ASSESSING HEALTH RISK AREAS and ACTIVITY-TRAVEL BEHAVIOUR OF CARER-EMPLOYEES

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TITLE ASSESSING HEALTH RISK AREAS and ACTIVITY-TRAVEL BEHAVIOUR OF CARER-EMPLOYEES

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ABSTRACT

Carer-employees are defined as individuals who provide unpaid care to a disabled / ill dependent person(s) while working full-time in the paid labour force. In Canada, there are 6.1 million carer-employees, many of which are experiencing work-life balance struggles, which may result in ill-health. To minimize negative impacts, there is interest in developing caregiver-friendly workplace policies (CFWPs) as an intervention strategy to improve CEs' work-life balance. However, the effectiveness of CFWPs are still in their infancy and often only focus on the work dimension.

One of the most critical dimensions that have not yet been assessed is the activity-travel behaviour of carer-employees, which is largely impacted by the assisted-transport demands of their care-recipient. To contribute to filling in this gap, this dissertation addresses the following objectives: 1) develop an activity-travel behaviour profile of carer-employees using sociodemographic and caregiving characteristics; 2) identify spatial locations with potentially high assisted-transport demand while suggesting new areas to improve mobility independence of care-recipients, and; 3) create and apply a mixed-methods framework that classifies the actual activity-travel behaviour of carer-employees. The purposes of all three objectives are to: contribute to closing the literature gap; visually inform decision-makers and health planners, and; efficiently develop caregiver-friendly transport policies (CFTPs).

Highlighted findings show that carer-employees conducting assisted-transport have lower income and are more likely to be tired and overwhelmed than those not performing the transport task (Objective 1). In Hamilton metropolitan area, 38% of the older adult population are not within immediate reach to a vital service, and another 15% are located in potentially high

assisted-transport demand areas. Suggested areas for service implementation would improve access for older adults by 18% (Objective 2). Lastly, the framework has classified and ranked three types of activity-travel behaviours (Objective 3). All of these findings have led to the discussion of a multi-pronged implementation strategy for uptake of CFTPs.

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PREFACE

This thesis dissertation consists of five chapters: an introduction, three peer-reviewed style research papers, and a conclusion. The first research paper was recently accepted for publication in the *Journal of Gerontological Social Work*. This paper focuses on developing an assisted-transport profile of carer-employees and provides a discussion on whether they are more likely to be overwhelmed than non-assisted transport carer-employees. The second research paper has been recently submitted for peer-review to the *Journal of Transport & Health.* This paper focuses on the potential accessibility to vital services and transit stops in the Hamilton metropolitan area, and the impacts of assisted-transport demand. The third research paper will soon be submitted to the *Journal of Transport & Health* as well. This research paper develops a mixed-methods framework and applies it to classify the activity-travel behaviour of carer-employees conducting assisted-transport.

For each research paper, the first author reviewed the literature, conducted the analyses, translated the results, and wrote the manuscripts. Dr. Allison M. Williams co-authored each paper and contributed her expertise on carer-employees, knowledge translation, and peer-review publication. For the first paper, Dr. Peter Kitchen and Dr. Li Wang provided statistical advice and revisions. Patrick DeLuca provided his expertise in GIS methods and cartography for the second paper. With respect to the third paper, Dr. Darren Scott lent his lab's GPS devices, and provided his expertise in travel behaviour and time geography theory. The three submissions that construct this sandwich thesis are as follows:

Chapter 2:

Dardas, A., Williams, A., Kitchen, P., and Wang, L. (2019). Assisted-Transport Caregiving and its impact towards Carer-Employees. *Journal of Gerontological Social Work.* doi: https://doi.org/10.1080/01634372.2019.1596184

Chapter 3:

Dardas, A., Williams, A., and DeLuca P. (2019). Measuring Potential Assisted-Transport Demand for Older Adult Care-Recipients using the E2SFCA. *Journal of Transport & Health.* Under consideration for publication.

Chapter 4:

Dardas, A., Williams, A., and Scott, D. (2019). Carer-Employees' Travel Behaviour: Assisted-Transport in Time and Space. *Journal of Transport Geography*. Submitted for peer-review.

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Chapter 1 Introduction

1.1 Justification of Research Topic

> "By 2030, seniors are projected to account for 25% of our population. We now bear the responsibility of caring for the elderly, the sick and our children in addition to holding down full-time jobs. Many caregivers are so overburdened that they have no choice but to put careers on hold."
>
> Charles Benayon, Founder & CEO of Aspiria Corp.
> (Huffington Post, June 6th, 2017)

Charles's statement, highlighting the consequences of population aging, has a sense of urgency that cannot be ignored. The causes of population aging are based on the following interwoven factors: 1) a mature economy; 2) medical advances, and; 3) lower fertility rates (Bloom & Luca, 2016; Becker et al., 1990; University of Missouri-Columbia, 2013). Historic evidence has shown that when societies start to industrialize, the population rate grows rapidly due to sudden drop in infant mortality rate (Population Reference Bureau, 2009). An industrializing society experiences improved basic hygiene and the building of institutions, such as an education and a health care system (Population Reference Bureau, 2009), thus improving living standards and longevity. Western societies have experienced this demographic stage from the start of the Industrial Revolution through to the baby-boomer era (Clark, 2014; Roser and Ortiz-Ospina, 2017). A mature economy recognizes well-established institutions and changing cultural norms, specific to women's roles in society and shrinking family size. Public health initiatives, a strengthening health care system, and the empowerment of women in both education and participation in the labour force, are the main drivers in a mature economy; this results in lower fertility and mortality rates and an aging population (Population Reference Bureau, 2009). Globally, there are over 962 million older adults (age 65+) in 2017; this number

is projected to be 2.1 billion in 2050 (United Nations, 2018). Population aging has adjusted the labour participation ratio, which measures the potential support available for older adults.

Japan and most western countries are experiencing low labour force participation ratios. Japan has the lowest, with 2.5 active laborers available to take care of one older adult population (NationMaster, 2013). By comparison, Canada has 4.5 and the United States at 4.8 (NationMaster, 2013). For the first time in Canadian history (2016), Canada's older adults proportionally outnumbered the youth (under 15 yrs.) (Grant and Jones, 2017). Most of the older adult population consists of the baby-boomer generation (born between 1945 and 1964). By 2031, all baby-boomers in Canada will have turned 65, and the proportion of older adults will have reached 25% of the country's population (Statistics Canada, 2018). This demographic change not only strains the economy and labour force, but also increases pressure on the working population to provide informal care to a growing older adult population. Past research has referred to the working population who simultaneously provide informal care as caregiver-employees, employed carers, and carer-employees. From this point forward, this dissertation will refer to them as carer-employees.

Carer-employees are individuals working full-time in the paid labour force while providing unpaid care to a dependent individual with a disability or chronic illness (Health Canada, 2002; Duxbury et al., 2012). There are 6.1 million of them in Canada, which represent 35% of the Canadian labour force (Duxbury et al., 2012; Research on Aging Policies and Practices, 2014). Carer-employees are the backbone of the health care system, potentially saving the Canadian government up to $25 billion of dollars in health care expenditures (Hollander et al., 2009). Regardless, many carer-employees are juggling time full-time work at the same as providing care to one or more care-recipient(s). For these reasons, 45% of carer-employees are

experiencing struggles with work-life balance, and consequently experiencing mental and physical health issues (Research on Aging Policies and Practices, 2014; Benefits Canada, 2015; Duxbury et al., 2012). This results in costing Canadian employers over $5 billion annually due to counter-productivity, difficulty in getting work done on time, and work reduction (Benefits Canada, 2015). This does not include the potential health care costs of the carer-employee.

Researchers and decision-makers have yet to fully address the growing problems that carer-employees present. First, carer-employees could be any individual working full-time in the labour force, regardless of their race, gender, education, type of work, and geographic location. Therefore, researchers and decision-makers cannot immediately identify if an individual is a carer-employee or not. Additionally, many individuals that are technically considered carer-employees often do not classify themselves as such. This is because many perceive that it is either their duty, or part of their culture to provide care to a care-recipient, especially for an immediate family member (Family Caregiver Alliance, 2009). In some cultures, the daughter or daughter-in-law are expected to take on the primary caregiver role for their aging parents (Family Caregiver Alliance, 2009). Second, many carer-employees do not openly discuss about their caregiving situation, especially in the work environment (Mak and Cheung, 2008; Papadopoulos et al., 2018). Carer-employees often 'self-stigmatize' themselves, which inhibits social isolation and mental health problems (Mak and Cheung, 2008; Papadopoulos et al., 2018). Third, most carer-employees are experienced employees, and thereby difficult to replace, even if temporarily (Duxbury et al., 2012). As noted above, baby-boomers, who represent the most experienced workers in the labour force (Duxbury et al., 2012), will soon retire and enter the older adult population. This will exponentially reduce work-life balance for the younger and inexperienced carer-employees. Lastly, there is a misperception and a lack of public awareness

of carer-employees (Scott, 2006; Clarke and Seymour, 2010). Many people will mistakenly mix carer-employees with formal caregivers (paid care professionals). Carer-employees are not nurses, personal support workers, professional caregivers, home health care providers, or primary care physicians. As a result of these multiple issues, many employers are not fully aware of carer-employees. Consequently, there is a lack of caregiver-friendly workplace programs (CFWPs) available to relieve the work-family balance challenge.

Ideally, CFWPs are classified as supportive programs or policies that protect carer-employees from their employer and improve their work-life balance (Ireson et al., 2016; Ramesh et al., 2016). The *Compassionate Care Benefit* (CCB) and the *Parents of Critically Ill Children Benefit* (PCIC) are two of Canada's national programs available to respond to carer-employees' demands. Conceptually, the CCB is a good implementation strategy to assist carer-employees with their financial and caregiving responsibilities; however, in practice there is lack of awareness and eligibility constraints (Williams et al., 2011). To illustrate, the carer-employee must be a full-time paid worker and their care-recipient must be diagnosed (via a medical certificate) with a terminal illness within 26 weeks of death (Williams et al., 2011). As for the PCIC, it is only to eligible workers who are caring for their critically ill or injured child under the age of 18 (Government of Canada, 2016). The child's health condition must have changed dramatically and be considered life-threatening (Government of Canada, 2016). As this dissertation focuses on carer-employees taking care of older adults, the PCIC has limited applicability.

CFWPs are not lawfully required in the workplace. Therefore, many employers don't implement them due to: the lack of flexibility available (i.e. construction); the lack of

affordability (i.e. small businesses); or simply due to the belief that their workplace has sufficient support for the needs of their employees (Lero et al., 2012).

Ding et al. (2019) and Dardas et al. (2019) have published CFWP intervention research that show CE's workplace experience and overall health have improved over time; demonstrating effectiveness of the CFWP intervention. Nonetheless, the efficacy of CFWPs more generally requires further research as this topic remains understudied. We know less about CFWPs that may alleviate the transport-related activities or assisted-transport tasks that carer-employees manage.

Assisted-transport encompasses necessary tasks related to grocery shopping or attending medical appointments. Many caregiving tasks (i.e. banking, visiting) are indirectly related to assisted-transport, thus making it the most common and one of the most demanding caregiving tasks in Canada (Statistics Canada, 2015). CEs meet many transport demands, including: work commutes; immediate family members' needs, as well as those of the care-recipient(s). Activity-travel behaviour shapes the spatial and temporal patterns of individuals' daily travel schedule (Kwan, 2000). From a broad lens, we would expect the carer-employee conducting these transport tasks to have more restrictive activity-travel behavior. This would result in a worse work-life balance than those that do not perform assisted-transport. Little to no research exists on carer-employee's activity-travel behaviour. This dissertation fulfills this gap and provides the basis for the development of transport policies as another dimension of CFWPs. We refer to the new policy dimension as caregiver-friendly transport programs (CFTPs).

1.2 Thesis Objectives and Research Questions

> "Travel behaviour analysis is a complex task because of the myriad of determinants influencing decision makers. The commuting trip constitutes an important travel purpose, but is not the dominant one. Because of its spatial and temporal concentration, the commuting flow is an ideal target for mobility management measures aiming at decreasing its negative externalities."
>
> Francois Sprumont (2017)

As stated by Francois Sprumont (2017), travel behaviour analyses is an approach for decision-makers to best develop transportation policies. Past studies have analyzed activity-travel behaviour within the fields of information and communications technologies (ICT), intelligent transportation systems (ITS), and transportation geography (Chen et al., 2014; Saarloos et al., 2009; Wang, 2015). To briefly list a few applications, these fields used activity-travel behaviour as an approach to address: traffic congestion; gender differences in the work-commute, and; actual accessibility of specific population groups to opportunities. However, to the author's knowledge, it has not been applied to the carer-employee context.

Since assisted-transport is known to impact health (Frank et al., 2001), it is the primary measurement to analyze the carer-employee's travel behaviour. Therefore, the ultimate goal of this thesis is to relieve the assisted-transport demands experienced by carer-employees through creating an effective framework which provides valuable insight to decision-makers. The framework acts as a tool for decision-makers to efficiently develop transport policies from a top-down approach. The top-down approach covers numerous geographic scales, from the national to the local community scale, by addressing the following core research objectives:

1) How can we identify the differences between assisted-transport carer-employees and standard carer-employees nationally? What are their socioeconomic characteristics and are they more likely to become overwhelmed than the standard carer-employees?

2) From an urban and health planning perspective, how does the location of the care-recipient's residence potentially impact carer-employee's work-life balance? Where can we suggest implementing additional services as a potential intervention strategy to reduce assisted-transport demand?
3) Individually and collectively, how can we efficiently highlight the actual travel behavior of assisted-transport carer-employees?

1.3 Dissertation Contents

Using descriptive statistics and logistic regression analysis, Chapter 2 investigates how assisted-transport tasks impact caregiver burden and overall health of the carer-employee. Using descriptive statistics, various socioeconomic profiles have been created, including that of: assisted-transport carer-employees; standard carer-employees, and; non-carer-employees. These profiles allow us to determine if there are any differences among these population groups. Modeling allows us to identify behavioural factors that increase the likelihood of conducting assisted-transport, and whether carer-employees are more likely to feel overwhelmed as a result.

Chapter 3 examines how spatial accessibility to vital services and public transit for the older adult (as a potential care-recipient) may alter carer-employees work-life balance and overall well-being. Ideally, an older adult living within walking distance to a vital service is more likely to be independently mobile and thus, potentially reduce assisted-transport demand. In this chapter, we used the Enhanced Two-Step Floating Catchment area (E2SFCA) to map out potential accessibility to vital services and public transit stops in the Hamilton metropolitan area. The older adult population was estimated for each accessibility zone, as well as outside service coverage. Additionally, we identified suitable areas to implement additional vital services, as

well as public transit stops as an intervention strategy to improve service coverage. Older adult population estimates for the suitable areas are included as well.

At the individual scale, carer-employees will have different travel behaviours due to the various demands of their care-recipient(s). This makes it difficult for researchers to identify similar travel behaviour patterns, and for decision-makers to develop transport policies. To overcome this, Chapter 4 uses a mixed-methods framework to classify carer-employees' travel behaviour by linking the theoretical concept of carescapes with time geography. Classification outcomes provide insightful information for both employers and decision-makers to develop transport policies tailored to improve work-life-transport balance for carer-employees.

The sandwich dissertation concludes with an outline of contributions, future research directions, and references from both chapters (Chapter 1 and 5). A final notice to the reader is that Chapter 2 to 4 has some similarity in the introduction and literature review, specific to what is known about carer-employees.

Chapter 2 Assisted-Transport Caregiving and its impact towards Carer-employees

2.1 Abstract

Assisted-transport is the most common informal caregiving task and will be in greater demand due to an aging society. One population group that predominantly covers the demands of informal eldercare while working full-time in the paid labour force are carer-employees. The developing carer-employee literature addresses: the health risks for carer-employees; employers of carer-employees, and policy/program interventions. Little research focuses on assisted-transport, which impacts health (Frank et al., 2001). This study begins to fill the gap by addressing the following objectives: (1) develop a socioeconomic profile of carer-employees performing assisted-transport tasks; (2) identify any gender differences based on the profile, particularly employment and caregiving traits; (3) examine behavioral factors that increase the likelihood of conducting assisted-transport caregiving, and; (4) determine whether carer-employees are more likely to be overwhelmed from assisted-transport caregiving. Descriptive statistics and logistic regression were used to analyze Statistics Canada's General Social Survey Cycle 26: Caregiving dataset (2012). Compared to general carer-employees, assisted-transport carer-employees have higher education, household income, and caregiving hours per week and feel more tired and overwhelmed from caregiving. Gender gaps exist based on socioeconomic and caregiving characteristics. Logit results show that female carer-employees are more likely to perform assisted-transport caregiving and feel overwhelmed. Carer-employees conducting assisted-transport caregiving are more likely to be overwhelmed than those who don't.

