAP and employment between mobile dating app users and non-users. There was no difference in measured socioeconomic status between mobile dating app users and non-users. Dating app users and non-dating app users access OSAP in similar proportions and are employed in similar proportions.

Gender

Chi-square analysis was used to compare gender identity between mobile dating app users and non-users. There was no difference in gender identification between mobile dating app users and non-users. The analysis did not compare the proportions of individuals who identified as transgender female or transgender male because the observed sample sizes were too small.

Race

Chi-square analysis was used to compare racial identity between mobile dating app users and non-users. There was no observed difference in race between mobile dating app users and non-users.

Sexuality

Chi-square analysis was used to compare sexual orientation between mobile dating app users and non-users. There was an observed difference in the identified sexualities of mobile dating app users and non-dating app users, with app-users being more likely to identify as homosexual (p=0.002) or bisexual (p<0.001). The odds of using dating apps was 0.46 (95% CI: 0.33-0.63) times lower in those who identified as heterosexual compared to those who were not heterosexual. The odds of using dating apps was 3.00 (95% CI: 1.45-6.24) times greater in those who identified as homosexual, compared to those who were not homosexual. The odds of using dating apps was 1.90 (95% CI:1.36-2.66) times greater in those who identified as bisexual compared to those who were not bisexual. However, this relationship between sexuality and dating app use no longer exists when analyzing each dating app independently, and therefore we cannot conclude that sexuality is associated with the use of Tinder (p=0.796), Bumble (p=0.943) and Hinge (p=0.529). Because Grindr and HER are geared solely towards individuals who identify as non-heterosexual, they were not considered in this analysis.

Sexual Activity

Number of Sexual Partners

Dating app users reported more lifetime sexual partners than non-dating app users. The mean number of lifetime sexual partners for mobile dating app users was 9.93 (SD=14.94) and the median was 6. The mean number of sexual partners for non-users was 4.07 (SD=10.63) and the median was 2. Using the non-parametric independent

samples median test, the median number of lifetime sexual partners was found to be statistically significant (p<0.001) between mobile dating app users and non-users. These results are summarized in Table 6 provided in Appendix C.

Dating app users report more sexual partners in the previous 12 months than non-dating app users. The mean number of sexual partners in the previous 12 months for mobile dating app users was 3.95 (SD=4.00) and the median was 3. The mean number of sexual partners for non-dating app users was 1.45 (SD=1.97) and the median was 1. Using the non-parametric independent sample median test, the median number of sexual partners in the previous 12 months was found to be statistically significant (p<0.001) between mobile dating app users and non-dating app users. These results are summarized in Table 6 provided in Appendix C.

Relationship Status

Chi-square analysis was used to compare current relationship status between mobile dating app users and non-users, and current relationship status differed between these two groups. Specifically, dating app users were more likely to be in relationships with multiple concurrent sexual partners (p<0.001). The odds of using dating apps was 5.65 times greater (95% CI: 2.28-14.00, p<0.001) in those who reported being in a non-monogamous romantic and sexual relationship compared to another relationship type. The odds of using dating apps was 12.57 (95% CI: 6.19-25.53, p<0.001) times greater in those who reported to be casually dating with multiple sexual partners compared to another relationship type. Overall, the odds of using dating apps was 10.72 (95% CI:

6.10-18.84, p<0.001) times greater in those who reported having multiple concurrent relationships, compared to those with only one sexual partner (Table 8).

Barrier Use During Vaginal Sex

Regarding barrier use during vaginal intercourse in the previous 12 months, dating app users reported a mean barrier use of 2.06, and a median barrier use of 2 (2=sometimes). Non-users reported a mean barrier use of 2.36 and a median barrier use of 2. Using the non-parametric independent samples median test, these differences were not found to be statistically significant (p=0.500). The comparison of barrier use during vaginal intercourse in the previous 12 months between mobile dating app users and non-users is summarized in Appendix C in Table 7.

Regarding their last sexual encounter involving vaginal sex, 44.5% of dating app users and 42.6% of non-dating app users reported having had used barrier protection, however the difference in proportions was not found to be statistically significant (p=0.619). The odds (OR) of using dating apps, was 1.08 (95% CI: 0.80-1.45) times higher in those who reported having used barrier protection during their last sexual encounter involving vaginal sex.

When examining the association between relationship type and barrier use, individuals who reported to not be in a monogamous sexual/romantic relationship were more likely to have used barrier protection during their last sexual encounter involving vaginal sex. The odds of not being in a monogamous relationship were 1.61 times greater

(95% CI:1.18-2.18, p=0.002) in those who reported using barrier protection during their last sexual encounter involving vaginal sex.

Barrier Use During Oral Sex

Regarding barrier use during oral sex in the previous 12 months, dating app users reported a mean barrier use of 3.9, and a median barrier use of 4 (4=never). Non-users reported a mean barrier use of 3.9 and a median barrier use of 4. Using the non-parametric independent sample median test, these differences were not found to be statistically significant (p=0.553). The comparison of barrier use during oral sex in the previous 12 months between mobile dating app users and non-users is summarized in Appendix C in Table 7.

Regarding their last sexual encounter involving oral sex, 2.2% of dating app users and 1.2% of non-dating app users reported having had used barrier protection, however, the difference in proportions was not statistically significant (p=0.259). The odds (OR) of using dating apps, was 1.93 (95% CI: 0.60-6.12) times higher in those who reported having used barrier protection during their last sexual encounter involving oral sex.

Chi-square analysis was used to compare barrier use during oral sex between individuals in different types of relationships. There was no statistically significant association between relationship type and use of barrier protection during oral sex.

Barrier Use During Anal Sex

Regarding barrier use during receptive anal intercourse in the previous 12 months, dating app users reported a mean barrier use of 2.93, and a median barrier use of 3 (3=rarely). Non-users reported a mean barrier use of 2.98 and a median barrier use of 3. Using the non-parametric independent sample median test, these differences were not found to be statistically significant (p=0.878). The comparison of barrier use during receptive anal intercourse in the previous 12 months between mobile dating app users and non-users is summarized in Appendix C in Table 7.