Keywords: Carer-employees, quantitative analysis, assisted-transport caregiving

2.2 Introduction

Currently, older adults (age 65+) represent 16% of Canada's population (Bohnert et al. 2015; Statistics Canada, 2017). By 2031, they are projected to nearly double proportionally due to the influx of baby-boomers transitioning to the older adult group (Bohnert et al., 2015; Sethi et al., 2015; Newbold et al., 2017). As people age, they are more vulnerable to develop complex chronic conditions and are more likely to utilize health care resources (Wister et al., 2015). In Canada, 15% of the population are older adults, yet they consume about 45% of public health expenditures (Canadian Medical Association, 2015). With that, the aging population poses pressing challenges for the health care system and the Canadian economy (Canadian Medical Association, 2016). For instance, while Canadian healthcare is advanced, with an emphasis on hospital-based acute care services, it is not designed to meet the aging population's need for preventative medicine and prolonged chronic care (Silversides, 2014; Wister et al., 2015; Canadian Medical Association, 2015). Most of this care takes place in the community by informal caregivers, who are the backbone of the health care system.

Most informal caregivers (75%) in Canada are carer-employees, who are defined as individuals providing unpaid care to someone (often a close relative) while working in the paid labour force (Health Canada, 2002; Duxbury et al., 2012). Often termed 'employed carers' in different national contexts, such as the UK, carer-employees do not refer to home health care professionals or care-related professions, such as nurses and physiotherapists. There are 6.1 million carer-employees in Canada, most of whom provide 1 to 30 hours of weekly informal care, are predominantly female and part of the baby-boom generation (Duxbury et al., 2012; Research on Aging Policies and Practices (RAPP), 2014). Based on these characteristics, past studies have highlighted that carer-employees are becoming more vulnerable to ill health due to

caregiver burden and their struggle to maintain a healthy work-life balance (Earle et al., 2011; Williams et al., 2014; Employer Panel for Caregivers, 2015). Pearlin et al. (1990) presents a conceptual framework of caregiver stress and its processes based on four domains: 1) background and context of stress based on key characteristics of the caregiver (i.e. socioeconomic capital); 2) stressors subdivided into primary (i.e. cognitive status), secondary (work-caregiving conflict), and secondary intrapsychic strain (i.e. self-esteem); 3) the mediators of stress from the second listed domain, and; 4) the outcomes or manifestations of stress (i.e. depression, anxiety) (Pearlin et al., 1990). These domains illustrate the composite effects of caregiver burden and work-life imbalance, which often result in negative physical and mental health outcomes (Williams et al., 2016). In the near future, younger carer-employees will experience exponential caregiving burden as baby-boomers transition to the older adult age cohort (Legare et al., 2014).

While there is growing research interest on carer-employees, it is a relatively understudied area and has garnered little public awareness. Much of the literature focuses on caregiver burden and the negative economic impacts that carer-employees unintentionally experience. Some studies have identified socioeconomic characteristics and family relationship to be correlated with experiences of caregiver burden (Montgomery et al., 1985; Robinson, 1983); while other studies have highlighted the severity level of the care-receiver's behavioral disturbance to increase caregiver burden (George et al., 1986; Lund et al., 1987; Cantor, 1983). These findings conclude that caregiver burden adversely impacts caregivers' health. In Canada, 44% of carer-employees report absenteeism, averaging approximately nine days of lost work annually (RAPP, 2014). Further, 15% reduced their paid work hours, thus cutting approximately ten hours per week (RAPP, 2014). When considered in totality, there are 9.7 million days of

absenteeism, 256 million fewer hours of paid work, and a loss of 560,000 carer-employees to the workforce, representing those who left the paid labour force completely (RAPP, 2014). In totality, this is equivalent to 1.2 million full-time paid workers in Canada, making up an approximate loss of $5.5 billion CAD annually due to counter-productivity and absenteeism (RAPP, 2014; Benefits Canada, 2015; Duxbury et al., 2015).

Some employers can mitigate counter-productivity and absenteeism by implementing caregiver-friendly workplace programs, such as compressed work weeks or prolonged leaves of absence (Ireson et al., 2016). However, many employers don't implement caregiver-friendly workplace programs as they either; lack the flexibility to do so, or; are unable to afford to implement such programs, or; simply believe their workplace already provides enough support (Lero et al., 2012).

In addition to the economic consequences, the current literature has focused on mental and physical health consequences to carer-employees. Several studies have focused on how and why moral support is the most demanding task for them, and especially so for females (Family Caregiver Alliance, 2009; Duxbury et al., 2012; Park et al., 2013). Other studies have and continue to work on intervention programs, particularly carer-friendly workplace programs, to improve work-life balance (Ireson et al., 2016; Ramesh et al., 2017). These demonstrate that research on carer-employees continues to grow over time; however, the literature still has many gaps that need to be addressed. One area that has received little attention is assisted-transport.

Assisted-transport involves transporting ill or disabled care-recipients to conduct errands, shop, attend medical appointments or participate in social activities. Informal caregivers are the main provider of assisted-transport needs for care-recipient populations, as it is the most frequent type of caregiving task (National Alliance for Caregiving and AARP, 2004; Statistics Canada,

2015). In the United States, 82% of all informal caregivers report providing assisted-transport for their care-recipients (National Alliance for Caregiving and AARP, 2004). Similarly, 73% of Canadian carer-employees provided assisted-transport as the most frequent type of care to their care-recipient in the past 12 months (Statistics Canada, 2015). Additionally, assisted-transport caregiving is the second most demanding task after moral support (Duxbury et al., 2012). Proportionally, an equal number of male and female carer-employees conduct this task. However, twice as many females as males find this task very demanding (Duxbury et al., 2012). One plausible explanation is women's larger responsibility for personal caregiving and domestic management (housework, cooking, laundry, etc.), thus reducing access to employment opportunities and increasing mental stress when traveling to and from their workplace (Hanson and Pratt, 1995; Kwan, 2000). Many women choose part-time jobs in female-dominated occupations to have the option of flexibility in caregiving. However, these jobs often have less autonomy with respect to employment hours and thus more travel constraints (Hanson and Pratt, 1995; Odih, 1999; Kwan, 2000). Overall, there is a lack of solid evidence of what specifically causes the gender gap with respect to assisted-transport.

Another gap in the literature is the lack of policy recommendations to improve work-transport-life balance. With the aging population, there will be a need to implement transport policies tailored towards the older adult and carer-employee populations. To accomplish this, more research is needed to better understand this informal caregiving task and how it impacts caregiver burden and overall health.

The objectives of this study are to: (1) identify socioeconomic and health differences amongst (i) non carer-employees, (ii) carer-employees performing assisted-transport tasks and (iii) carer-employees that don’t perform assisted-transport tasks; (2) for carer-employees

performing assisted-transport tasks, determine any gender differences based on socioeconomic and caregiving characteristics; (3) examine socioeconomic and sociodemographic characteristics that increase the likelihood of conducting assisted-transport, and; (4) determine whether carer-employees performing assisted-transport are more likely to be overwhelmed than carer-employees not conducting assisted-transport. Results, via descriptive statistics and multivariate logit regression analyses, intend to be informative for both the carer-employee population and for decision-makers in transport policy and planning.

2.3 Data

Statistics Canada's General Social Survey (GSS Cycle 26: 2012) was used for this study, as it is the only dataset providing caregiving information at the national level (n = 23,093). We were required to fill out a clearance form, which granted us access by Statistics Canada to acquire the dataset that provides individual information on respondents not publicly available. Ethics clearance to perform the data analysis was exempt. The GSS Cycle 26 collected data over a 9- month period (March to December 2012) from Canadians aged 15 years and older by telephone interview. A "Rejective Sampling" technique was used to increase sample size by reaching out to respondents living in isolated or small communities of unknown population threshold size. Respondents that are classified as caregivers or care-receiver are then asked to participate in a long interview, whereas those who are not are sub-sampled into one of two groups: one for long and the other for short interview. The response rate was nearly 66%. The objective of the GSS 26 is to obtain a brief overview of the caregiver and care-recipient's lives. More specifically, the intent is to provide information on current or emerging social policy issues by observing changes in the wellbeing of Canadians over time. This dataset provides enough socioeconomic information to compare amongst the three population groups mentioned above.

More specifically, it provides a specialized carer-employee profile for those performing assisted-transport tasks for the care-receiver, offering a better understanding of: 1) the level of caregiving demand related to transportation (i.e. frequency and proximity to care receiver); 2) whether gender plays a role, and; 3) factors that may increase the likelihood of conducting assisted-transport.

For the first objective, 19 variables were chosen from the survey for analyses and classified into two groups: (1) socioeconomic and demographic, and; (2) caregiving-related, including health impacts as a result of caregiving tasks. Socioeconomic and demographic variables include gender, household income, ethnicity, work type, and geographic setting (urban or rural). Based on the data, most of the respondents live in an urban setting; thereby, this research study is characterized as having primarily an urban perspective. Wealth and race were not incorporated in the analyses, due to the fact that they were not available in the dataset. Examples of caregiving-related variables include: ‘relationship to the care recipient’, ‘weekly hours of caregiving’, and ‘conducting assisted-transport.’ Variables describing the health impact from caregiving tasks include: ‘if they feel tired from caregiving’, and ‘feel overwhelmed.’ Table 2.1 provides a detailed description of each variable.

Table 2.1

List of variables used from GSS Cycle 26

Variable Name	Definition	Values
AGEGR5	Age of Respondent	18+
SEX	Gender of Respondent	Male, Female
ETHNIC25	Ethnic Background of Respondent	26 values recoded to: (1) European (2) Canadian / Mixed Canadian (3) Asian (4) Other
EOR_Q04	Education-level of Respondent	(1) High school or less (2) Trade certificate, University certificate below bachelor's level, College, CEGEP, or non-university certificate or diploma (3) Bachelor's Degree (4) Post-graduate Degree
INR_Q110	Respondent's Estimated Annual Household Income	(1) $20k - $49.9k (2) $50k - $74.9k (3) $75k - $99.9k (4) $100k +
NOCS2011 C10	National Occupation classification of the respondent – last 12 months.	(1) **White-collar** – (Health occupations; Management occupations; Natural and applied sciences occupations; Occupations unique to primary industry; Occupations in art, culture, recreation, and sport; Business, finance,

		and administrative occupations) (2) **Blue-collar** - (Sales & Services Occupation; Trades, transport and equipment operators, and related occupations; Occupations unique to processing, manufacturing, and utilities)
WHW_Q130	How many hours per week do you usually work at your main job?	35 – 168
GEO_UA_RA_TYPE	Geographic Setting of where Respondent resides	Urban, Rural
PRN_Q20	Age of care recipient	18+
PRG_Q10	Relationship to care recipient	(1) Immediate Family - (Spouse, Mother, Father, Son, Daughter, Brother, Sister) (2) Extended Family – (Grandmother, Grandfather, Grandson, Granddaughter, Mother-in-law, Father-in-law, Son-in-law, Daughter-in-law, Brother-in-law, Sister-in-law, Aunt, Uncle, Niece, Nephew, Cousin) (3) Other – (Close Friend, Ex-Spouse, Neighbour, Co-Worker, Other)
PRD_Q10	Drive Proximity to Care Recipient	(1) 0 – 29 min (2) 30 – 59 min (3) 60 – 179 min (4) 180+ min
PRH_Q10	Frequency Seeing Care Recipient	(1) Daily

		(2) At Least Once a Week (3) At Least Once a Month (4) Less than Once a Month
HAP_Q10	In an average week, how many hours of care or help did you provide with these activities?	0 - 168
CRH_Q10	During the past 12 months, have your caregiving responsibilities caused you to feel tired?	Yes, No
CRH_Q30	During the past 12 months, have your caregiving responsibilities caused you to feel overwhelmed?	Yes, No
ICL_Q110 – 120	In the past 12 months, have your caregiving responsibilities caused you to spend less time with your spouse or partner, and children?	Yes, No
ICL_Q135 – 140	In the past 12 months, have your caregiving responsibilities caused you to spend less time with your friends and/or activities or hobbies?	Yes, No
ART_Q10 (Assisted-transport)	During the past 12 months, have you helped the primary care-receiver with transportation to do shopping or errands, or to get to medical appointments, or social events?	Yes, No
ART_Q20	Based on ART_Q10, how often have you helped the primary care-receiver to do shopping or errands, or to get to medical appointments, or social events?	(1) Daily (2) At least Once a Week (3) At least Once a Month (4) Less than Once a Month
ART_Q40	Received Unpaid Assistance for Assisted-Transport	Yes, No
ICL_Q100	In general, how have you been coping with your caregiving responsibilities?	(1) Very Well (2) Generally Well (3) Not so well (4) Not well at all

WGHT_PER	Estimate population representing per observation	Continuous
Bootstrap 1 – 500	Bootstrapped Weights	Continuous

2.4 Methodology

Defining CE & Assisted-Transport

Descriptive statistics consisted of cross-tabulations among the three groups to create the specialized carer-employee transport profile. We identify carer-employees based on the following three GSS questions:

1. Have you provided care for a person with a long-term health condition or a physical or mental disability during the past 12 months? (If yes)
2. How old is your primary care receiver? (If above 18 years old)
3. Are you employed full-time? (If yes)

Carer-employees conducting assisted-transport were identified based on the fourth question:

4. During the past 12 months, have you helped the primary care receiver with transportation to do shopping or errands, or to get to medical appointments, or social events? (If yes)

Non-carer-employees are classified as those working full-time, not active in caregiving, and at least 18 years of age. Of the 23,093 observations in the original dataset, 3,867 observations met the carer-employee criteria as defined in the first three questions. This data subset was used in the logistic regression analyses. With the assisted-transport question (question #4) added, only 1,274 of the 3,867 carer-employees had conducted assisted-transport caregiving. This smaller data subset was used to create a carer-employee transport profile. RStudio was used for descriptive statistics and logistic regression modeling.

Descriptive Statistics

First, we created the profile of the carer-employees who performed assisted-transport via descriptive analyses. The weighted proportion of categorical variables and the averages of continuous variables are reported in Tables 2.2-2.5 (Results section). This builds the specialized profile of carer-employees conducting assisted-transport, including gender differences. The two-proportion t-test was used to test for statistical significance of differences between two proportions of each variable's value (Table 2.2 and Table 2.4).

Logistic Regression

Second, we conducted two logistic regressions. The first logit model (n = 1,163; Table 2.6A) examines the socioeconomic difference of carer-employees 'conducting assisted-transport' (dependent variable). The second model (n = 1,056; Table 2.6B) reveals the determinants contributing to the carer-employee 'feeling overwhelmed' (dependent variable), particularly if they are more overwhelmed from assisted-transport caregiving. Bootstrap weights were applied to improve accuracy and estimate the standard error of coefficients in the logit models.

Approximately 20% of carer-employees' income information was not provided. To retain enough sample size for the multivariate regression analyses, missing income was imputed by the predictive mean matching algorithm (PMM) found in the MICE package in RStudio. The following predictors were used: respondent's age, sex, number of hours worked per week, and whether they worked in the white-collar sector. PMM ensures that imputed values are credible and possibly more suitable than standard regression methods (Horton and Lipsitz, 2001).

2.5 Results

Socioeconomic & Health Differences Amongst Population Groups

The following variables relevant to the two carer-employee groups were examined: 1) age of the respondent; 2) age and relationship to the care-recipient; 3) weekly hours of

caregiving, and; 4) working in the white-collar sector. Surprisingly, there were proportionally more male carer-employees than female carer-employees. Each population group has its own socioeconomic profile (Table 2.2).

Table 2.2

Socioeconomic and caregiving characteristics contrasts among Non-CEs, CEs, and CEs with Assisted-Transport

Socioeconomic Variables	(1) Non-CE n = 100	(2) CE n = 658	(3) CE (Transport) n = 1274	T-Test[1]
Age of the Respondent				
18 – 29	13.3%	22.0%	19.1%	2-3
30 – 44	37.7%	26.0%	27.7%	–
45 – 64	46.0%	50.2%	51.6%	1-3
65+	3.1%	1.7%	1.6%	–
Gender of the Respondent				
Male	58.5%	63.0%	54.4%	2-3
Female	41.5%	37.0%	45.6%	2-3
Ethnicity of the Respondent				
Canadian / Mixed-Canadian	9.7%	14.9%	13.5%	1-2
European	66.3%	55.8%	54.6%	1-2; 1-3
Asian	–	2.4%	2.5%	–
Other	7.8%	7.8%	7.5%	–
Highest Education Obtained				
High School or Less	22.1%	34.3%	32.1%	1-2; 2-3
Some College / Trade	36.3%	37.0%	34.5%	–

[1] p-value significance (≤ 0.05) at 95% confidence; LS: sample size too low to report; NA: not applied; – indicates not significant.

Bachelor's Degree	27.4%	20.1%	24.2%	2-3
Post-Graduate	14.2%	8.3%	9.1%	1-2; 1-3
Household Income				
$20k - $49.9k	LS	4.6%	2.9%	LS
$50k - $74.9k	6.8%	8.6%	7.4%	2-3
$75k - $99.9k	8.1%	10.5%	9.9%	–
$100k+	50.8%	32.1%	39.9%	1-2; 1-3; 2-3
Type of Work				
Blue Collar	27.9%	37.7%	33.3%	1-2; 2-3
White Collar	71.7%	61.4%	66.0%	2-3
Hours of Work per Week				
35 – 50 hrs.	76.5%	86.8%	85.8%	2-3
51 – 70 hrs.	20.1%	11.1%	11.1%	1-2
71+ hrs.	LS	2.1%	3.1%	LS
Geographic Setting				
Urban	77.1%	73.1%	79.2%	2-3
Rural	22.9%	26.9%	20.8%	2-3
Caregiving Variables				
Age of Care Recipient				
18 – 30	NA	5.6%	4.9%	–
31 – 44	NA	4.4%	4.9%	–
45 – 64	NA	19.1%	20.5%	–
65 – 79	NA	36.9%	35.2%	–
80+	NA	34.0%	34.4%	–
Relationship to Care Recipient				

Immediate Family	NA	51.8%	59.9%	2-3
Extended Family	NA	29.6%	28.6%	–
Other	NA	18.1%	10.7%	2-3
Drive Proximity to Care Recipient				
0 – 29 min	NA	71.2%	78.0%	2-3
30 – 59 min	NA	11.7%	9.4%	–
60 – 179 min	NA	7.3%	7.5%	–
180+ min	NA	9.8%	5.1%	2-3
Hours of Caregiver per Week				
1 – 15 hrs.	NA	77.3%	82.9%	2-3
16 – 30 hrs.	NA	4.7%	7.2%	2-3
31 – 44 hrs.	NA	0.3%	2.0%	–
45+ hrs.	NA	1.3%	2.0%	–
Feel Tired from Caregiving				
Yes	NA	18.9%	46.6%	2-3
No	NA	31.9%	31.2%	–
Feel Overwhelmed from Caregiving				
Yes	NA	11.0%	27.5%	2-3
No	NA	39.8%	50.5%	2-3
Time for Spouse				
Yes	NA	8.2%	21.8%	2-3
No	NA	24.8%	30.3%	–
Time for Children				

Yes	NA	9.0%	27.6%	2-3
No	NA	25.1%	29.3%	2-3
Time for Friends				
Yes	NA	17.5%	43.2%	2-3
No	NA	34.3%	35.8%	–
Time for Hobbies				
Yes	NA	18.0%	46.9%	2-3
No	NA	33.8%	32.0%	–
Frequency of Conducting Assisted-Transport				
Daily	NA	NA	9.0%	NA
At Least Once a Week	NA	NA	45.0%	NA
At Least Once a Month	NA	NA	30.0%	NA
Less than Once a Month	NA	NA	16.0%	NA

Based on proportional t-tests, the socioeconomic profile of non-carer-employees is shown to be significantly: younger, of European background, of higher education and household income, and putting in more labour hours per week when compared to carer-employees. Comparing the socioeconomic profile of carer-employees who conducted assisted-transport to those who did not, carer-employees conducting assisted-transport are more educated (bachelor's degree), have a somewhat higher household income, are more likely to work in the white-collar sector, and are more likely to live in urban areas. Carer-employees conducting assisted-transport are more likely to: care for an immediate family member; live in closer proximity to their care-recipient; have higher caregiving hours per week; feel tired and overwhelmed from caregiving, and; have less time for their children compared to carer-employees who did not conduct assisted-transport.

With respect to the frequency of conducting assisted-transport caregiving, three-quarters of them conduct this task at "least once a week" to "at least once a month." Each value for each frequency of conducting assisted-transport is broken down into the number of hours spent (Table 2.3).

Table 2.3

Amount of Time Spent CEs Conducting Assisted-Transport

Frequency of Conducting Assisted-Transport	Time Spent on Assisted-Transport	%
Daily (n = 87)	*< 1 hr.*	22.0
	1 – 2.9 hrs	52.0
	3 – 9.9 hrs	26.0
At Least Once a Week (n = 530)	*< 1 hr.*	5.9
	1 – 2.9 hrs	53.7
	3 – 4.9 hrs	26.9
	5 – 9.9 hrs	10.7
	10 hrs +	2.7
At Least Once a Month (n = 445)	*< 1 hr.*	6.9
	1 – 2.9 hrs	43.4
	3 – 4.9 hrs	28.0
	5 – 9.9 hrs	14.6
	10 hrs +	6.7
Less than Once a Month (n = 207)	*< 1 hr.*	6.0
	1 – 2.9 hrs	58.0
	3 – 4.9 hrs	24.0
	5 – 9.9 hrs	8.0
	10 hrs +	4.0

In summary, most carer-employees spent between 1 to 4.9 hours on assisted-transport caregiving, ranging from "daily" to "less than once a month".

Gender Differences of CEs conducting assisted-transport

The following variables were used to examine gender differences: 1) employment sector and type; 2) income; 3) education level; 4) work hours per week, and; 5) variables related to caregiving (Table 2.4).

Table 2.4

Gender Differences of Assisted-Transport CEs

Variable	Value	Male (%) n = 608	Female (%) n = 666	T – Test[2]
Business Sector	*Business, Finance, & Admin.*	13.1	25.6	√
	Health Occupations	1.8	11.5	√
	Management Occupations	12.9	8.9	–
	Natural & Applied Sciences	13.9	5.1	√
	Art, Recreation, and Sports	1.4	3.0	√
	Social Sciences, Education, & Government	7.4	22.4	√
	Primary Industry	5.6	1.1	√
	Processing, Manufacturing, & Utilities	4.6	3.1	–
	Sales & Services	15.6	15.9	–
	Trades, Transport, and Equipment Operators	23	2.5	√
Work Sector Type	*Blue Collar*	43.3	21.4	√
	White Collar	56.1	77.7	√
Income	*$20k - $49.9k*	3.2	2.6	–
	$50k - $74.9k	8.3	6.3	–
	$75k - $99.9k	10.6	9.1	–
	$100k +	40.0	37.8	–
Education	*High School or Less*	36.3	27.0	√
	Some College / Trade	31.7	37.8	√
	Bachelors Degree	24.0	24.5	–
	Post-Graduate Degree	7.8	10.8	√

[2] √ = p-value significance (≤ 0.05) at 95% confidence; – is not significant

Ethnicity	*European*	54.8	54.3	–
	Canadian / Mixed Canadian	13.8	13.0	–
	Asian	1.5	3.6	–
	Other	7.8	7.2	–
Weekly Hrs. Of Employment	*35 – 50 hrs*	81.7	90.8	√
	51 – 70 hrs	14.4	7.1	√
	71+ hrs	3.8	2.1	√
Geographic Setting	*Urban*	76.2	82.8	√
	Rural	23.8	17.2	√
Weekly Hrs. Of Caregiving	*1 – 15 hrs*	84.4	81.1	√
	16 – 30 hrs	7.1	7.3	√
	31 – 44 hrs	2.2	1.7	–
	45+ hrs	1.1	3.1	√
Proximity to Care Recipient	*0 – 29 min*	79.1	76.8	√
	30 – 59 min	8.8	10.0	–
	60 – 179 min	7.7	7.2	–
	180+ min	4.4	6.0	√
Frequency Seeing Care Recipient	*Daily*	9.5	17.8	√
	At Least Once a Week	48.5	47.9	–
	At Least Once a Month	11	12.9	–
	Less than Once a Month	4.2	3.6	–
Frequency Conduct Assisted-Transport	*Daily*	8.7	7.9	–

	At Least Once a Week	44.5	45.5	–
	At Least Once a Month	30.6	29.6	–
	Less than Once a Month	16	16.6	–
Receive Unpaid Assistance for Assisted-Transport	*Yes*	81.2	69.8	√
	No	18.1	30.1	√
Cope with Caregiving	*Generally Well*	44.8	47.3	√
	Very Well	30.6	28.2	√
	Not Well At All	0.8	0.5	–
	Not Very Well	1.9	3.6	–
Feel Tired from Caregiving	*Yes*	41.7	52.3	√
	No	35.6	26.0	√
Overwhelmed from Caregiving	*Yes*	19.4	37.2	√
	No	58.3	41.1	√

From the t-test scores, most females are employed in business, finance, and administrative positions, health occupations, and social sciences, education, and government positions. Proportionally more females than males work in the white-collar work force, have some college/trade training, are more likely to have a post-graduate degree, work 35 – 50 hrs. per week, and are urban dwellers. Proportionally more females than males do “extreme” cases, reflected in weekly hours of caregiving exceeding 45, driving for more than 180 minutes to see the care-recipient (180+ min), and visiting their care-recipient daily. Additionally, proportionally fewer females than males receive unpaid help for assisted-transport and feel more tired and overwhelmed from caregiving tasks. There were no household income differences between the

genders; however, table 2.5 displays each household income value per assisted-transport carer-employee gender.

Table 2.5

Gender differences of Assisted-transport CEs per income bracket - females and males

Females (n = 666)

Variable	Value	$20k - $49.9k	$50k - $74.9k	$75k - $99.9k	$100k+
Weekly Work (Hrs)	35 – 50	63.4 %	95.2 %	94.3 %	88.4 %
	51+	36.6 %	–	5.7 %	11.6 %
Weekly Caregiving (Hrs)	1 – 15	57.9 %	96.3 %	78.3 %	74.8 %
	16+	38.0 %	–	12.7 %	13.5 %
Received Unpaid Assistance for Assisted-transport	No	38.6 %	30.8 %	28.9 %	32.8 %
	Yes	61.4 %	69.2 %	70.5%	67.2 %

Males (n = 608)

Variable	Value	$20k - $49.9k	$50k - $74.9k	$75k - $99.9k	$100k+
Weekly Work (Hrs)	35 – 50	94.9 %	92.4 %	79.4 %	78.4 %
	51+	–	7.6 %	20.6 %	21.6 %
Weekly Caregiving (Hrs)	1 – 15	87.6 %	92.3 %	83.2 %	84.5 %
	16+	–	7.7 %	16.0 %	8.2 %
Received Unpaid Assistance for Assisted-transport	No	25.2 %	16.8 %	34.7 %	11.8 %
	Yes	73.6 %	82.7 %	65.3 %	87.6 %

Proportionally, fewer females tend to work longer (51+ hrs.) and provide care fewer weekly hours (16+ hrs.) as they climb the household income ladder; whereas, more males work longer hours (51+ hrs.).

Characteristics Associated with Providing Assisted-Transport

Using the sample of carer-employees dataset (n = 3,867), the first model examined the characteristics of carer-employees, including geographic variables that are associated with the probability of providing assisted-transport caregiving. Observations were dropped due to missing values. Table 2.6A reports the results of the logistic regression.

Table 2.6A

CEs conducting Assisted-Transport (Dependent – Reference: Yes)

Odds Ratio of Model 1

Variable	Reference	EXP (B)[3]	95% CI[4]
Income	Continuous	1.00	1.00
Advanced Degree	1 = Bachelor or Above	1.00	0.89 – 1.11
Immediate Family	1 = Immediate Family member	1.56	1.41 – 1.72
Gender	1 = Female	1.76	1.58 – 1.94
Age of CE	1 = 18 – 44	0.84	0.75 – 0.93
Age of Recipient	1 = 45+	0.50	0.42 – 0.60
Frequency Seeing Care Recipient	1 = Frequent (Daily or Weekly)	1.33	1.19 – 1.48
Weekly Hrs. Of Caregiving	1 = 16+ hrs	3.99	3.24 – 4.90
White Collar	1 = White	1.48	1.32 – 1.67
Urban	1 = Urban	1.31	1.13 – 1.52
Public Transit	1 = Available	1.51	1.31 – 1.73

[3] EXP(B) – exponentiation of the B coefficient, hence the odds ratio

[4] 95% Confidence Interval of odds ratio

It indicates that carer-employees are more likely to conduct assisted-transport caregiving if they are taking care of an immediate family member [OR = 1.56], see the care-recipient on a daily/weekly basis [OR = 1.33], are female [OR = 1.76], provide at least 16 hours of caregiving per week [OR = 3.99], work in the white-collar sector [OR = 1.48], and live in an urban area [OR = 1.31]. The second model tested whether carer-employees with assisted-transport caregiving are more likely to be overwhelmed while controlling for the characteristics of carer-employees. Model 2 (Table 2.6B) lost 2,811 observations due to many, "Not Asked" values in assisted-transport.

Table 2.6B

CEs Feel Overwhelmed (Dependent –Reference: Yes)

Odds Ratio of Model 2

Variable	Reference	Exp (B)	95% C.I.
Income	Continuous	1.00	1.00
Advanced Degree	1 = Bachelor or Above	1.02	0.94 – 1.10
Gender	1 = Female	3.47	3.22 – 3.75
Age of CE	1 = 45+	1.42	1.32 – 1.52
Age of Recipient	1 = 18 - 44	1.91	1.68 – 2.17
Proximity to Care Recipient	1 = Close (< 30 min of drive)	1.16	1.07 – 1.27
Assisted-Transport Caregiving	1 = Yes	1.18	1.04 – 1.35
Weekly Hrs. Of Caregiving	1 = 16+ hrs	3.06	2.75 – 3.42
Weekly Hrs. Of Work	1 = 35 – 50 hrs	1.34	1.22 – 1.47
Public Transit	1 = Available	1.15	1.04 – 1.26
Urban	1 = Urban	0.84	0.76 – 0.94

The odds of being overwhelmed for the carer-employees conducting assisted-transport caregiving are 18% more than for carer-employees not conducting this task. The highlight of Model 2 is that carer-employees are more likely to be overwhelmed from assisted-transport

caregiving [OR = 1.18], which validates whether carer-employees are more likely to be overwhelmed from assisted-transport caregiving. Other highlights are carer-employees more likely to be overwhelmed from caregiving if they are female [OR = 3.47] and provided at least 16 hours of caregiving per week [OR = 3.06] (Table 2.6B).

2.6 Discussion

Little is known about assisted-transport caregiving, particularly the socioeconomic profiles of carer-employees, behavioral factors that increase the likelihood of conducting the task, and whether carer-employees are more likely to feel overwhelmed from it.

Assisted-Transport CE Profile

The assisted-transport carer-employee profile is similar to those found in previous studies (Duxbury et al., 2012; RAPP, 2014; Employer Panel for Caregivers, 2015), especially the predominant characteristics of carer-employees being baby-boomers, providing caregiving for 1 to 15 hours per week, and being related to their care-recipient as an immediate family member. What differentiates the assisted-transport carer-employee profile are: gender, education, household income, work sector, location, feeling tired and overwhelmed from caregiving, driving time to their dependent, frequency of conducting the task, and receiving additional informal assistance for the task. Compared to the general carer-employee, the carer-employee assisted-transport population are: 1) more gender equal; 2) have higher education and income; 3) more representative of the white-collar sector; 4) more representative of urban dwellers; 5) provide more weekly caregiving hours, and; 6) feel more tired and overwhelmed from caregiving. Of all the findings in this paper, the assisted-transport carer-employee profile is noteworthy, despite its simplicity. The profile can be set as an establishment for future interdisciplinary research, particularly in the fields of demography, public health, and transport

geography, specifically as a channel to cultivate appropriate assisted-transport policies for carer-employees. Additionally, it can be set as the first domain (key characteristics of the caregiver) of Pearlin's framework for modeling purposes.

Gender Differences of CEs Conducting Assisted-Transport

Both descriptive and model results highlighted several gaps between male and female carer-employees conducting assisted-transport, which addressed the second objective. Proportionally more assisted-transport female carer-employees are overwhelmed and feel tired from general caregiving tasks. One possible explanation for this gender gap may be the multiple roles female carer-employees often occupy, including: caregiver, employee, mother, domestic manager, cook, and spouse. This uneven division of labour is reflected in who conducts the assisted-transport: female carer-employees are 76% more likely to conduct assisted-transport than male carer-employees (as shown in Table 2.6A).