Regarding barrier use during penetrative anal intercourse in the previous 12 months, dating app users reported a mean barrier use of 2.88, and a median barrier use of 3 (3=rarely). Non-users reported a mean barrier use of 2.96 and a median barrier use of 3. Using the non-parametric independent sample median test, these differences were not found to be statistically significant (p=0.553). The comparison of barrier use during penetrative anal intercourse in the previous 12 months between mobile dating app users and non-users is summarized in Appendix C in Table 7.

Regarding their last sexual encounter involving anal sex, 28.6% of dating app users and 15.1% of non-dating app users reported having had used barrier protection and this difference in proportions was statistically different (p=0.020) from the proportion of those who did not use barrier protection. The odds (OR) of using dating apps was 2.52 (95% CI:1.13-4.51) times higher for those who reported having used barrier protection during their last sexual encounter involving anal sex.

When examining the association between relationship type and condom use, individuals who reported to not be in a monogamous sexual/romantic relationship were less likely to have used barrier protection during their last sexual encounter involving anal sex. The odds of being in a monogamous relationship were 2.2 times greater (95% CI:1.09-4.42, p=0.025) in those who reported using barrier protection during their last sexual encounter involving anal sex.

Substance Use During Sex

The frequency of substance use during sexual encounters was measured on a five-point Likert scale (0=Never, 1=Rarely, 2=Sometimes, 3=Usually, 4=Always). These responses were recoded into binary outcomes due to low responses at the high end of the scale. 'Frequent consumption' is noted to include those who responded to questions 16-18 with 'Always' or 'Usually' and 'infrequent or never consumption' includes those who responded with 'Sometimes', 'Rarely' or 'Never'.

Alcohol Consumption

Regarding alcohol consumption during sexual activity in the previous 12 months, dating app users reported a mean use of 1.43, and a median use of 1 (1=rarely). Non-users reported a mean use of 0.95 and a median use of 1. Using the non-parametric independent samples median test, these differences were found to be statistically significant (p<0.001). The comparison of alcohol consumption during sexual activity in the previous 12 months between mobile dating app users and non-users is summarized in Appendix C in Table 9.

Regarding 'frequent' alcohol consumption during sexual activity, 12.9% of dating app users and 3.6% of non-dating app users reported 'frequent' alcohol consumption during sexual activity. Chi-square analysis was used to compare alcohol consumption during sexual activity between mobile dating app users and non-users. This difference in proportions was statistically significant (p<0.001).

The odds (OR) of using dating apps was 3.94 (95% CI:2.17-7.14) times higher in those who reported frequent alcohol consumption in combination with sexual activity (Table 8).

Cannabis Consumption

Regarding cannabis consumption during sexual activity in the previous 12 months, dating app users reported a mean use of 0.69, and a median use of 0 (0=never). Non-users reported a mean use of 0.40 and a median use of 0. Using the non-parametric independent samples median test, these differences were found to be statistically significant (p<0.001). The comparison of cannabis consumption during sexual activity in the previous 12 months between mobile dating app users and non-users is summarized in Appendix C in Table 9.

Regarding 'frequent' cannabis consumption during sexual activity, 5.9% of dating app users and 1.8% of non-dating app users reported 'frequent' cannabis consumption during sexual activity. Chi-square analysis was used to compare cannabis consumption during sexual activity between mobile dating app users and non-users. This difference in proportions was statistically significant (p=0.003).

The odds (OR) of using dating apps was 3.36 (95% CI:1.45-7.78) times higher in in those who reported frequent cannabis consumption in combination with sexual activity (Table 8).

Illicit Drug Consumption

Regarding illicit drug consumption during sexual activity in the previous 12 months, dating app users reported a mean barrier use of 0.12, and a median barrier use of 0 (0=never). Non-users reported a mean barrier use of 0.03 and a median barrier use of 0. Using the non-parametric independent samples median test, the difference in illicit drug use in combination with sexual activity between app users and non-dating app users was found to be statistically significant (p<0.001). The comparison of illicit drug consumption during sexual activity in the previous 12 months between mobile dating app users and non-users is summarized in Appendix C in Table 9.

Sexually Transmitted Infections

STI Testing

Dating app users were more likely to get tested for STIs, with 52.1% of dating app users and 32.6% of non-dating app users reporting having had an STI test in the previous 12 months. Chi-square analysis determined that the proportion of individuals who received an STI test in the previous 12 months was statistically (p<0.001) different from the proportion of those who did not seek testing.

The odds (OR) of using dating apps was 2.25 (95% CI:1.73-2.94) times higher in those reporting having had an STI test in the previous 12 months (Table 8).

STI Diagnosis

Over 9% (9.8%) of dating app users and 5.0% of non-dating app users reported being diagnosed with an STI in the previous 12 months. Chi-square analysis determined that the proportion of app users who were diagnosed with an STI test in the previous 12 months was not statistically different from the proportion of non-users who were diagnosed with an STI (p=0.075). The odds (OR) of using dating apps was 2.07 (95% CI: 0.92-4.66) times higher in those who reported having been diagnosed with an STI test in the previous 12 months (Table 8)

Diagnosis with an STI was statistically associated with alcohol consumption, cannabis consumption, and condom use (p=0.075). Individuals who were diagnosed with an STI were more likely to frequently use alcohol in combination with sexual activity (OR=5.20, 95% CI: 1.99-13.63). Individuals who were diagnosed with an STI were more likely to frequently use cannabis in combination with sexual activity (OR=4.89, 95% CI: 1.45-16.46). Individuals who were diagnosed with an STI were less likely to report 'Always' or 'Usually' using barrier protection during vaginal sex (OR=0.39, 95% CI: 0.16-0.96). There was no statistically significant association between STI diagnosis and condom use during oral or anal sex. Current relationship status was not associated with STI diagnosis. These results are summarized in Table 10 provided in Appendix C.