Gender roles continue to gradually change, as males become more involved with household tasks while females become more engaged in the workforce; however, gender inequality continues to remain problematic. Findings from Table 2.4 and from past studies (Beede et al., 2011; Canadian Women's Foundation, 2017), indicate that women continue to be concentrated in the service sectors; teaching, nursing, health care, office, and administrative work, while men are more represented in numerous STEM fields. As mentioned in the literature, many of these female-dominated occupations are often lower in the employment hierarchy, resulting in less freedom over employment times and less travel flexibility. This explanation may be represented as a secondary stressor (i.e. work-caregiving conflict) from Pearlin's framework. Lastly, it is possible that assisted-transport female carer-employees feel tired and overwhelmed

due to fewer receiving unpaid assistance for their transport tasks, together with more likely seeing their care-recipient daily (as shown in Table 2.4).

Behavioral Characteristics

The logit models constitute as the outcomes of stress in Pearlin's framework. The first logit model predicted the likelihood of carer-employees conducting assisted-transport based on their socio-characteristics, such as proximity and age of their recipient, and thus, addressed the third research objective. Based on descriptive statistics findings, some of the results in the model were expected. For instance, it was expected that carer-employees were more likely [OR = 1.56] to provide assisted-transport to an immediate family member (Table 2.6A). Strong indicators of the likelihood of conducting assisted-transport are frequency of seeing the care-recipient and weekly hours of caregiving per week. Interestingly, carer-employees were 50% less likely to provide assisted-transport to care-recipients aged 45+. This may indicate that an increase in age does not reflect to the demand of assisted-transport. One question to explore in the future is to see if carer-employees are more likely to conduct assisted-transport based on the poor health status of the care-recipient. Carer-employees working in the white-collar sector are 48% more likely to provide assisted-transport than those working in blue-collar (Table 2.6A). This may be attributed to the traits of work flexibility, such as: co-workers covering the carer-employee's work tasks while temporarily unavailable; telecommuting, and/or; having compressed work weeks (Duxbury et al., 2012).

Assisted-Transport CEs feeling Overwhelmed

The second logit model addressed whether carer-employees performing assisted-transport were more overwhelmed than those who do not perform this task, thus fulfilling the fourth objective. Expected results are similar to the first logit model, particularly carer-employees'

gender and age, proximity to the care-recipient, and weekly hours of caregiving. Carer-employees aged 45 years, or more were 42% more likely to be overwhelmed from caregiving (Table 2.6B). This age group, sometimes referred to as the sandwich generation, make up most of the carer-employee population. The sandwich generation are mainly baby-boomers and Gen Xers, which take care of both their children and parents at the same time (Rubin et al., 2009). This group: have the most work experience and family responsibility; tend to struggle with work-life balance; are more likely to be overwhelmed (Duxbury et al., 2012), and; are more likely to conduct assisted-transport daily (Nichols et al., 1997; Rubin et al., 2009). Carer-employees are more likely to be overwhelmed from assisted-transport. This is likely due to the frequency of conducting assisted-transport and the amount of time spent doing it. Results show most carer-employees carrying out doing assisted-transport on a weekly basis, averaging 1 to 4.9 hours per week (Table 2.2). Though this may not seem much, this accumulates together with other caregiving tasks – some of which are indirectly related, such as running errands to the bank and visiting the recipient for emotional support. Additionally, about 10% of carer-employees conduct assisted-transport daily.

One additional explanatory factor may be related to what comprises carer-employees activity-travel behaviour, such as stopping in-between their commute, and/or taking detours for their dependent's needs; these activities would increase their commute time and potentially cause them to become more stressed. This transit concept is known as trip-chaining (McGuckin et al., 1995). Several studies have noted that sociodemographic and socioeconomic characteristics are one of the primary drivers for people to conduct trip-chains, which make up their activity-travel behavior (Islam et al., 2012; Wang, 2015). Transport policies, such as the development of mass transit systems, also impact activity-travel behavior. In Canada, the current mass transit systems

are not well-designed for the needs of the older adult population (Mercado et al., 2007); thus, many resort to informal caregivers as their main provider of assisted-transport. Transit policies will soon need to be revolutionized to mitigate assisted-transport demand. Fortunately, Transport Canada has proposed an investment of approximately $77 million CND for the next 5 years to modernize transportation systems, including the development of automated vehicles (Government of Canada, 2017). Automated vehicles may be a solution to the need for assisted-transport; however, it will take a few decades to implement after factoring in regulations, ethics, beta-testing, and activity-travel behavior research. Mass transit and automated vehicles would only be feasible in urban locations. More data would need to be collected from rural locations in order to suggest more tailored mobility solutions for rural areas. Another significant discipline in transport policy is accessibility to essential services (i.e. clinics, grocery stores). The availability of transit services is one of the main factors that affects accessibility, which in turn can impact travel demand. Several Canadian cities recognize the importance of investing in new transit infrastructure to improve their economy, environment, and residents' health (SNC-Lavalin, 2015). The Canada Line in Vancouver opened in 2009 and carries more than 122,000 people per day (SNC-Lavalin, 2015). In Calgary, the West Light Rail Transit extension was implemented in 2012, which has increased accessibility to 44,000 residents (SNC-Lavalin, 2015). In addition, an improvement in accessible transit can save $390 million CND in annual public costs (Canadian Urban Transit Association, 2013). These estimates signify that an improvement in transit systems augments accessibility for the residential population. Thereby, potentially reducing the older adults' dependency upon the automobile including the demands of assisted-transport from carer-employees. More research will be required for the fields of accessibility and activity-travel behavior as it has not been addressed thus far in the caregiving context. Nonetheless, this

research paper sets as a steppingstone towards the implementation of transport policies related to assisted-transport and activity-travel behavior.

The significance of both models validates the results from the descriptive statistics and enables decision-makers to have a better understanding of assisted-transport caregiving. Therefore, decision-makers may use predictive models as a prevention tool to monitor their carer-employees, particularly at the workplace, whilst implementing a caregiver-friendly workplace program tailored towards carer-employee conducting assisted-transport. One example of an assisted-transport caregiver-friendly workplace program would be the opportunity to conduct assisted transport during low-activity business hours, allowing the carer-employee to make up these hours outside of business hours.

Limitations

The main strength of this study is that it addresses the assisted-transport gap in the carer-employee literature via descriptive statistics and logistic regression models. Both methods revealed useful information for decision-makers. However, this study has encountered limitations as well. One limitation is the nature of the data, especially classifying amongst the three population groups of concern. The dataset is tailored to caregiver respondents, which is why there were low observations of non-carer-employee (n = 100). Additionally, the survey had a variable similar to the assisted-transport one, which asked if the respondent generally provided transportation assistance; whereas the other is only if conducted to the primary care-recipient, which was used for the carer-employee assisted-transport profile. For descriptive analyses, this similar assisted-transport variable was incorporated to classify carer-employees strictly not conducting assisted-transport; hence, relatively low observations (n = 658). As for modeling, household income was used rather than individual income due to far more missing observations

(~50%) in the individual category rendering it not suitable for imputation. The second model indicates that carer-employees conducting assisted-transport are overwhelmed. There is no concrete explanation as to why or what causes this feeling (despite the first model). The first model includes carer-employees that conduct assisted-transport, regardless if they are overwhelmed or not. This model was not further refined due to small sample size. After imputing and subsetting to the definition of the carer-employee and those conducting assisted-transport, the dataset accounted only 5.5% of the total observations to perform logistic regression. This was the result of a high number of values denoting "Don't Know" or "Not Asked" for assisted-transport, which were treated as NA values. "Not Asked" was the most common value and may have to do with the question not being applicable to the respondent. These limitations can be addressed, for instance, by developing a new survey instrument.

2.7 Conclusion

This paper is the first in the CE literature to develop a socioeconomic profile of CEs performing assisted-transport tasks, differentiating it from the other two groups of concern. It examines whether gender differences exist based on the profile, identifies behavioral factors that increase likelihood of conducting assisted-transport, and whether CEs are more likely to be overwhelmed as a result. Gender gaps have been identified based on employment features and caregiving characteristics as plausible explanations. Weekly hours of caregiving, gender, age of the recipient and white-collar employment are the primary variables that strongly associate the likelihood of CEs conducting assisted-transport. Lastly, CEs conducting assisted-transport are more likely to feel overwhelmed than those not conducting this task. This paper further addresses the assisted-transport gap; however, there is a need for more research to address the limitations of this study. Future research will require creating a dataset with enough sample size to perform

a new model. The dataset would consist of all variables used for the three population groups of concern, incorporating a work-commute scale. The work-commute scale would measure the activity-travel behavior of carer-employees conducting assisted-transport while traveling to work or working on-site. Examples of variables in this proposed scale include: “Do you make stops related to assisted-transport while commuting to work?”, “Does your current work schedule make it harder for you to perform assisted-transport?”, and “Does the assisted-transport task require you to leave during work hours because of limited opening hours (i.e. physician office)?” The new model would identify characteristics that cause assisted-transport carer-employees to be overwhelmed. These suggested improvements would provide the foundation for decision-makers to begin implementing caregiver-friendly workplace programs related to assisted-transport, as no such transit policy exists to improve the carer-employee’s work-life balance. An example of a caregiver-friendly workplace policy related to assisted-transport is to allow the carer-employee to take one day off every two weeks (without using their personal days) to conduct their caregiving-related tasks. In exchange, the carer-employee would have to devote an extra hour per day for the week. A more comprehensive caregiver-friendly workplace policy related to assisted-transport would require a deeper profile of the carer-employee’s activity travel behavior. This could be accomplished through collecting GPS and trip diary data from carer-employees, which can then be analyzed using geographic information systems (GIS) (Kwan et al., 2015). GIS is an effective tool to measure the demands of assisted-transport caregiving by analyzing accessibility through changes in service areas of mass transit systems. Additional analyses would be identifying locations that’ll require immediate need to implement services to improve accessibility, which may reduce assisted-transport burden amongst carer-employees.

Consequently, this area of research has the potential to facilitate the decision-making processes for both, the carer-employee and care-recipient populations.

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Chapter 3 Measuring Potential Assisted-Transport Demand for Older Adult Care-Recipients using the E2SFCA

3.1 Abstract

Carer-employees are defined as individuals who are providing unpaid care usually to a loved one or friend while simultaneously working in the paid labour force. This specific population group is vulnerable to ill-health due to the various challenges faced in managing work-life balance. One of the most demanding and common caregiving tasks in Canada is assisted-transport, which involves running errands for the care-recipient, or driving the care recipient to appointments. Little is known about assisted-transport, except that the frequency of assisted-transport is based on the links between daily constraints and carer-employees' care tasks; thereby, directly impacting work-life balance. An alternative to mitigate assisted-transport demand is to improve mobility independence of care-recipients using accessibility to services as a demand measurement index. Therefore, this research study explores potential accessibility to vital services for the older adult, suggesting areas that may require service intervention within the case of Hamilton metropolitan area (CMA). The enhanced two-step floating catchment area method was used to analyze potential accessibility from residential addresses of those aged 65+, to vital services; access zones were then outlined. Older adult populations for each access zone was calculated using census data. Suggested areas for service implementation were identified using quadrat analyses of addresses via hexabins. Results inform the location of care-recipients living in potentially underserved areas (high assisted-transport demand) of the Hamilton CMA and, in so doing, provide visual insight for decision-makers and city planners to better mitigate

mobility dependence. Suggested areas for vital service implementation would increase the older adult populations' access from 62 to 80%; access would increase from 82 to 86% for public transit stops.

Keywords: Carer-employees, care-recipients, potential accessibility, mobility dependence, Hamilton metropolitan area

3.2 Introduction

Based on historic and current demographic data, there are currently four known demographic transitions which essentially describe population growth, stability and decline (Sloggett, 2015). Overall, the industrialized world is currently in the late transition period, where birth rates start to decline, leading to sluggish population growth (Bongaarts, 2015). Many nations with high GDP per capita (i.e. Germany, Italy) are currently experiencing stagnant population (post-transition) growth, resulting in aging populations and long-term unprecedented consequences, such as the dramatic increase in health care demand (Aetna, 2014). In Canada, 15% of the population is made up of older adults (age 65+), which consume 45% of public health expenditure (Canadian Medical Association, 2016). More specifically, the top 1% of health care users in Ontario accounted for one-third of health-care spending, whereas the lower 50% of users barely used 1% (Rosella et al., 2014). These high-cost groups are high-risk populations, such as older adults with multiple chronic illnesses, which pose challenges to Canada's universal health care system (Rosella et al., 2014; Canadian Medical Association, 2016). Like other western nations, Canada's healthcare is medically advanced and emphasizes acute care services; however, it needs to be adapted to meet the aging population's need for preventative medicine and prolonged chronic care (Silversides, 2014). Currently, informal caregivers provide most of the care to the aging population in Canada (Giesbrecht et al., 2012).

Most informal caregivers in Canada are carer-employees, which are defined as individuals who are providing unpaid care usually to a loved one or friend while working in the paid labour force (Health Canada, 2002; Duxbury et al., 2012). There are 6.1 million carer-employees in Canada, the majority which: provide between 1 to 30 hours of informal care per week; are predominantly female, and; are part of the baby-boomer generation (Duxbury et al.,

2012; Research on Aging Policies and Practices (RAPP), 2014). While carer-employees provide the backbone in caring for the aged (i.e. bathing, dressing, driving, paying bills), and potentially saving the Canadian government $25 billion dollars in annual health expenditures (Bastawrous, 2012), they are becoming more vulnerable to ill-health due to their struggle to maintain a healthy work-life balance (Earle et al., 2011; Duxbury et al., 2012; Williams et al., 2014; Employer Panel for Caregiver, 2015). Many carer-employees express negative emotional, physical, and mental health outcomes, such as stress, anxiety, depression, sleep loss, muscle pain, and fatigue (Williams et al., 2016). As noted by RAPP (2014), 44% of Canadian carer-employees report absenteeism, averaging about 9 days of work loss in the previous 12 months. In addition, 15% experienced a reduction in their paid work hours of work, averaging 10 hours/week, to provide caregiving (RAPP, 2014). In totality, this computes to 9.7 million days of absenteeism, and 256 million fewer hours of paid work. Furthermore, caregiving caused a loss of 560,000 employees to the labour force, due to carer-employees completely leaving paid employment (RAPP, 2014). From an economic perspective, this is equivalent to 1.2 million full-time paid workers in Canada, and an estimate loss of $5.5 billion CAD annually due to counter-productivity and absenteeism (RAPP, 2014; The Vanier Institute of the Family, 2017; Duxbury et al., 2015).

Current literature focuses on mitigating counter-productivity and optimizing work-life balance by implementing caregiver-friendly workplace policies (CFWPs) at work (Ramesh et al., 2016; Ireson et al., 2016). CFWPs, such as the ability to work compressed work weeks or request prolonged leaves of absence, are alternative strategies for employers to implement (Ireson et al., 2016). However, many employers: lack the flexibility; cannot afford to implement, or; simply believe that their workplace has adequate support for the needs of their employees, especially caregivers (Lero et al., 2012). Based on these gaps, there is a lot of work to be done to improve

CFWP implementation strategies. Furthermore, research on carer-employees is needed as this population is very poorly understood. Of interest in this paper is better understanding how accessibility to vital services for the older adult may impact carer-employees work-life balance, quality of life and overall well-being, given that assisted-transport is the most common caregiving task.

The objectives of this study are to: (a) create service areas to vital services and public transit stops in Hamilton Census Metropolitan Area (CMA) for the older adult; (b) using the enhanced two-step floating catchment area (E2SFCA), identify locations in Hamilton CMA that may pose highest assisted-transport burden for the carer-employee, based on the older adult's low access scores to vital services and public transit stops, and; (c) employing quadrat analysis to suggest areas of future implementation for both vital services and public transit stops. This implementation would act as an intervention strategy to mitigate assisted-transport dependence by enhancing mobility independence of the older adults; thus, improving the wellbeing of carer-employees. Although this analysis can be applied to the general population, the primary focus is mainly the older adult (potential care-recipient), as they are more prone to mobility limitations and demand for assisted-transport. For this study, highest assisted-transport burden is defined by longer driving distances and more frequent stops to services conducted by the carer-employee, due to the mobility limitations and poor accessibility of their older adults. Accessibility and service area metrics can provide informative visual insights for transportation and health planners and carer-employees, as they not only illustrate how accessible the services are (including the transit system) but highlight any major spatial disparities in the location of services serving the older adult. We begin of a review of literature specific to accessibility and how it impacts carer-employees providing assisted-transport, followed by a discussion of the:

study site; data, and; methods used in meeting the above-mentioned objectives. A discussion of the results follows, where policy and practice implications are highlighted. We end with a conclusion outlining next steps in this research trajectory.