Logistic Regression Analysis

<u>STI Testing</u>

A binary logistic regression model was created to predict the probability of having had an STI test in the previous 12 months. In this logistic regression model, the only two statistically significant predictors of having had an STI test in the previous 12 months number of sexual partners in the previous 12 months (p<0.001), and sexuality (p=0.023). Specifically, the probability of having had an STI test in the previous 12 months is higher for those who have a higher number of sexual partners and identify as heterosexual. This model had a Nagelkerke R square value of 0.168. This model is summarized in Table 11.

The Andrew F. Hayes PROCESS test[26] was performed on the model to assess what mediated the association of dating app use with STI testing. The indirect effects of dating app use on STI testing through number of sexual partners was significant (effect=0.63, 95% CI:0.37-1.04) (Table 12), suggesting that people who use dating apps are more likely to be tested for STIs because they also have more sexual partners.

<u>STI Diagnosis</u>

A binary logistic regression model was created to predict the probability of having been diagnosed with an STI in the previous 12 months. In this logistic regression model, the only statistically significant predictor of having had an STI diagnosis in the previous 12 months was number of sexual partners in the previous 12 months (p=0.046). Specifically, the probability of having had an STI diagnosis in the previous 12 months is

higher for those who have a higher number of sexual partners. This model had a

Nagelkerke R square value of 0.106. This model is summarized in Table 13.

The Andrew F. Hayes PROCESS test was performed on the model to determine

any indirect effects of dating app use on STI diagnosis. No mediators of dating app use

were detected in this model.

CHAPTER 4: DISCUSSION

Risky Sexual Behaviour

In this sample population, Ontario university students who used dating apps in the previous 12 months were more likely to engage in some risky sexual behaviours compared to students who did not use dating apps. Survey respondents who reported using mobile dating apps in the previous 12 months were more likely to have a greater number of lifetime sexual partners and sexual partners in the previous year, have multiple concurrent sexual partners, and use alcohol and cannabis in combination with sexual activity more frequently than non-dating app users.

Number of Sexual Partners

Individuals who reported using dating apps in the previous 12 months reported a significantly greater number of lifetime sexual partners and partners within the previous 12 months, compared to individuals who did not report using mobile dating apps. Dating app users reported an average of 9.93 lifetime partners while the mean number of sexual partners for non-users was 4.07. For the previous 12 months, mobile dating app users reported an average of 3.95 sexual partners while non-users reported an average of 1.45.

These results are consistent with similar studies. A 2018 cross-sectional study conducted with 20,091 respondents belonging to the general population of Australia between the ages of 16 and 69 years old reported that the strongest correlate of having had sex with someone met using the internet was having a higher number of sexual partners in the previous year. Also, an American study with MSM found that respondents

who used Grindr™ to meet sexual partners reported having more sexual partners in the past 12 months compared to individuals who had never used Grindr™.

Because dating apps allow individuals to meet many others within a small geographic area in a given time period, they offer the potential for individuals to meet more sexual partners than typically expected. Therefore, it is of no surprise that individuals who use dating apps report more sexual partners than those who do not use dating apps.

Substance Use

Dating app users reported a statistically significant higher use of alcohol and cannabis in combination with sexual activity, in comparison with non-dating app users. The odds (OR) of using dating apps was 3.94 times higher in those who reported frequent alcohol consumption in combination with sexual activity. The odds (OR) of using dating apps was 3.36 times higher in in those who reported frequent cannabis consumption in combination with sexual activity.

Studies have demonstrated an association between substance use and risky sexual behaviour. A cross-sectional study of American college students reported that students who exhibited risky sexual behaviour were more likely to report higher alcohol use ($p < 0.001$) and higher drug use ($p < 0.001$)[27]. Beymer et al (2014) also reported that mobile dating app use was higher amongst MSM who reported higher ecstasy and cocaine use[23].

Relationship Status

Dating app users were more likely to be in relationships with multiple concurrent sexual partners, specifically non-monogamous romantic relationships and casual sexual relationships. The odds (OR) of using dating apps was 5.65 times greater in those who reported being in a non-monogamous romantic and sexual relationship. The odds (OR) of using dating apps was 12.57 times greater in those who reported to be casually dating with multiple sexual partners. This association between relationship status and dating app use is unsurprising as dating apps are used to facilitate the meeting of individuals. Also, many dating app users reported using dating apps to find partners for casual sex, indicating that they may not be seeking long-term partners, but may be looking to establish sexual relationships with multiple individuals.

Condom Use

There was no difference in condom use during vaginal sex and oral sex between mobile dating app users and non-dating app users, both over the previous 12 months and at the last sexual encounter. Regarding sexual activity involving both penetrative and receptive anal sex in the previous 12 months, there was no difference in condom use between mobile dating app users and non-dating app users. However, when examining respondent's last sexual encounter involving anal sex, condom use was more likely amongst dating app users. Regarding their last sexual encounter involving anal sex, 28.6% of dating app users and 15.1% of non-dating app users reported having had used barrier protection. The odds of using dating apps was 2.52 times greater for those who

reported having used barrier protection during their last sexual encounter involving anal sex. However, these results should be interpreted with caution as the number of respondents reporting engaging in anal sex is small in comparison to the entire sample.

Though barrier use during vaginal sex did not appear to vary with dating app use, overall, barrier use was low in this population. A 2013 study of Canadian university students aged 18-24 reported that 47.0% of study participants reported having used a condom during their last sexual encounter involving penile-vaginal intercourse[28]. In comparison, in this sample, 43.5% reported having used a condom during their last sexual encounter involving vaginal sex. When asked how frequently respondents used some form of barrier protection during vaginal intercourse in the previous 12 months, 28.2% reported 'Always' and 21.0% reported 'Never' using barrier protection during vaginal sex. When discussing barrier use during sex, it is important to interpret the findings in the context of the sexual relationship. This sample was overwhelmingly female (83.5%) and many reported being in a monogamous romantic/sexual relationship. It is possible that barrier protection was not frequently used because of a perceived low risk of contracting an STI, in addition to the use of other forms of birth control. Other studies have also demonstrated that women are less likely to use condoms when engaging in sex with a known and committed partner[29].

With oral sex, an overwhelming 94.7% of respondents reported never using barrier protection during oral sex in the previous 12 months, and 98.4% reported not using barrier protection during their last sexual encounter involving oral sex. With oral sex, low barrier use could be due to inadequate knowledge surrounding dental dams and

low access to these alternative forms of barrier protection, in addition to the lower

perceived risk of STIs and no risk of pregnancy associated with oral sex.

Regarding anal sex, 60.5% reported never using barrier protection during

receptive anal sex and 68.1% reported never using barrier protection during penetrative

anal sex in the previous 12 months. When asked about their last sexual engagement

involving anal sex, 20.2% of respondents reported using a form of barrier protection, and

79.8% reported not using barrier protection. The high percentage of female respondents

may also explain why barrier use during anal sex was also low in this sample. Females

engaging in anal sex may be less likely to use barrier protection during receptive anal

intercourse because there is no risk of pregnancy, and the perceived low risk of STI

transmission in committed relationships.

Sexually Transmitted Infections

In this sample population, Ontario university students who used mobile dating

apps were more likely to have been tested for STIs in the previous 12 months compared

to non-dating app users, however, STI diagnosis was not significantly associated with

dating app use.

STI Testing

Dating app users were more likely to get tested for STIs, with 52.1% of dating app

users and 32.6% of non-dating app users reporting having had an STI test in the previous

12 months. The odds (OR) of using dating apps was 2.25 times higher in those reporting

having had an STI test in the previous 12 months. Other studies have also reported that dating app users are more likely to seek STI testing. A 2016 cross-sectional study analyzed the HIV and STI testing behaviours of 199,308 individuals over the age 18 residing in the United States and found that dating app users were 64.0% more likely to have been tested for an STI compared to non-dating app users[10].

In this study, dating app users were more likely to engage in certain risky behaviours, such as having a greater number of sexual partners and having multiple concurrent sexual partners. Having a greater number of sexual partners also mediated the association of dating app use with a higher likelihood of STI testing. Individuals exhibiting these behaviours may be aware of the associated risks, and therefore make STI testing a regular component of their health behaviour.

STI Diagnosis

Over 9% (9.8%) of dating app users and 4.9% of non-dating app users reported being diagnosed with an STI in the previous 12 months, however this difference was not statistically significant (p=0.075). In this sample, only 29 respondents reported being diagnosed with an STI in the previous year. Due to this small sample, it is possible that the lack of statistical significance at the 95% confidence level is due to sample size. Additionally, reliance on self-reported data for medical diagnoses can be misleading. It is possible that social desirability biased respondents to not report their STI status, or that individuals were genuinely confused if they had in fact been diagnosed with an STI (notably, 6 respondents reported that they were 'unsure' if they had been diagnosed with

an STI in the previous 12 months). Additionally, only 49.5% of the sample who reported

engaging in sexual activity in the previous 12 months also reported having been tested for

STIs in the same time period. It is therefore important to note that cases of STIs were

likely missed due to the lack of testing demonstrated in this sample.

STI diagnosis was statistically associated with alcohol consumption, cannabis

consumption, and condom use. The odds (OR) of having been diagnosed with an STI in

the previous year were 5.2 times greater in those who frequently used alcohol in

combination with sexual activity, 4.89 times greater in those who frequently used

cannabis in combination with sexual activity, and around 60.0% less likely for those who

reported 'Always' or 'Usually' using barrier protection during vaginal sex. These results

are consistent with other studies. Chan et all (2018) found in their cross-sectional study of

American MSM that STI diagnosis was associated ($p<0.05$) with higher frequency of

alcohol consumption (aOR=2.87), methamphetamine use (aOR=4.49), and lower

frequency of condom use (aOR=2.3-3.67).

Study Limitations

To my knowledge, no previous study has analyzed sexual health and mobile

dating app use in Ontario university students and this study therefore provides novel

insight into the association between mobile dating apps use, risky sexual behaviour and

STIs. This study has several limitations which must be considered when interpreting its

results. First, because this study used a cross-sectional design, we cannot assume a cause-

effect relation between mobile dating app use and risky sexual behaviour and STIs.

Additionally, because this study asked respondents to reflect on their behaviour within the previous 12 months, we cannot establish temporality between the exposure and outcomes.

This study also relied on self-reported data collected via Internet survey and this methodological design also has limitations. Due to the sensitive nature of the survey, respondents may not have responded truthfully to all questions, especially those of sensitive topics, such as STIs, sexual activity, sex work, and substance use. This may have resulted in an under-reporting of such behaviours. To limit social desirability bias, respondents were told upon beginning the survey that it was completely anonymous and that no personal identifiable information would be collected.

Although this study had a moderate sample size (N=965), the majority of the sample was cisgender female (83.7%) and heterosexual (76.1%). These characteristics do not reflect the true population of Ontario university students[30], and therefore it is likely that the results are not completely generalizable to all university students.

Public Health Implications

The incidence rates of STIs have been increasing across Canada for several years, and this indicates the need for a better understanding of sexual behaviour, especially in young adults aged 15-29, who represent the population at highest risk of contracting an STI. Mobile dating apps have changed how people engage with others romantically and sexually. Their popularity has altered the dating environment and will likely continue to influence how people will meet partners and initiate romantic and sexual connections. Therefore, it is necessary that we understand how mobile dating apps have contextualized

sexual behaviour. Additionally, public health must find ways to use mobile dating apps to promote healthy sexual behaviour. The results of this study allude to low condom use and testing behaviour in Ontario university students. Public health should use mobile dating apps in health promotion campaigns, and partnerships between dating apps and public health should be established. Under this partnership, mobile dating apps could be used to connect users with STI testing centers and could be used to facilitate contact tracing if needed. This study also presents a relationship between mobile dating app use and substance use. It is important for public health to acknowledge this relationship in the context of sexual health and provide education and harm reduction strategies for individuals engaging in substance use in combination with sexual activity.