Literature Review

Accessibility

The term accessibility can be misleading to the public, which is the main reason several studies have differentiated the definition of potential and actual accessibility (Guagliardo, 2004; Bissonnette et al., 2012). Potential accessibility is defined as the population coexisting in space and time with the characteristics of the current delivery system (Guagliardo, 2004; Bissonnette et al., 2012). This can refer to measuring the maximum number of services a population can potentially reach within a 30-minute drive. In contrast, actual accessibility is defined as the actual use of services controlled by barriers, such as sufficient financial insurance access, and the quality of services provided (Guagliardo, 2004; Bissonnette et al., 2012). For instance, an individual may have high potential access to grocery stores, but their actual use may be more limited due to poor financial status. Ideally, every individual should have equal access to basic services, such as adequate food, water, and primary health care. Unfortunately, there are many barriers to meeting this ideal, including financial, political, and even physical. Given this, the concept and study of accessibility has changed from originally being only the purview of transportation planning, to now being studied across a wide range of interdisciplinary fields, such as urban and health geography and spatial econometrics (Cascetta, 2016).

From the geographical perspective, accessibility can be used as a powerful conceptual framework to analyze supply and demand opportunities via spatial analyses (Paez, 2013). Many studies have used spatial analyses to pinpoint vulnerable areas through displaying the spatial

variation of vital services (Luo et al., 2003; Paez et al., 2013; Kwan et al., 2015; Bauer et al., 2016). In this context, vital services are defined as services that are essential to individual needs, especially common demands from older adult care recipients (Freedman & Spillman, 2014). Analyzing accessibility demonstrates how the physical location of individuals impacts their access to vital services, whether food and/or health care (Feldscher, 2011). For example, an individual may be residing in a food desert that forces them to drive more than 30 minutes to the nearest grocery store. Although the individual has enough financial resources to afford a vehicle, their wellbeing may be negatively impacted due to the amount of driving required to access a vital destination point. Few studies have highlighted the fact that prolonged exposure to driving or traffic increases the odds of premature mortality and morbidity due to fatigue, physical inactivity, and various traffic-related environmental factors (i.e. vibration, noise, and air pollution) (Ding et al., 2014; Khreis et al., 2016). Older adult populations (age 65+) are particularly at risk and more likely to make less trips (Mercado et al., 2009; Newbold et al., 2017), thus increasing their mobility dependence on alternatives (Newbold et al., 2017).

In general, having mobility independence is critical to an individual's health and wellbeing, especially for older a Limited, if any access to some form of transportation (including walking) results in social isolation, which ultimately leads to deteriorating health (Webber et al., 2010; Rubenstein et al., 2001; von Bonsdorff et al., 2006). Therefore, it is imperative to improve mobility independence of older adults as a preventative health strategy. For this study, walking is used as it: promotes active aging; encourages social cohesion in neighborhoods and may be considered as a prerequisite for mobility independence (Rantanen, 2013; Patla & Shumway-Cook, 1999). Public transit could be a form of mobility independence for older adults; however, the current public transit system is not well-designed for the needs of the older adult population ,

especially in Hamilton (Mercado et al., 2007). Therefore, caregivers are often the main provider of transport needs or assisted-transport for the older adult population.

Caringscape Terrain defined by Space-Time

Assisted-transport involves transporting ill or disabled care recipients to conduct errands and is the most frequent type of caregiving (National Alliance for Caregiving and AARP, 2004; Statistics Canada, 2015). The frequency of assisted-transport is influenced by both the location of the informal caregiver and care-recipient, and the performance of informal caring, which involves accessing specific locations at certain times (Bowlby, 2012). These characteristics are referred to as the intertwined concepts of space-time accessibility, and landscapes of care, or carescapes. Derived from Hagerstrand's theory of time geography, space-time accessibility (STA) has the capacity to illustrate how combined constraints (i.e. physical, societal, time) of everyday life develop the individual's agency in handling specific tasks and responsibilities; hence, STA proves to be a practical concept in research on work-life balance (Schwanen et al., 2008). The components of STA are what define the conceptual framework of carescapes, which shape the "caringscape terrain". In the interdisciplinary fields of caregiving and geography, the carescape framework has been applied mostly in the context of childcare (Bowlby, 2012), and not to the provision of assisted-transport to older adults by carer-employees. Thereby, we can assume that the decisions around assisted-transport amongst carer-employees are governed by space-time constraints, which then shape the "caringscape terrain." For this context, "caringscape terrain" is the amount of assisted-transport demand that may impact the carer-employee's health. Figure 3.1 displays the "caringscape terrain" of carer-employees conducting assisted-transport.

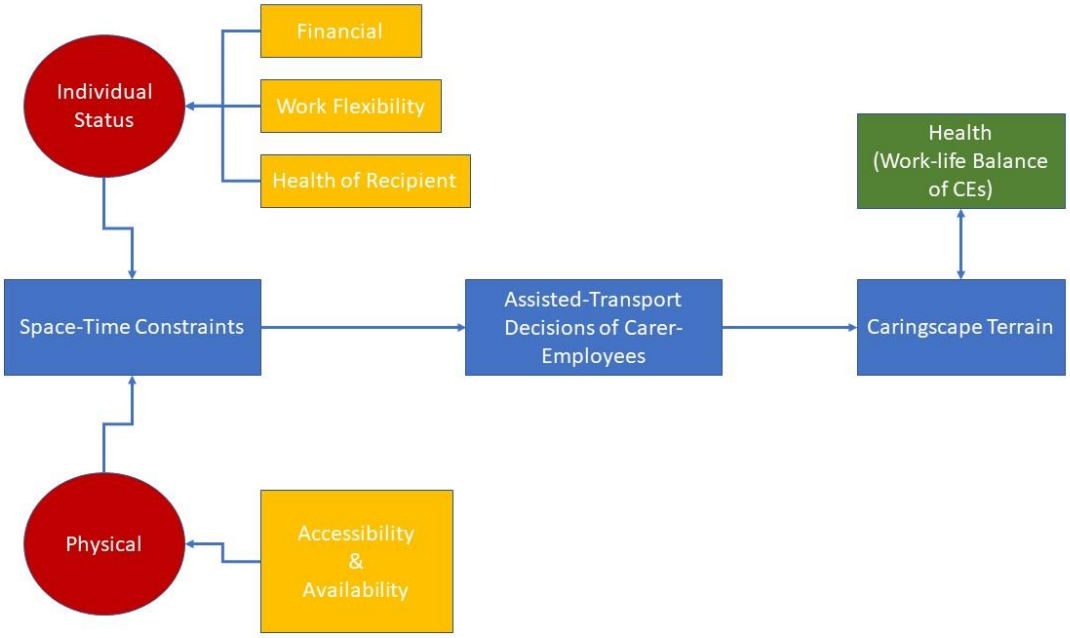


Figure 3.1 Caringscape terrain of carer-employees conducting assisted-transport

In the framework, *individual status* would measure the amount of social capital each carer-employee has. We define social capital as the aggregate of actual and potential resources that are linked to individual networks, which can transform into economic capital (Bourdieu 1986, p. 243). A healthy carer-employee with extensive networks to various resources is likely to have good financial status, flexible work schedule, and a relatively healthy care-recipient that does not require frequent care. However, this component requires individual data to accurately measure the caringscape terrain. For the purpose of this paper, we will be focusing on the geographic dimensions (*physical* component) of availability and accessibility to vital services, and how this impacts the assisted-transport demand of the care-recipient based on their location. This ultimately impacts the demands made on the carer-employee.

Accessibility and Availability

Availability is the supply of services based on population demand, whereas accessibility is the geographical location of services in relation to the location of individuals by incorporating

geographical constraints (Shah et al., 2016). Service area covers accessibility and the Enhanced Two-Step Floating Catchment Area (E2SFCA) covers both availability and accessibility through a two-step process with distance decay weights factored in (Luo & Qi, 2009). The first step defines the supply-to-demand ratio by calculating populations that are located within the catchment area of each service provider; in this case the supply is the number of vital services. The calculated supply-to-demand ratio is then weighted by a distance decay coefficient based on the defined impedance (time or distance) threshold (Luo & Qi, 2009). The main advantage of the E2SFCA is that several distance decay weights (more details in the methods section) replace the binary 0 and 1 in the original 2SFCA; thus, it portrays a more reasonable approximation of people accessing services based on the differences in travel time (Luo & Qi, 2009). The second step is to sum the calculated supply-to-demand ratio that are within the impedance threshold from the first step and then again weighted by the distance decay coefficient (Luo & Qi, 2009; Page et al., 2017). *Equation 3.1* outlines the two steps, known as the E2SFCA (Boscoe, 2013; Luo & Qi, 2009; Page et al., 2017; Donohoe et al., 2016):

$$A_k = \sum_{j \in (d_{kj} \leq d_0)} W_{kj} * R_j = \frac{S_j}{\sum_{k \in (d_{kj} \leq d_0)} P_k * W_{kj}}$$

Equation 3.1

S_j is the supply volume, $\sum P_k$ is the sum of all the demand centre populations that are within the threshold impedance ($d_{kj} \leq d_0$). W_{kj} is the distance decay weighted coefficient. This measures population to provider ratio (R_j). The location access score (A_k) takes the sum of the population provider ratio and multiplied by the distance decay weighted coefficient. No study has assessed spatial accessibility to vital services in Hamilton CMA. Therefore, having a better visual scope

of potential demand for assisted-transport and identifying areas that may require policy intervention soon via spatial analyses is necessary.

3.3 Study Area

Hamilton CMA is part of the "Golden Horseshoe" and located midway between Niagara Falls and Toronto with an approximate population of 750,000, thus making it the 9th most populous CMA in Canada (Statistics Canada, 2016). The CMA comprises an area of approximately 1,400 square kilometers, including the City of Hamilton, City of Burlington, and Town of Grimsby. Currently, only the cities of Hamilton and Burlington have public transportation service, while Grimsby decision-makers are currently planning to implement one (Town of Grimsby, 2017). About 85% of the population reside in the urban cores of Hamilton, Burlington, and Grimsby, which consists of only 15% of the total area (Figure 3.2). About 16% (~115.4k) of the population in Hamilton CMA are at least 65 years old (Statistics Canada, 2016).

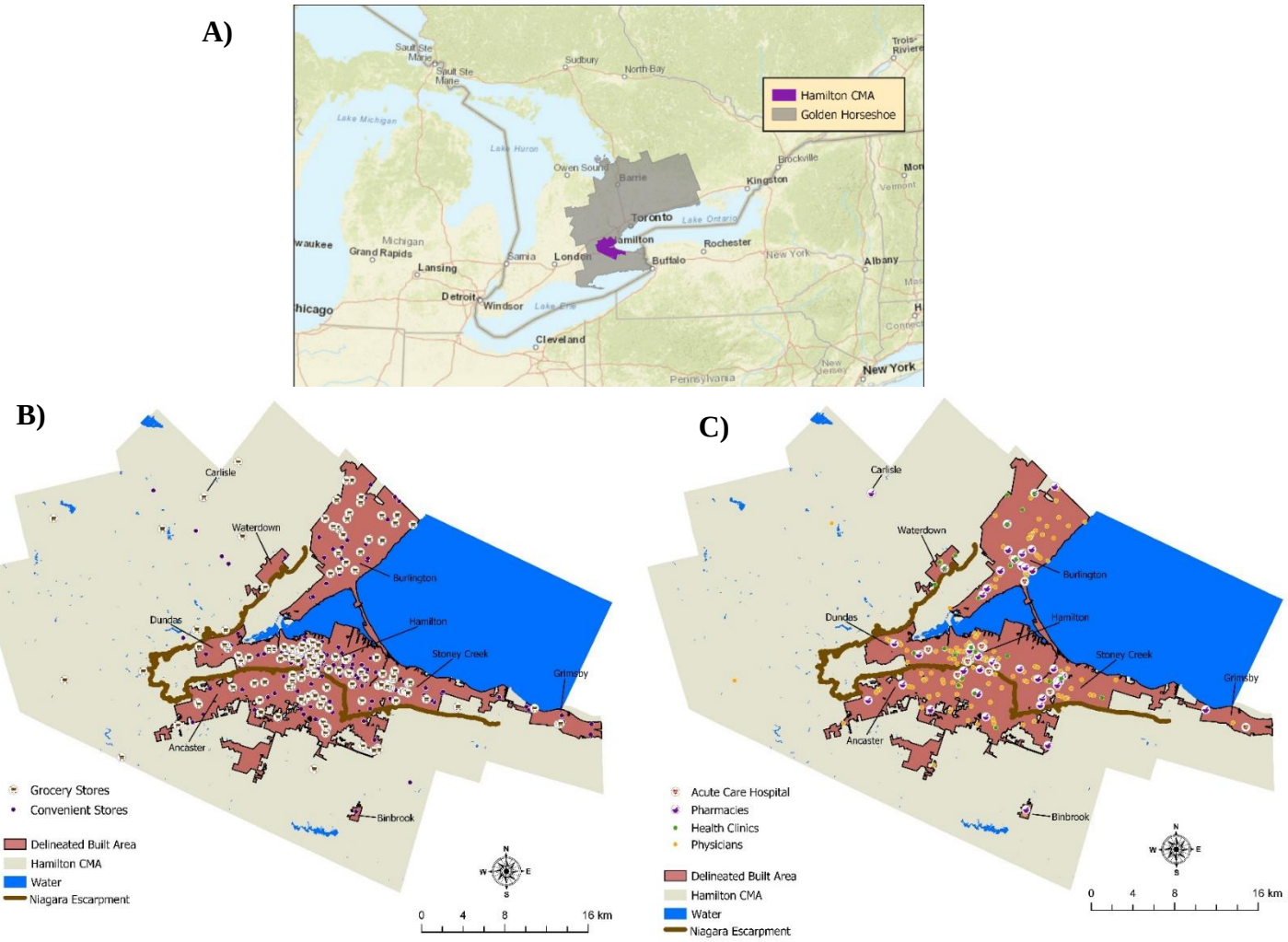


Figure 3.2 Study area of Hamilton CMA with distribution of vital services

3.4 Data

As mentioned earlier, vital services were used to assess the individuals' needs as a measurement of accessibility for older adult care recipients, and especially the more common demands (Freedman & Spillman, 2014). These include addresses for: grocery (n = 159) and convenience stores (n = 248), pharmacies (n = 46), primary care physicians (n = 287), health clinics (n = 27), and acute care hospitals (n = 9) (Figure 2B and 2C). All except health care clinics were acquired from the Canadian Business Database (Canadian Business Database).

Health care clinics were obtained from Hamilton Niagara Haldimand Brant Health Line (HNHBH, 2018). Another form of mobility independence for older adults is access to public transit stops. Public transit stops were collected from the Hamilton Street Railway (City of Hamilton), and Burlington Transit (City of Burlington) websites. Residential addresses (representing older adults as potential care-recipients) were acquired from the open data portals of Hamilton, Burlington, and Niagara. A road network (DMTI Spatial Inc.) was obtained to measure potential accessibility and assisted-transport demand of each residential address. The road network was refined for pedestrian access by eliminating roads with speed limits over 90 km/h and ramps over 50 km/h.

3.5 Methodology

Service area analyses evaluates accessibility within a specified impedance (i.e. distance, time) from the vital service point. In other words, service area demonstrates the amount of time or distance a service is based on an existing road network. Walk impedance for service area and the E2SFCA was set to 10 minutes based on reasonable time and average walking speed of older adults, which is 1.25 m/s (Watson et al., 2016; TransSafety, Inc., 1997; Langlois et al., 1997; Bohannon, 1997). In preparation to calculate the E2SFCA, the origin-destination (OD) matrix was used as it identifies and measures the least cost path along a road network from multiple origins to multiple destinations (Esri, 2016). Using the Network Analyst tool in ArcGIS, one OD matrix was created for vital services and the other for public transit stops. The Geopandas and Pandas packages in Python were used to calculate the E2SFCA for each residential address from the OD matrix results. Fast-step and slow-step distance decay weights were applied based on past research (McGrail, 2012; Wan et al., 2012; Donahue et al., 2016):

- Slow-decay weights (w): 1, 0.80, 0.55, 0.15
- Fast-decay weights (w): 1, 0.60, 0.25, 0.05

Going from left to right, the decay weights correspond to the increase travel time impendence for every 2.5-minute interval. For instance, a travel time between 0 and 2.5 minutes to the nearest service would have a distance decay weight of 1; whereas, a travel time of over 7.5 to 10 minutes would have a slow distance decay of 0.15 and fast distance decay of 0.05. Initially, we were going to measure potential accessibility to vital services by the public transit network as recommended by several studies (Langford et al., 2011; Langford et al., 2012; Guo et al., 2015). This would require granular data of the public transit network such as the amount of times buses pass by the stop per day, which is unavailable to access for our study area. An alternative is to modify the Langford's modified E2SFCA (Langford et al., 2011) by factoring only the nearest stop containing multiple routes; however, the aim is to maximize mobility for older adults since they're the least mobile in comparison to younger age cohorts. Therefore, we used the current E2SFCA and populated S_j by the number of routes each stop serves.