Conclusion

This cross-sectional study provides novel insight into the association between mobile dating app use, risky sexual behaviour and STIs. My study found that Ontario university students who use dating apps were more likely to engage in some risky sexual behaviours compared to students who did not use dating apps and were more likely to have been tested for STIs in the previous 12 months compared to non-dating app users. However, STI diagnosis was not significantly associated was dating app use. This study provides a foundational understanding for the relationship between dating app use and sexual behaviour in Ontario university students, and further studies should be conducted to deepen this understanding. This study could provide public health professionals with guidance for encouraging safer sexual practices amidst a changing dating landscape that

increasingly relies on mobile dating apps to facilitate the meeting of potential partners. It is almost certain that mobile dating apps will continue to be a prominent tool for fostering romantic and sexual connections, and it is therefore important that public health develops a thorough understanding of sexual behaviour within this context to ensure positive sexual health outcomes.

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Appendix A: List of Mobile Dating Apps and Their Intended Audiences

Mobile Dating App	Intended Audience
Tinder	Everyone
Bumble	Everyone
Hinge	Everyone
HER	Lesbian, queer and bisexual women and non-binary people
Grindr	Gay, queer, bisexual and transgendered people

Appendix B: Mobile Dating Apps, Sexual Behaviour and STIs Survey

Survey: The association between mobile dating app use and incidence of sexually transmitted infections and risky sexual behaviour in Ontario university students

SCREENING QUESTION: **Are you currently a full- or part-time undergraduate or graduate student enrolled in an Ontario university?**
Yes
No *(Those who answer no will be directed to the end of the survey)*

1. MOBILE DATING APP INFORMATION

1.1 In the past 12 months, have you used a mobile dating app (Ex. Tinder, Grindr, Bumble, Hinge, or any mobile phone-based application that uses GPS technology to facilitate the meeting of individuals for dating purposes) to meet romantic partners or partners for casual sex?
Yes
No *(Those who answer 'No' will skip this section and be directed to question 2.1)*
Prefer not to say *(Those who answer 'Prefer not to say' will skip this section and be directed to question 2.1)*

1.2 Please indicate to what extent you have used the following mobile dating apps in the past 12 months to meet romantic partners or partners for casual sex.
  A) Tinder
Never
Once a year
Once every few months
1-3 times per month
3-5 times per week
daily

B) Grindr
Never
Once a year
Once every few months
1-3 times per month
3-5 times per week
daily

C) Bumble

Never
Once a year
Once every few months
1-3 times per month
3-5 times per week
daily

D) Hinge
Never
Once a year
Once every few months
1-3 times per month
3-5 times per week
daily

E) HER
Never
Once a year
Once every few months
1-3 times per month
3-5 times per week
daily

F) Other App
Never
Once a year
Once every few months
1-3 times per month
3-5 times per week
daily

1.3 What is your primary objective for using each mobile dating app listed below? Please select all that apply.

A) Tinder
To meet partners for casual sex
To meet partners for romantic relationships
To meet individuals for friendships

B) Grindr
To meet partners for casual sex

To meet partners for romantic relationships
To meet individuals for friendships

C) Bumble
To meet partners for casual sex
To meet partners for romantic relationships
To meet individuals for friendships

D) Hinge
To meet partners for casual sex
To meet partners for romantic relationships
To meet individuals for friendships

E) HER
To meet partners for casual sex
To meet partners for romantic relationships
To meet individuals for friendships

F) Other App
To meet partners for casual sex
To meet partners for romantic relationships
To meet individuals for friendships

2. SEXUAL BEHAVIOUR

2.1 In the past 12 months have you engaged in sexual activity of any kind?
Yes *(Those who answer 'Yes' will be directed to questions 2.2-2.17)*
No *(Those who answer 'No' will be directed to question 2.18)*
Prefer not to say *(Those who answer 'Prefer not to say' will be directed to question 2.18)*

2.2 How many sexual partners have you had in your lifetime?
_____

2.3 How many sexual partners have you had in the past 12 months? _____

2.4 In the past 12 months, how many sexual partners have you met using mobile dating apps? _____

2.5 Regarding your sexual encounters in the last 12 months, how often did you and your partner(s) use barrier protection (condom, dental dam, etc.) during vaginal intercourse?

Always (100%)
Usually (75%)
Sometimes (50%)
Rarely (25%)
Never (0%)
Not Applicable

2.6 Regarding your sexual encounters in the last 12 months, how often did you and your partner(s) use barrier protection (condom, dental dam, etc.) during oral sex?
Always (100%)
Usually (75%)
Sometimes (50%)
Rarely (25%)
Never (0%)
Not applicable

2.7 Regarding your sexual encounters in the last 12 months, how often did you and your partner(s) use barrier protection (condom, dental dam, etc.) during receptive anal intercourse?
Always (100%)
Usually (75%)
Sometimes (50%)
Rarely (25%)
Never (0%)
Not applicable

2.8 Regarding your sexual encounters in the last 12 months, how often did you and your partner(s) use barrier protection (condom, dental dam, etc.) during penetrative anal intercourse?
Always (100%)
Usually (75%)
Sometimes (50%)
Rarely (25%)
Never (0%)
Not applicable

2.9 If you did not answer 'Always' to any of questions 2.5-2.8, what are some of the reasons as to why you and your partner(s) did not use barrier protection (condom, dental dam, etc.)
OPEN RESPONSE QUESTION

2.10 Regarding your most recent sexual encounter involving vaginal penetration, did you and your partner(s) use barrier protection?
Yes
No
Not applicable

2.11 Regarding your most recent sexual encounter involving oral stimulation, did you and your partner(s) use barrier protection?
Yes
No
Not applicable

2.12 Regarding your most recent sexual encounter involving anal penetration, did you and your partner(s) use barrier protection?
Yes
No
Not applicable