Many research studies in health geography have used and recommend these methods to measure accessibility (Luo & Qi, 2009; Langford et al., 2011; Chen et al., 2018); though, these methods alone would not sufficiently highlight areas that may require attention to reduce assisted-transport demands for caregiving. Therefore, extra steps were developed to classify accessibility zones as a measurement of potential assisted-transport, estimate populations within each zone and suggest areas outside of the service region to develop more services. Residential addresses with calculated access scores were then aggregated to the dissemination areas (DAs), thus displaying overall average access in the service area. *Equation 3.2* calculates the estimated older adult population in each classified accessibility zone:

$$\sum_{(S \in Q)} OP_D = \frac{OP_D}{P_D} * Est.Pop = \sum(a \in mD) * PR_D = \frac{P_D}{\sum(a \in D)}$$

Equation 3.2

where PR_D (population rate per DA) is obtained by dividing the DA's population (P_D) by the sum of the residential addresses that are located within ($\sum(a \in D)$). Next, the estimated population of the DA's service area (Est. Pop) is calculated by multiplying the new sum of residential addresses within the DA's service area ($\sum(a \in mD)$) by PR_D. The estimate of older adult population within the DA's service area is finalized by multiplying both, *Est. Pop* and the older adult population rate (OP_D divided by P_D), together. The final part of the equation takes the sum of the estimated older adult population which corresponds to the subset queries ($S \in Q$) of the defined accessibility zones (Table 3.1 & 3.2 in the Results section). Using quantile distributions, the accessibility zones were classified into six access score ranges as cutoffs. Each access score cutoff was qualitatively labeled into the following terms: (1) "hardly accessible"; (2) "poor access"; (3) "partial access"; (4) "fair access"; (5) "high access", and; (6) "well accessible." These six classification schemes were aggregated based on similar definition (i.e. "hardly" and "poor access" become "lower access") and reclassed into three categories (lower, middle, and upper). This reclassification would simply rank the relative potential accessibility and report estimate population ranges. All areas outside the service zone may require future additional services; however, some will have greater priority than others based on the number of residential addresses per defined cell. To locate which areas are most suitable, we need to first identify the ideal threshold values. This was accomplished using quadrat analyses within the service area. Quadrat analysis is a method of point pattern analysis that looks at the number of events or points (i.e. residential addresses) per cell of shape in the study area. Specifically, hexabins were selected as the shape due to the following reasons: 1) they reduce sampling bias;

2) points are closer to the hexabin's centroid than squares or triangles; 3) they're more preferable for analysis involving connectivity or movement paths, and; 4) more neighbors are included in the calculations as opposed to a fishnet grid (square) (Esri, 2019). The coverage cell size was set to 750 meters as it is the maximum walking distance in which the average older adult can cover in ten minutes (1.25 m/s * 60 sec * 10 min). The mean number of residential addresses captured in the service area for vital services was approximately 260, and 365 for public transit; this was the ideal threshold values for implementing the new vital services and public transit stops. Suggested areas are for decision-makers to potentially implement additional services as an intervention strategy. This strategy extends coverage zones and alleviates assisted-transport demand, while addressing the third research objective. The suggested areas are discussed in the *Discussion* section.

3.6 Results

Service Area

For comparison purposes, Figure 3.3 displays walkable service areas to both vital services (3A) and public transit stops (3B). As expected, the service area of public transit stops is more extensive than vital services. The service area of public transit stops covers 253 sq. km., whereas, vital services comprises of 190 sq. km. Most of the transit stops and vital services are within a very short walk time (≤ 2.5 min) and are situated in the inner urban cores of Hamilton and Burlington. The majority of the longer walk times (7.6 – 10 min.) to the nearest public transit stop are located at the Niagara Escarpment.

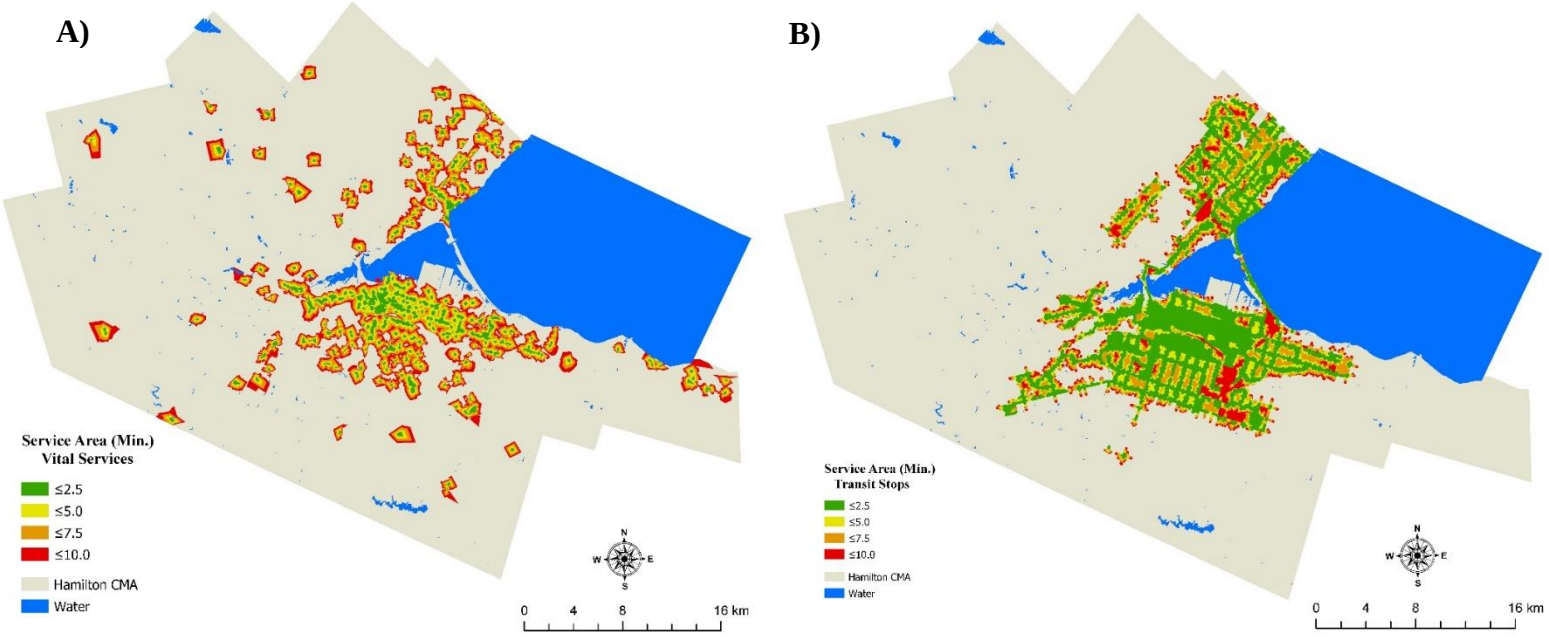


Figure 3.3 Service Area in minutes – (A) Vital Services; (B) Public transit stops

Potential Accessibility to Vital Services

Lower accessibility consists of "hardly accessible" (dark red) and "poor access" (dark orange). "Partial access" (orange) and "fair access" (golden yellow) describe middle accessibility. Finally, upper accessibility incorporates "high access" (light green) and "well accessible" (dark green). These categories apply for potential accessibility to vital services and transit stops. From here on, all potential accessibility results from Table 3.1 and 3.2 refer to the "Access Class" column. About 71.6k (62%) of the older adult population are within the threshold walk time to the nearest vital service. Of the 71.6k older adult population, over 40% are in the upper, a range of 34 to 37% in the middle, and between 20 to 25% in the lower accessibility zone (Table 3.1).

Table 3.1

Estimate population of age 65+ (71.6k) in each accessibility zone of vital services

Access Class	Accessibility Score		Slow Decay (Vital)	Fast Decay (Vital)	Pop. Range
Lower	Hardly Accessible	(< 0.0009)	6,354 [8.9%]	9,266 [12.9%]	14,800 – 17,800 [20.7 – 24.8%]
	Poor Access	(0.0009 – 0.0015)	8,504 [11.9%]	8,497 [11.9%]	
Middle	Partial Access	(0.0016 – 0.0023)	11,493 [16.1%]	10,395 [14.5%]	24,600 – 26,300 [34.4 – 36.7%]
	Fair Access	(0.0024 – 0.0035)	14,854 [20.7%]	14,201 [19.8%]	
Upper	High Access	(0.0036 – 0.0060)	15,184 [21.2%]	14,425 [20.1%]	29,200 – 30,400 [40.8 – 42.4%]
	Well Accessible	(> 0.0060)	15,210 [21.2%]	14,815 [20.7%]	

Figure 3.4A and 3.4B display a visual contrast of the accessibility zone for slow and fast distance decay respectively. There is some evident distance decay to the travel time as described in the methods section, but similar accessibility score overlays. For the slow distance decay, most of the upper access scores (> 0.0060) are located in the inner urban cores of Hamilton and Burlington, an area on the "mountain", along the escarpment, and outside of the delineated built-up area. The lower access scores (< 0.0015) are located north of the escarpment (below the "mountain"), and south of the "mountain." Relative to the slow decay, the fast decay results (Fig. 3.4B) didn't display many changes. Figure 3.4C illustrates percent differences with a mean of (19.3%). Most of the major changes above the mean are scattered across with few distinct clusters in Stoney Creek and Ancaster. Comparing population data in both decays, the slow decay seems to have a slightly higher older adult population than the fast decay. The fast decay

has a higher population in the "hardly accessible" area. Nonetheless, there is not much of a population difference between the two decays.

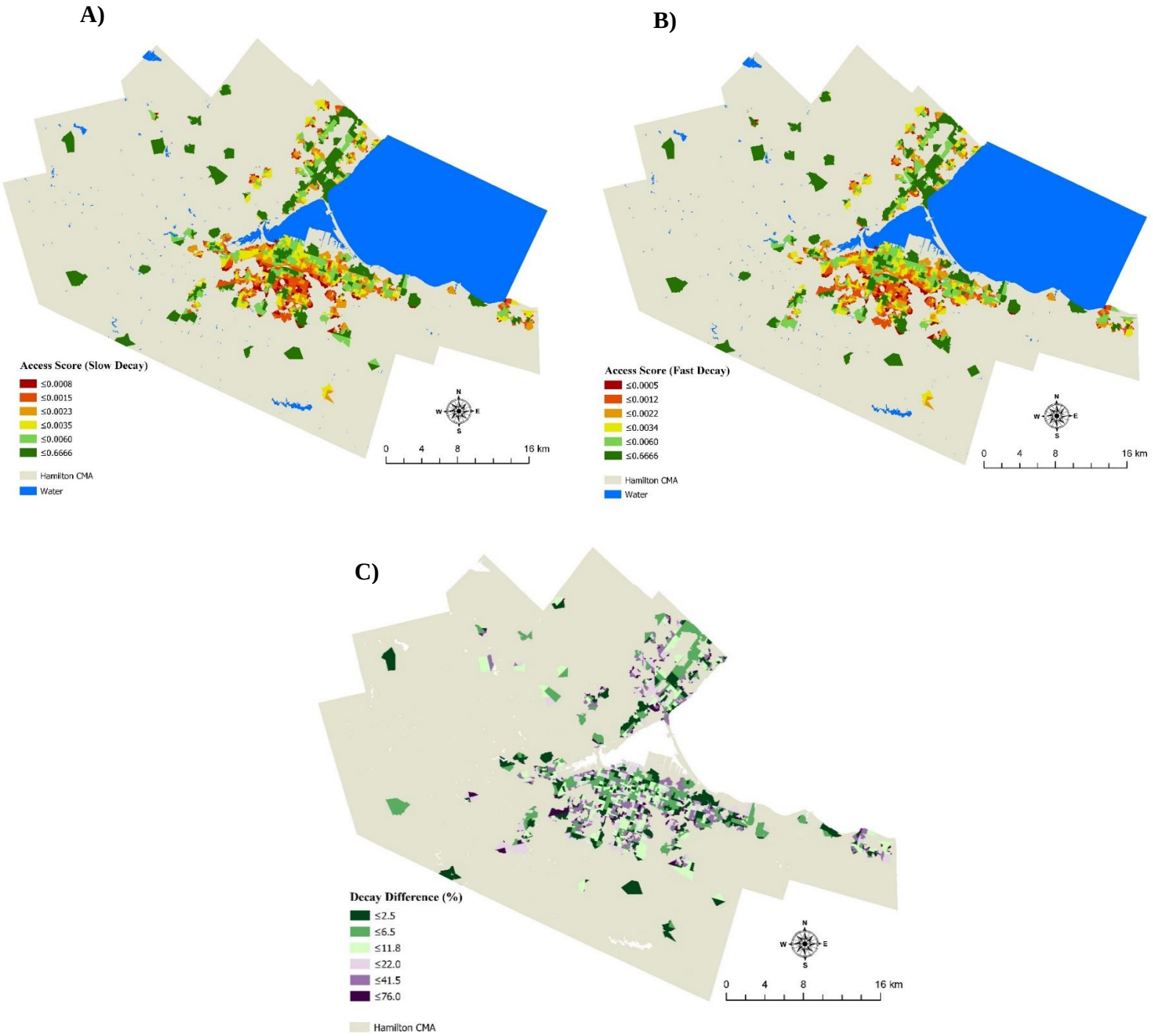


Figure 3.4 Accessibility score to vital services – (A) Slow distance decay; (B) Fast distance decay; (C) Decay differences (next page).

Potential Accessibility to Transit Stops

About 82% (~94.6k) of the older adult population are within the threshold walk time to the nearest public transit stop. Similar to Table 3.1, Table 3.2 compares the approximate older adult population of each accessible zone for slow and fast distance decay. The older adult population is somewhat equally distributed in both the upper and middle accessible zones with a range of 37 to 40% (Table 3.2).

Table 3.2

Estimate population of age 65+ (94.6k) in each accessibility zone of public transit stops

Access Class	**Accessibility Score**		**Slow Decay (Vital)**	**Fast Decay (Vital)**	**Pop. Range**
Lower	Hardly Accessible	(< 0.007)	12,347 [13.1%]	13,900 [14.7%]	21,500 – 23,300 [22.7 – 24.6%]
	Poor Access	(0.007 – 0.009)	9,196 [9.7%]	9,389 [9.9%]	
Middle	Partial Access	(0.01 – 0.013)	20,758 [21.9%]	20,052 [21.2%]	36,000 – 37,500 [38.1 – 39.6%]
	Fair Access	(0.014 – 0.017)	16,740 [17.7%]	15,992 [16.9%]	
Upper	High Access	(0.018 – 0.027)	17,325 [18.3%]	17,408 [18.4%]	35,300 – 35,600 [37.3 – 37.6%]
	Well Accessible	(> 0.027)	18,235 [19.3%]	17,860 [18.9%]	

Similar decay trends from the vital services, the slow decay seems to have a higher older adult population in the upper and middle; whereas, fast decay has more in the lower accessibility zone. Figure 3.5A and 3.5B also illustrate the accessibility zone variations. Surprisingly for both decays, the highest access scores to public transit stops are concentrated in Burlington and the north end of Hamilton. The lowest access scores are clustered in Waterdown, Stoney Creek,

Dundas, and south the "mountain." Most of the decay differences (Figure 3.5C) are in Burlington, Waterdown, and Stoney Creek. The mean difference is 8.5%.