2.13 In the previous 12 months, have you engaged in sexual activity in return for money or other resources?
Yes
No
Prefer not to say

2.14 In the previous 12 months, have you payed someone, whether in money or other resources, in exchange for sex?
Yes
No
Prefer not to say

2.15 How often do you use alcohol in combination with sexual activity?
Always (100%)
Usually (75%)
Sometimes (50%)
Rarely (25%)
Never (0%)

2.16 How often do you use cannabis in combination with sexual activity?
Always (100%)
Usually (75%)
Sometimes (50%)

Rarely (25%)
Never (0%)

2.17 How often do you use illicit drugs in combination with sexual activity?
Always (100%)
Usually (75%)
Sometimes (50%)
Rarely (25%)
Never (0%)

2.18 Please choose the option that most accurately represents your dating/romantic status at the present time.
In a monogamous romantic and sexual relationship with one partner
In a non-monogamous romantic relationship (one main sexual partner, with additional partners)
Casual monogamous relationship (one sexual partner, "Friends with benefits")
Casually dating with multiple sexual partners
Not dating or engaging in sexual activity

3. SEXUALLY TRANSMITTED INFECTIONS

3.1 In the previous 12 months, have you been tested for sexually transmitted infections (STIs, excluding HIV)?
Yes *(Those who answer 'Yes' will be directed to question 3.3)*
No *(Those who answer 'No' be directed to question 3.2)*

3.2 If you answered 'No' to question 3.1, what are some of the reasons as to why you did not seek STI testing in the previous 12 months?
OPEN RESPONSE QUESTION

3.3 In the previous 12 months, have you been diagnosed with an STI (excluding HIV)?
Yes (*Those who answer 'Yes' will be directed to questions 3.4-3.5)*
No *(Those who answer 'No' will skip this section and be directed to question 4.1)*
Unsure *(Those who answer 'Unsure' will skip this section and be directed to question 4.1)*

3.4 If yes, what diagnosis did you receive? Select all that apply.
Chlamydia
Gonorrhea
Primary Syphilis

Secondary Syphilis
Early Latent Syphilis2.
Genital Herpes
Genital Warts (caused by Human Papillomavirus (HPV))
Trichosomiasis ("Trich")
None
Other:_____

3.5 How did you find out you had an STI?
Tested
Notified as a contact by my partner
Notified as a contact by public health or healthcare provider

4. DEMOGRAPHIC INFORMATION

4.1 What is your gender?
Cis Female
Cis Male
Transgender Female
Transgender Male
Non-Binary
Other: _____
Prefer not to say

4.2 Do you consider yourself to be:
Heterosexual
Homosexual
Bisexual
Other: _____
Prefer not to say

4.3 What is your age?

_____

4.4 What is your race?
East Asian
Black/Afro-Caribbean
Caucasian
Indigenous/First Nations/Aboriginal Canadian
Latinx
South Asian

Middle Eastern
Other: _____
Prefer not to say

4.5 Are you using the Ontario Student Assistant Program (OSAP), or a similar government-funded loan, to pay for your post-secondary education?
Yes
No
Unsure

4.6 Are you currently employed?
Yes
No

4.7 If yes, how many hours do you approximately work each week?
< 5 hours per week
5-10 hours per week
10-15 hours per week
15-20 hours per week
20-25 hours per week
>25 hours per week
Not applicable

(The survey will automatically take the participant to a new URL where the following information will be displayed)

Do you wish to receive a report summarizing the results of this survey?
Yes, I wish to receive a report summarizing the results of this survey.
No, I do not wish to receive a report summarizing the results of this survey. (Those who choose 'No' will be directed to the end of the survey)

Please provide us with the following contact information:

Name:_____

Email Address:_____

Note that your name and contact information will remain completely confidential and will not be associated with any of your survey answers.

END OF SURVEY

Appendix C: Results Tables

Table 1. Analysis of Survey Respondents' Demographic Characteristics	
Variable	**n (%)**
Race	
Black/Afro-Caribbean	30 (3.1)
Caucasian	612 (63.4)
East Asian	102 (10.6)
Indigenous	4 (0.4)
Latinx	18 (1.9)
Middle Eastern	38 (3.9)
South Asian	101 (10.5)
Other	60 (6.2)
TOTAL (N)	965 (100)
Gender	
Cis Female	808 (83.7)
Cis Male	138 (14.3)
Trans Female	1 (0.1)
Trans Male	2 (0.2)
Non-Binary	8 (0.8)
Other	8 (0.8)
TOTAL (N)	965 (100)
Sexuality	
Heterosexual	734 (76.1)
Homosexual	34 (3.5)
Bisexual	171 (17.7)
Prefer not to say	1 (0.1)
Other	25 (2.6)
TOTAL (N)	965 (100)
OSAP	
Yes	515 (53.4)
No	436 (45.3)
Unsure	14 (1.5)
TOTAL (N)	965 (100)

Employment	
Yes	495 (51.6)
No	465 (48.4)
TOTAL (N)	960 (100)
Hours worked per week	
<5	67 (13.5)
5-10	126 (25.5)
10-15	117 (23.6)
15-20	67 (13.5)
20-25	27 (5.5)
>25	86 (17.4)
Not Applicable	5 (1.0)
TOTAL (N)	495 (100)
Relationship Type	
Monogamous Romantic Relationship	491 (50.9)
Non-monogamous Romantic Relationship	29 (3.0)
Casual Monogamous Sexual Relationship (Friends with Benefits)	86 (8.9)
Multiple Casual Sexual Partners	77 (8.0)
Single/No Sexual Activity	282 (29.2)
TOTAL (N)	965 (100)

Table 2. Frequency of Mobile Dating App Use by Respondents Reporting Usage in the Previous 12 Months

Mobile Dating App	Once a Year		Once Every Few Months		1-3 Times per Month		3-5 Times per Week		Daily		Total (N) Reporting Any Use (% of all users)	Total Reporting Any Use (% of entire sample)
	n	%	n	%	n	%	n	%	n	%		
Tinder™	54	15.2	107	30.14	79	22.3	70	19.7	45	12.7	355 (88.5)	36.8
Grindr™	0	0	3	25	2	16.7	1	8.3	6	50	12 (3)	1.2
Bumble™	51	25.2	59	29.2	45	12.7	31	15.4	16	7.9	202 (50.4)	20.9

Hinge™	27	31.0	21	24.1	17	19.5	17	19.5	5	5.8	87 (21.7)	9.0
HER™	10	29.4	13	38.2	4	11.8	7	20.6	0	0	34 (8.5)	3.5
Other	12	23.5	17	33.3	11	21.6	9	17.7	2	3.9	51 (12.7)	5.3

Table 3. Primary Reason for Using Mobile Dating Apps by Respondents Reporting Usage in the Previous 12 Months

Dating App	Casual Sex		Romantic Relationships		Friendships		TOTAL
	n	%	n	%	n	%	N
Tinder™	154	41.1	202	53.9	19	5.1	375
Grindr™	32	43.8	22	30.1	19	26.0	73
Bumble™	38	16.9	161	71.6	26	11.6	225
Hinge™	29	23.4	82	66.1	13	10.5	124
HER™	20	25.0	45	56.4	15	18.8	80
Other	24	28.2	49	57.7	12	14.1	85

Responses to question 3 of the *Mobile Dating Apps, Sexual Behaviour and Sexually Transmitted Infections Survey*: What is your primary objective for using each mobile dating app listed below?

Table 4. Frequency of Barrier Protection Used During Vaginal, Oral, and Anal Sex

	Always (%)	Usually (%)	Sometimes (%)	Rarely (%)	Never (%)	TOTAL (N)
Vaginal Sex	203 (28.2)	131 (18.2)	94 (13.1)	141 (19.6)	151 (21.0)	720
Oral Sex	12 (1.6)	6 (0.8)	4 (0.5)	17 (2.3)	702 (94.7)	741
Receptive Anal Sex	26 (16.3)	10 (6.3)	3 (1.9)	12 (7.5)	109 (68.1)	160
Penetrative Anal Sex	30 (18.5)	16 (9.9)	3 (3.1)	13 (8.0)	98 (60.5)	162

Table 5. Frequency of Substance Use During Sexual Activity

	Always		Usually		Sometimes		Rarely		Never		TOTAL
	n	%	n	%	n	%	n	%	n	%	N
Alcohol	19	2.5	39	5.1	167	21.8	360	46.9	182	23.7	767

Cannabis	9	1.2	18	2.4	60	7.8	190	24.8	490	63.9	767
Drugs	0	0	0	0	9	1.2	35	4.6	722	94.1	766

Responses to questions 16-18 of the *Mobile Dating Apps, Sexual Behaviour and Sexually Transmitted Infections Survey*: In the past 12 months, how often did you use alcohol, cannabis or illicit drugs in combination with sexual activity?

Table 6. Comparison of Number of Sexual Partners Between Mobile Dating App Users and Non-Users Using the Non-Parametric Independent Sample Median Test

	Lifetime Sexual Partners			Sexual Partners in Previous 12 Months			Sexual Partners Met on Dating Apps in Previous 12 months		
	Median	Min	Max	Median	Min	Max	Median	Min	Max
Dating App Users	6	1	157	3	0	25	1	0	22
Non-Users	2	1	200	1	1	32			
p	0.000			0.000					

Table 7. Comparison of Barrier Use During Sexual Activity of Mobile Dating App Users and Non-Users Using the Non-Parametric Independent Sample Median Test

	Condom Use During Vaginal Intercourse		Condom Use During Oral Intercourse		Condom Use During Receptive Anal Intercourse		Condom Use During Penetrative Anal Intercourse		Average Condom Use	
	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median
Mobile Dating App Users	2.06 (1.605)	2	3.90 (0.687)	4	2.93 (0.507)	3	2.88 (0.522)	3	2.648 (0.613)	2.667
Non-Users	2.36 (1.686)	2	3.93 (0.578)	4	2.98 (0.460)	3	2.96 (0.554)	3	2.820 (0.729)	2.667
P		0.500		0.553		0.878		0.553		0.002

Table 8. Univariate analyses to detect factors associated mobile dating app use			
	Odds Ratio	**95% CI**	**P**
Condom Use During Last Sexual Encounter Involving Anal Sex	2.253	[1.125, 4.512]	0.020
Condom Use During Last Sexual Encounter Involving Oral Sex	1.926	[.605. 6.124]	0.259
Condom Use During Last Sexual Encounter Involving Vaginal Sex	1.079	[0.801, 1.453]	0.619
Frequent Alcohol Consumption	3.942	[2.174, 7.148]	0.000
Frequent Cannabis Consumption	3.361	[1.452, 7.776]	0.003
Multiple Concurrent Sexual Partners	10.724	[6.103, 18.844]	0.000
STI Testing	2.254	[1.732,2.935]	0.000

Table 9. Comparison of Substance Use Between Mobile Dating App Users and Non-Users Using the Non-Parametric Independent Sampled Median Test						
	Alcohol Consumption During Sexual Encounters		**Cannabis Consumption During Sexual Encounters**		**Illicit Drug Consumption During Sexual Encounters**	
	Mean (SD)	**Median**	**Mean (SD)**	**Median**	**Mean (SD)**	**Median**
Dating App Users	1.43 (1.022)	1	0.6862 (0.95579)	0	0.12 (0.39409)	0
Non-Users	0.95 (0.78)	1	0.4023 (0.70112)	0	0.0318 (0.18823)	0
Significance	0.000		0.000		0.000	

Table 10. Univariate analyses to detect factors associated with STI Diagnosis			
	Odds Ratio	**95% CI**	**P**
Frequent Alcohol Consumption	5.202	[1.986, 13.626]	0.000
Frequent Cannabis Consumption	4.887	[1.451, 16.461]	0.005