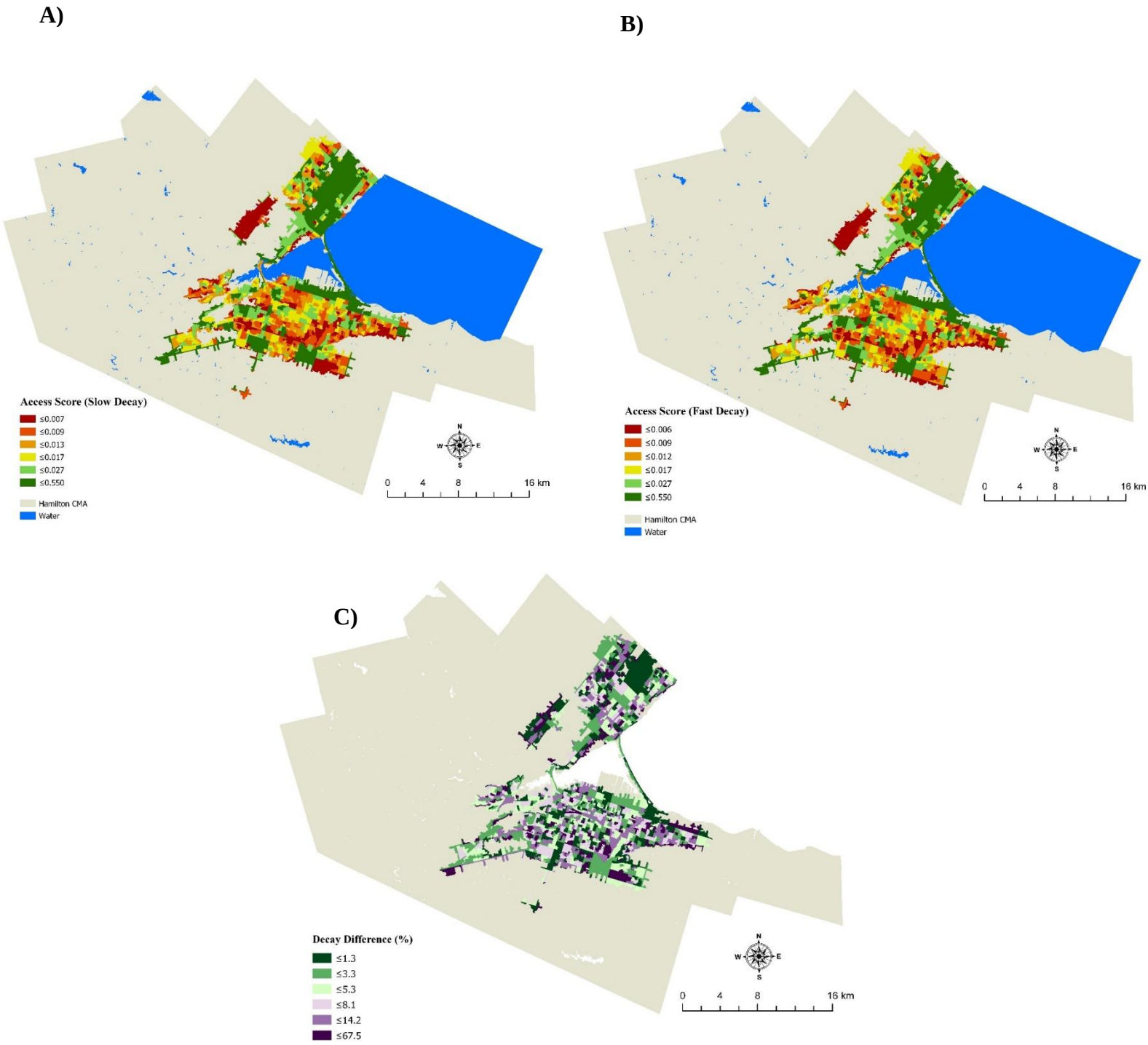


Figure 3.5 Accessibility score to public transit stops – (A) Slow distance decay; (B) Fast distance decay; (C) Decay differences (next page).

3.7 Discussion

Research studies have conducted walkability analyses amongst the older adult population (Boakye-Dankwa et al., 2019; Todd et al., 2016). However, the objectives of this study are to potentially mitigate assisted-transport demand by first identifying areas that may be in high demand and require additional services, while also suggesting areas for service expansion. The combination of service area and defined accessible zones provide the foundation to measure potential assisted-transport demand, which ultimately lead to the amount of mobility dependence Availability and accessibility largely depend on the location of both, the carer-employee and care-recipient.

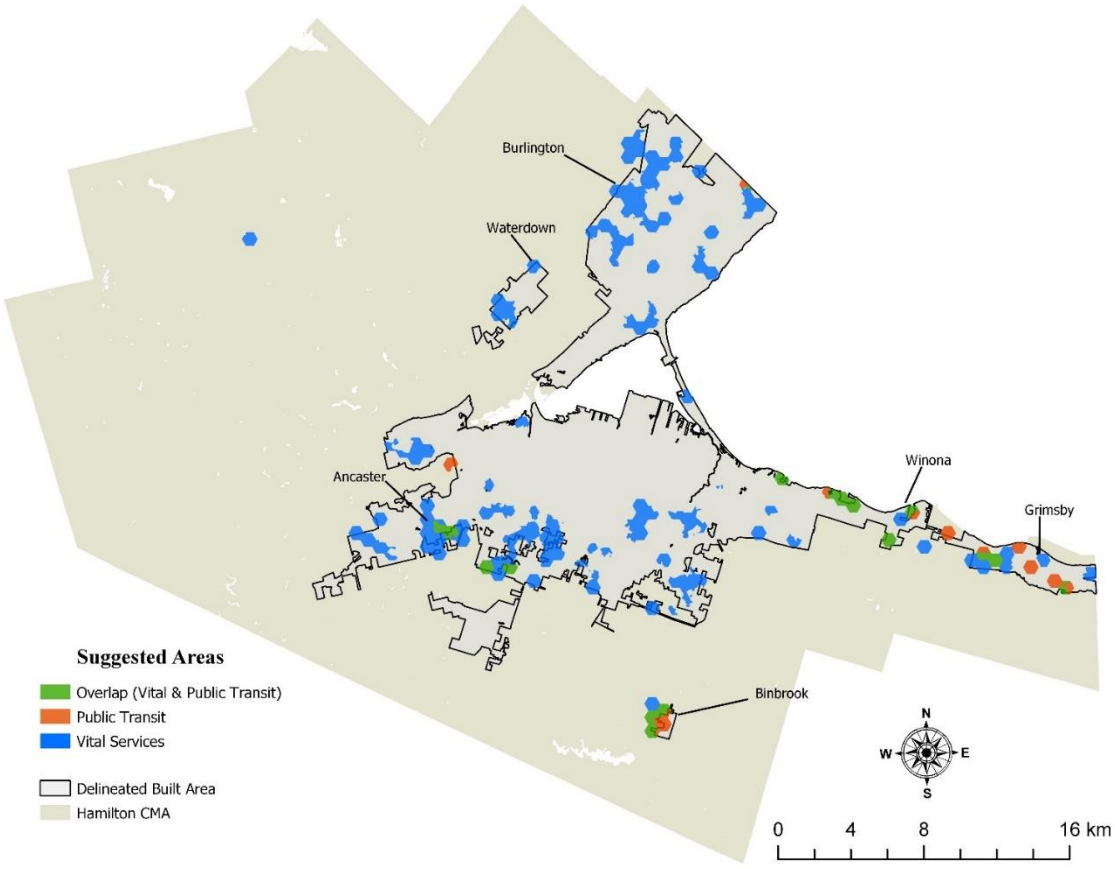
Starting with service area, it has been found that most people are willing to walk up to 10 minutes as a reasonable threshold, given the average walking speed of older adults (1.25 m/s) to the nearest vital service and public transit stop (Watson et al., 2016; TransSafety, Inc., 1997; Langlois et al., 1997; Bohannon, 1997). Walking was the only mode of mobility analyzed, as it considers: those that cannot afford to drive a vehicle, lost their license due to infraction, or are cognitively and/or physiologically unable to drive. This assumes the older adult population are at least in fair condition to walk. Surprisingly, 62% of the older adult population are within the threshold walkable distance to at least one vital service; however, improvements in the near future may be required, as 14.8k to 17.8k of the older adult population have low access, with the remaining 38% [43.8k] not within immediate reach. From both decays, most of the low access zones are located along the Niagara Escarpment and on “the mountain” (south side of the city). The Niagara Escarpment poses a natural physical barrier between “the mountain” and the lower city of Hamilton; therefore, it is more difficult to access any service along the escarpment due to relatively few roads that connect the upper and lower parts of the city. This area can be improved

by adding connections (i.e. gondolas or funicular railway) or additional services. Furthermore, the implementation of additional services may vastly improve service coverage from 62% to 80% of the older adult population (Table 3.3). These implementation strategies have the potential to improve mobility independence for the older adult population, and thus, reduce assisted-transport demands.

By comparison, the public transit system in Hamilton CMA seems to be the backbone to accessibility for the population, especially for older adults. Eighty-two percent (82%) of the older adult population are within the threshold walk time to the nearest public transit stop. Most of the older adult population seem to be residing in the delineated built-up area, as 96% of the public transit stops are located there. Given these characteristics, it may be deemed unsustainable to implement new public transit services as it is likely that the remaining 18% of the older adult population are residing in the rural parts of the CMA. This is evident with the suggested areas, given an increased older adult population coverage of 1.2 to 3.9% (Table 3.3), most of which are in the delineated built-up areas in Binbrook and Grimsby. From the distance-decay weight perspective, most of the low access areas are located in Waterdown, Stoney Creek, and south of the “mountain”. Waterdown and Stoney Creek have suburban environments, where the location of public transit stops is usually far and few in between.

The suggested areas to implement new vital services and public transit are illustrated in Figure 3.6. Most of the suggested vital services would be expanded at the fringes of the delineated built-up areas in Hamilton, and parts of Waterdown and Burlington. This would potentially impact an additional 17.9k [~25%] of older adults to have walkable access (Table 3.3). Suggested public transit stops would be situated in Grimsby, Winona, and Binbrook. An additional 1.2k [1.2%] of older adults would have access to public transit (Table 3.3). Lastly, the

overlap of vital services and public transit stops (green) would be in Ancaster, Binbrook, and in between Stoney Creek and Grimsby. This would increase the older adult population by 2.6k (Table 3.3). In total, the expansion of the suggested services would provide walkable access to an additional 21.6k older adults (Table 3.3). Table 3 displays the increase in older adult population of each suggested service type. The "Increase Range" column accounts for the minimum and maximum older adult population by adding one of the services with the "Vital Service & Public Transit Stop." For instance, public transit has a range of 1,130 (min) to 3,659 (max). The 3,659 was calculated by taking 1,130 and adding it with the 2,529 from the "Vital Service & Public Transit Stop", assuming the overlap service would end up implementing only public transit stops.



. **Figure 3.6** Suggested areas to expand accessibility.

Table 3.3

Estimate population of age 65+ in suggested area type

Suggested Area (Service Type)	**Older Adult Population**	**Increase Range**
Public Transit Stop (only)	+1,130	1,130 – 3,659 [1.2% - 3.9%]
Vital Services (only)	+17,984	17,984 – 20,513 [25.1% - 28.6%]
Vital Service & Public Transit Stop (Overlap)	+2,529	
Subtotal	+21,643	

As stated in the literature, assisted-transport demand is the most common and second most demanding caregiving task. Extending public transit systems can be costly to taxpayers with negative return of investment unless the area is densely populated and has potential high demand. Only a few suggested areas may qualify for transit expansion (Figure 3.6); however, intensive transit research would be required for validation. Fortunately, the province of Ontario is aiming for an accessible province by 2025, based on the Accessibility for Ontarians with Disabilities Act (AODA 2005). Its mandated purpose is to provide accessible transportation services that would facilitate people with disabilities to be mobile independent. Through research and stakeholder consultations, Ontario is focusing on the following objectives: 1) improving conventional and specialized transit; 2) exploring new avenues, such as shared economies and interjurisdictional transit coordination, and; 3) by 2020 implementing a universal identification card for persons with disabilities as proof for eligibility benefits (Province of Ontario, 2016). Particularly, the universal identification card system may be of use as data collection to optimize the existing transit systems. Hospitals, groceries, and pharmacies with pick-up/drop-off services

can use the card system to optimize management and finances, such as predicting the client's daily behavioral patterns. An alternative approach would be drone delivery, which is likely to become a reality within the next decade (Quittner, 2016). Drone delivery will eventually become a more convenient way to deliver goods for the general population and for retailer companies alike (Vincent, 2017). For instance, drones have been used to deliver medical supplies to a small clinic in rural Virginia and have been used to transport blood products in rural Rwanda (Manohari Balasingam FRCP, 2017). This would greatly increase accessibility.

Paratransit is similar to public transit except it is tailored for the older adult population and the disabled. Only eligible transit users can receive this service and require advanced planning for pick-up. Hamilton CMA has the Disabled and Aged Regional Transportation System (DARTS) as a paratransit service available. One proposed solution to Ontario's first objective is to develop a somewhat similar model to paratransit that would offer firm routine schedules to those that do not have access to public transit, except it would be operated by private transit companies. These firm routine schedules would be made up of mini-buses going through multiple less accessible areas on specific routes for mass pick-ups. To make it economically feasible and continuously update routes for optimization, companies would collect data of the individual via an online application for qualification and location. For starters, Figure 6 illustrates suggested areas to extend services, especially transit stops. Most of the suggested areas for transit are either at the edges of the delineated built area (upper part of Hamilton), isolated Binbrook, or close to the waterfront towards Grimsby. All suggested areas would extend the current service area for transit, thus increasing older adult population coverage from 82 to 86%, or an additional 3,700 older adults. The small improvement would be particularly suitable for this type of service. Additionally, it would be more convenient and efficient than paratransit.

Another solution is to have a caregiving transit-related service tailored towards the business model of Uber. The company would be able to identify areas that have potentially high transport demand via an online application or web app. Through a web app, care-recipients or informal caregivers can request the transport service on short notice. Fares would be based on public transit models, with price increases based on the number of zones traveled (Horgan, 2017; Borndörfer et al., 2012). A public transit agency in Austin, Texas similarly mirrors this kind of model with a mass sharing riding app that would increase convenience, speed, and trip-planning information for its commuters (Deron, 2017). The service can provide limited waiting times and assistance (i.e. shopping) that may be either partially covered by the health insurer or paid extra from the care-recipient. Uber and Lyft have been reinventing the public transit system of various cities worldwide by conducting carpooling service, "smarter pickups and suggestions", and transporting commuters to nearest public transit service (Circella, 2018; Hall et al., 2018). A caregiving transit-related service may follow the models of Uber and Lyft, collecting massive amounts of data and creating their own application interface (API); this can be used to predict and create hot-spots for pick-ups and drop-offs. One limitation to this model is that it would not be tailored to the walking impaired. Most Uber/Lyft style vehicles do not have wheelchair accessibility and the service does not provide door-to-door assistance for those who are mobility impaired. Overall, while these solutions may be somewhat vague, they provide a good starting point for discussion around effective policies and services that would be sustainable for the current and future providers, while convenient for the carer-employee and care-recipient.

Limitations

There are several limitations evident in this study. First, the geographic scale of analyses was constrained to the census metropolitan area of Hamilton, and as such excluded neighbouring

communities. Consequently, there is the possibility of spatial spillover effects. For example, Flamborough, a rural part of Hamilton CMA, borders with Kitchener-Cambridge-Waterloo CMA and Guelph CMA. If residents live in communities closer to either of the aforementioned CMAs, then they would be more likely to travel to one of them instead of into Hamilton service areas. For example, residents living in Sheffield and Rockton will more likely travel to the City of Cambridge. In contrast, residents in other parts of Flamborough, such as Carlisle and Millgrove, would be more likely to use services in nearby Waterdown or Dundas. Secondly, opening and closing times rare not accounted for in this study. For instance, not all grocery or pharmacy stores operate 24 hours; hence, this could be an additional constraint of access for the individual. A third limitation are the areas classified as "Hardly accessible" or "Poor access" assumes the older adult population in those areas are likely to require assisted-transport. This may not always be the case as individuals may have their own form of capital (i.e. economic and social). A fourth limitation is the lack of self-rated health information available. Obtaining self-rated health information at the DA or smaller scale, especially mobility status, would improve identifying areas requiring additional services. A fifth limitation is the estimated population that falls within each access zone. Residential addresses are the most accurate location to estimate population per DA in the service area; however, it may be overestimating or underestimating the served population as the residential addresses do not disclose additional household information (i.e. number of residents per household). This type of information would improve population estimates with smaller marginal errors.

3.8 Conclusion

This research explores walkability service area, potential accessibility as a measurement of potential assisted-transport demand, and suggested areas for improvement. With the

limitations listed earlier, there is certainly room for both minor and major improvements to this research area. Minor improvements would include: re-conducting the study and incorporating the times of operation for public transit stops and each vital service type, including services outside Hamilton CMA, and; adding household information per address for finer population estimation. Most of these data sources are either not currently available or require data center clearance access for such fine resolution (i.e. household information). Major improvements would include going beyond this study to develop an online interactive application for mass data and research, which would be used as an informative tool for users, especially carer-employees. This would enable the user to type in their address to visualize opportunities that are available to them within 10 minutes, as well as determine their access score of their area. They would have options to: filter out service type, anonymously state their self-rated health at the disseminate level, and if applied as a carer-employee, state whether their assisted-transport demand falls above or below the access zone in their area. Building the application would require research and development teams and intensive computational resources. Overall, findings can provide informative visual insights to health and transportation planners, highlighting areas that may require attention. Consequently, this research has the potential to facilitate decision-making processes for the growing carer-employee and associated care-recipient populations. These include the implementation of new services in underserved or inaccessible areas, and thus reducing assisted-transport demand amongst carer-employees by improving mobility independence of the older adult population. This requires collaboration and involvement with other planning projects in Hamilton CMA, such as the recently approved light rail project, and the ongoing discussion of implementing Grimsby's public transportation system.