Frequent Condom Use During Penetrative Anal Sex	0.502	[0.115, 2.910]	0.502
Frequent Condom Use During Receptive Anal Sex	0.934	[0.296, 3.761]	0.934
Frequent Condom Use During Vaginal Sex	0.396	[0.164.957]	0.034
Mobile Dating App Use	2.066	[0.916, 4.661]	0.075
Multiple Concurrent Sexual Partners	1.001	[0.393,2.548]	0.998

Table 11: Logistic Regression Model Predicting STI Testing			
	Sig.	**Exp.B (OR)**	**95% CI**
Null Model	0.881	0.989	
Block 1			
Do you use dating apps?	0.000	2.492	[1.839, 3.378]
Constant	0.000	0.665	
Block 2			
Dating App Use	0.064	1.406	[0.981, 2.016]
Number of Sexual Partners in Previous 12 Months	0.000	1.333	[1.200, 1.481]
Heterosexuality	0.103	1.480	[0.924, 2.371]
Frequency of alcohol consumption in combination with sexual activity	0.862	1.016	[0.847, 1.220]
Frequency of cannabis consumption in combination with sexual activity	0.168	1.156	[0.941, 1.420]
Average Condom Use	0.327	1.111	[0.900, 1.371]
Constant	0.000	0.219	
Block 3			
Dating App Use	0.054	1.429	[0.994, 2.054]
Number of Sexual Partners in Previous 12 Months	0.000	1.340	[1.206, 1.489]
Heterosexuality	0.023	2.835	[1.152, 6.978]

Frequency of alcohol consumption in combination with sexual activity	0.891	1.013	[0.842, 1.218]
Frequency of cannabis consumption in combination with sexual activity	0.214	1.141	[0.927, 1.405]
Average Condom Use	0.298	1.119	[0.906, 1.383]
Age	0.206	1.048	[0.975, 1.127]
Employment	0.919	0.983	[0.709, 1.363]
Race	0.980	0.999	[0.913, 1.093]
Gender	0.125	1.628	[0.875, 3.034]
Constant	0.003	0.043	

Variables Included in Model:
- Mobile dating app use - Binary (0=No, 1=Yes)
- Number of sexual partners in previous 12 months - Continuous
- Heterosexuality - Binary (0=Not-heterosexual, 1=Heterosexual)
- Average Condom Use - Continuous (1=Always - 5=Never)
- Alcohol Consumption in Combination with Sexual Activity - Continuous (0=Never - 5=Always)
- Cannabis Consumption in Combination with Sexual Activity - Continuous (0=Never - 5=Always)
- Age - Continuous
- Employment - Binary (0=Employed, 1=Not employed)
- Gender - Nominal (0=Cisgender Female, 1=Cisgender Male, 2=Transgender Female, 3=Transgender Male, 4=Non-Binary, 5=Other)
- Race - Nominal (0=East Asian, 1=Black/Afro-Caribbean, 2=Caucasian, 3=Indigenous, 4=Latinx, 5=South Asian, 6=Middle Easter, 7=Other)

Table 12. Results of the Andrew F. Hayes Test of the Indirect Effects of Dating App Use on STI Testing

	Effect	**BootSE**	**BootLLCI***	**BootULCI***
# of Sexual Partners in Previous 12 Months	0.6259	0.1701	0.3712	1.0443

*95% Confidence Interval
Covariates in model: Average condom use, frequency of alcohol consumption, frequency of cannabis consumption and sexuality.

Table 13. Logistic Regression Model Predicting STI Diagnosis

	Sig.	**Exp.B (OR)**	**95% CI**
Null Model	0.000	0.083	
Block 1			
Do you use dating apps?	0.041	2.525	[1.039, 6.136]

Constant	0.000	0.046	
Block 2			
Dating App Use	0.364	1.562	[0.596, 4.093]
Number of Sexual Partners in Previous 12 Months	0.042	1.091	[1.003, 1.186]
Heterosexuality	0.618	1.376	[0.392, 4.824]
Frequency of alcohol consumption in combination with sexual activity	0.304	1.275	[0.802, 2.029]
Frequency of cannabis consumption in combination with sexual activity	0.442	1.172	[0.783, 1.754]
Average Condom Use	0.364	0.809	[0.508, 1.287]
Constant	0.000	0.036	
Block 3			
Dating App Use	0.361	1.571	[0.597,4.137]
Number of Sexual Partners in Previous 12 Months	0.046	1.094	[1.002, 1.194]
Heterosexuality	0.999	0.000	
Frequency of alcohol consumption in combination with sexual activity	0.319	1.273	[0.791, 2.049]
Frequency of cannabis consumption in combination with sexual activity	0.390	1.193	[0.798, 1.786]
Average Condom Use	0.388	0.815	[0.513, 1.296]
Age	0.933	1.088	[0.832, 1.222]
Employment	0.864	0.928	[0.394, 2.184]
Race	0.244	0.848	[0.643, 1.119]
Gender	0.999	0.000	

Variables Included in Model:
- Mobile dating app use - Binary (0=No, 1=Yes)
- Number of sexual partners in previous 12 months - Continuous
- Heterosexuality - Binary (0=Not-heterosexual, 1=Heterosexual)
- Average Condom Use - Continuous (1=Always - 5=Never)
- Alcohol Consumption in Combination with Sexual Activity - Continuous (0=Never - 5=Always)
- Cannabis Consumption in Combination with Sexual Activity - Continuous (0=Never - 5=Always)
- Age - Continuous
- Employment - Binary (0=Employed, 1=Not employed)

- Race - Nominal (0=East Asian, 1=Black/Afro-Caribbean, 2=Caucasian, 3=Indigenous, 4=Latinx, 5=South Asian, 6=Middle Easter, 7=Other)
- Gender - Nominal (0=Cisgender Female, 1=Cisgender Male, 2=Transgender Female, 3=Transgender Male, 4=Non-Binary, 5=Other)