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Chapter 4 Carer-Employees' Travel Behaviour: Assisted-Transport in Time and Space

4.1 Abstract

Assisted-transport demand is a daily caregiving task that affects carer-employee's activity-travel behaviour; however, little is known about such behaviour and the types of constraints that impact carer-employee health. Combining the principles of Hägerstrand's time geography and Mckie et al.'s caringscape terrain, this research develops a mixed-methods framework to classify the travel behaviour of carer-employees based on their travel experience and the space-time fixity of their weekly schedules. The mixed-methods framework consists of sentiment analysis and k-means clustering, both which are used to analyze 25 randomly selected participants within the Greater Toronto-Hamilton Area (GTAH). Participants were asked to reflect on their recorded one-week trips in a trip summary questionnaire. Sentiment analysis was used to thematically describe carer-employees' travel behavior, whereas, k-means clustering generated travel behaviour profiles. "Time", "pressure", "parents", "run", and "long" were several thematic keywords describing the carer-employees' travel behaviour. K-means clustering identified three relative types of carer-employees' travel behaviours: 1) flexible, 2) between flexible and fixed, and; 3) fixed. These results provide critical information for the establishment of custom transport programs, such as maximum monthly telecommuting allotment; such programs are useful for employers to use in order to alleviate assisted-transport demand on their employees.

Keywords: Carer-employees, assisted-transport, travel behaviour, mixed-methods framework

4.2 Introduction

Informal caregivers are the current foundation for providing care to the aging population in many developed nations, including Canada (Giesbrecht *et al.*, 2012). There are 8.1 million informal caregivers in Canada, of which 6.1 million (75%) are classified as carer-employees (Duxbury *et al.*, 2012). Carer-employees are defined as individuals who deliver unpaid care, usually to a family member or friend, while working in the paid labour force (Health Canada, 2002; Duxbury *et al.*, 2012; Carers Canada, 2015). This excludes primary care physicians, nurses, and home health care professionals. Approximately 35% of the Canadian labour force are carer-employees, and are characterized as follows: 1) allot between 1 to 30 hours of informal care per week; 2) are female, and; 3) part of the baby-boomer generation (Duxbury *et al.*, 2012; RAPP, 2014; Williams *et al.*, 2014). Despite carer-employees being the workhorse in the provision of care for the aging population, and potentially saving the Canadian government $25 billion CAD in annual public health expenditures (Bastawrous, 2012), they are becoming more susceptible to illness due to experiencing an unhealthy work-life balance (Earle *et al.*, 2011; Duxbury *et al.*, 2012; Williams *et al.*, 2014; Employer Panel for Caregivers, 2015; Carers Canada, 2015). Some of the most common negative health outcomes carer-employees experience include: anxiety, depression, social isolation, and sleep loss (Williams *et al.*, 2016). Additionally, conflicts related to carer-employees' work-life balance negatively impact employers; 45% of carer-employees are severely impacted by their caregiving responsibilities, costing the Canadian economy $5.5 billion CAD annually (Employer Panel for Caregivers, 2015; RAPP, 2014; Benefits Canada, 2015). With the aging population expanding, it is expected the costs will continue to rise if mitigation strategies are not implemented.

Currently, research institutions and the Canadian government are collaborating to develop optimal caregiver-friendly workplace programs (CFWPs) that will improve the work-life balance of carer-employees without compromising productivity in the workplace (Ramesh *et al.*, 2016; Ireson *et al.*, 2016). Examples of CFWPs include telecommuting, compressed work weeks, and requested prolonged leaves of absence. While the implementation of CFWPs for carer-employees are at their relative infancy, we have yet to learn of any that address assisted-transport demands, such as transporting the care recipient to medical appointments, picking up medicines from the pharmacy, etc. To our knowledge, there has been no research done on carer-employees' travel behavior, as it informs caregiver-friendly transport programs (CFTPs). Therefore, this research aims to enhance the understanding of the carer-employees' travel behaviour, both individually and collectively. This is accomplished through applying Hagerstrand's time geography theory (1970) and McKie et al.'s caringscape terrain (2002) into our mixed-methods framework. The mixed-methods framework uses sentiment analysis and k-means clustering to classify the degree of the carer-employees' travel behavior via space-time constraints, which measures how fixed or flexible their activities are.

We begin with a literature review of Hägerstrand's (1970) time geography theory, describing how it has been applied in past travel behavior frameworks, and how it connects with the caringscape terrain framework. Next, the linkage of the caringscape terrain with the concepts of time geography is presented within our mixed-methods framework. The data and methods sections elaborate the approaches used to fulfill the objectives outlined. More specifically, the methods are to: (1) thematically describe the carer-employees' travel behaviour, and; (2) cluster carer-employees' travel behaviour into groups using k-means clustering. The results and discussion highlight the degree of space-time fixity, informing suggestions specific to CFTPs.

We conclude by outlining innovative directions for future research, including suggested improvements in our mixed-methods framework, and the creation of an online development tool.

4.3 Literature Review

Time Geography

The standard for transportation studies has transitioned from discrete trips to patterns of travel-based behaviour (Kitamura, 1996; Doherty, 2006; Kang & Scott, 2008; Chen *et al.,* 2016). The core principle of travel behaviour examines causal factors that influence individuals' decision processes when conducting trips (Aarts *et al.,* 1998), which are often caused by household members (Shaw and Wang, 2000). Examining patterns of travel-based behaviour are becoming more popular in transportation research due to the fact that they: (1) emphasize derived demand via activities rather than trips; (2) employ a holistic approach towards decision-making processes by incorporating multi-dimensional frameworks (time geography) and variables (i.e., activity type, time, location, and mode of travel); (3) involve multidisciplinary fields (i.e., civil engineering, geography, public health, and economics), and; (4) are policy-sensitive in that they apply travel-behaviour models on both supply-demand strategies and urban and transportation planning (Scott, 2006). All of these reasons are underpinned by the theoretical framework of Hägerstrand's (1970) time geography.

Hägerstrand's (1970) time geography framework enables researchers to understand where, when, and by whom travel activities are performed, and how individuals differ from each other, often modeled in space-time paths, bundles, and prisms. Space-time paths narrate the individual's movement from one location to the next in two dimensions; time is positioned orthogonally on the z-axis, providing a 3D presentation (Miller, 2008). Figure 4.1 visualizes the space-time path.

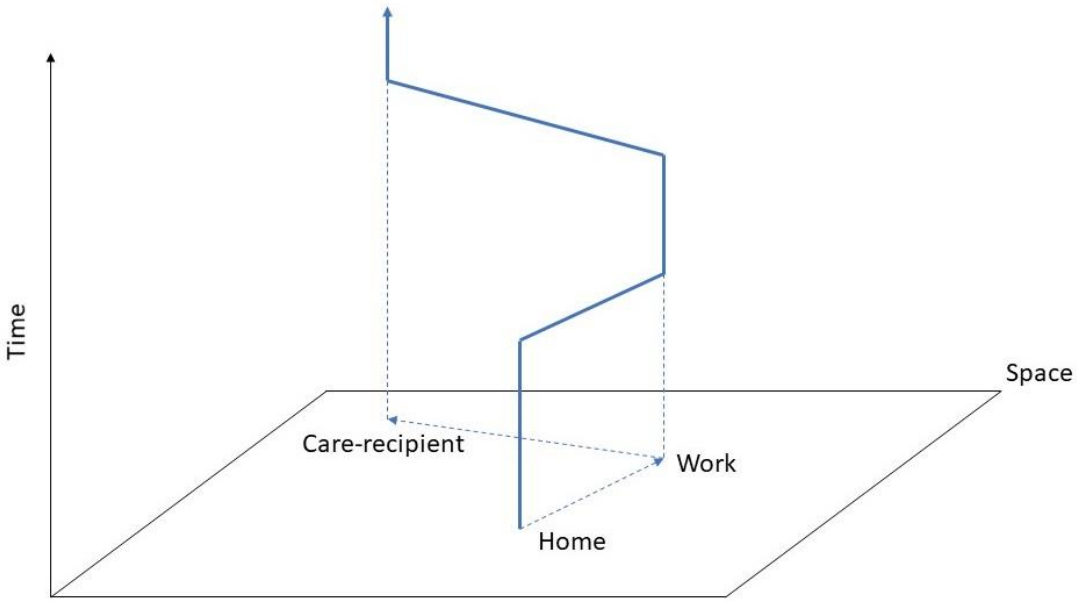

Figure 4.1 Space-time path

A vertical path indicates the amount of time in which the individual is stationed at a location. A horizontal path designates the individual's movement across space. The slope of the path depends on the individual's travel speed (i.e. the steeper the slope, the faster the travel speed). A space-time bundle is the grouping of several space-time paths (Figure 4.2). It visualizes at least two individual paths that rendezvous, arrive, or leave from a place, and thus disclose a shared activity (Miller, 2004; Ellegärd, 2019). More importantly, the space-time bundle concept is an efficient way of outlining intra-household activities (Hägerstrand, 1970; Miller, 2005; Kang & Scott, 2007), which is relevant in the context of carer-employees transporting their care-recipients to their final destination. In this case, Figure 4.2 shows three individuals' paths.

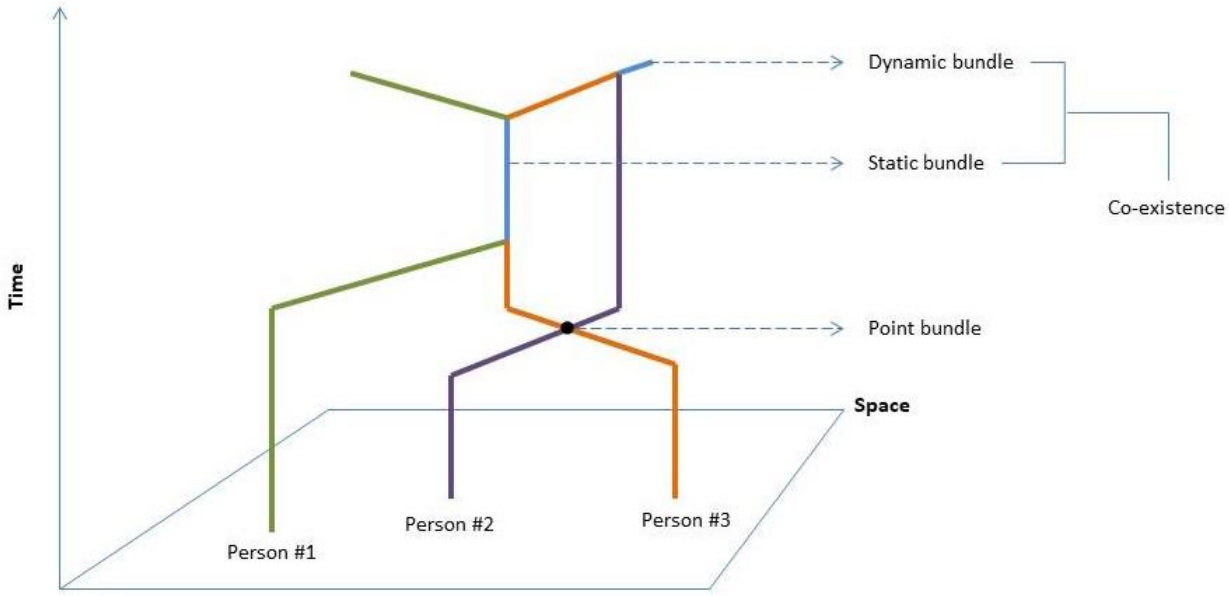

Figure 4.2 Space-time bundle

A dynamic bundle is when two or more individuals are traveling together at the same time and sharing the same location. A static bundle is where two or more individuals are not traveling but rather staying in place at the same location across a common time frame. A point bundle is when two or more individuals cross paths while travelling.

According to Scott (2010), a space-time prism (STP) unveils possible locations that are reachable by the individual's current space-time characteristics, hence the prism shape (Figure 4.3). The STP's shape relies on three factors: (1) the spatial locations or anchors of the departure (l_i) and destination (l_j); (2) the individual's time window or time budget (t_i and t_j), which conveys the amount of time available for travel and activity participation, and; (3) the individual's maximum travel speed that governs the time window (v_{ij}), where a_{ij} expresses the minimum amount of time required to complete the travel activity (Scott, 2010; Ellegärd, 2019). Applying this to the caregiving context, a carer-employee may leave work at noon to check up on their

care-recipient for 15 minutes, and then be back to work by 1:00 PM. The care-recipient's home is 10 km away from the workplace, or 20 km roundtrip. With a time, budget of one hour, the carer-employee has 22.5 minutes to complete the travel distance of 10 km each way; thus, the carer-employee must obtain a minimum speed of approximately 27 km/h, which may be averaged out after factoring in: walking to the car, traffic lights, and level of traffic congestion.

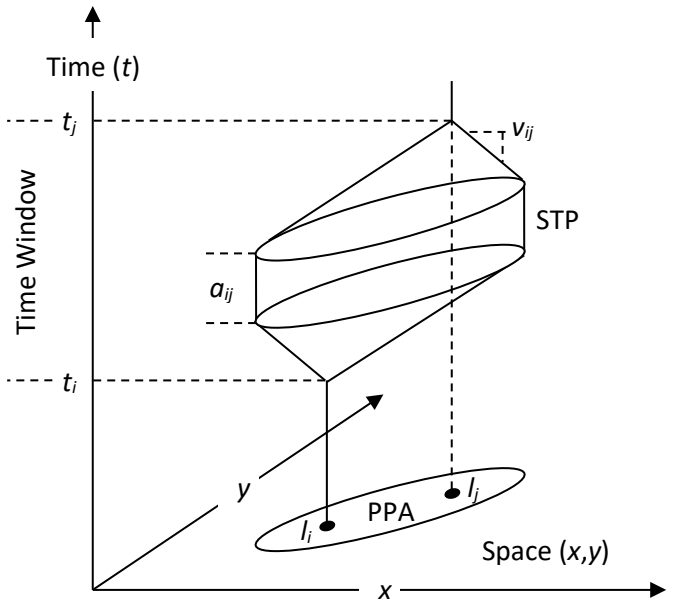

Figure 4.3 Space-time prism (Scott, 2010)

The three listed characteristics reflect the individual's travel opportunities, which are dictated by a set of constraints. While there are countless constraints, Hägerstrand (1970) narrowed them down to the three most influential constraints that fashion the STP's shape: (1) capability, (2) coupling, and (3) authority constraints (Miller, 2008; Neutens *et al.*, 2007).

Capability constraints outline the biological and physical characteristics of the individual (Miller, 2008), such as the individual's age and health status. Coupling constraints refer to the limitations of the individual to perform their own activities due to the restriction of a third-party

participant(s)'s schedules (Miller, 2008). This could be an individual interrupting their work-commute by dropping off their child to school, or an elderly care recipient to a medical appointment. Authority constraints limits individuals to have access to certain places situated by authorities, or the individual's social capital. For example, an individual may not be able to make an appointment with their primary care physician after work hours due to the physician's office being closed on a typical work day. Another is that an individual, by law, is not allowed to drive a car if they don't have a valid driver's license. Other examples include impacts due to various other socio-demographic characteristics.

Several gender-based studies have highlighted the authority constraint to be the most crucial of all. Rosenbloom and Burns (1993) identified that women's travel patterns were different from that of men's due to household roles. Hanson and Pratt (1995) found that women tend to choose part-time jobs in female dominated occupations as an approach to have more temporal flexibility in balancing paid work and caregiving. Chai (1993) clustered Japanese men and women's time use patterns and identified that women comparatively spend substantial time doing household work. Kwan (1999a) found that women in Columbus, Ohio, were more likely to work part-time, likely related to their more fixed travel patterns. From these studies, and our knowledge of space-time constraints, we hypothesize that carer-employees will have comparatively more fixed (constrained) time use and travel patterns than non-carer-employees, as carer-employees are "juggling" work, social, and caregiving responsibilities.

Overall, time geography captures the space-time dimensions and external processes influencing the individuals' travel behaviour. Miller (2008) describes the framework as space-time differences in travel outcomes, as influenced by various influential factors (i.e., health status, work-commute, picking up children, etc.). For example, McQuoid *et al.* (2017) examined

the everyday space-time contexts and routines of individuals with chronic kidney disease, and particularly accessibility to health services. Orban (2013) aimed at developing preventative measures of child obesity by changing the parents' routines using time-geography. Trygg and Hermelin (2017) explored the work-life balance of employees working in high-level consultant services using time-geography. More recently, Okamoto and Arai (2019) used time-geography to locate affordable and accessible childcare for employees. While these studies have contributed within the interdisciplinary fields of caregiving and geography, no study has yet to assess these issues in the context of carer-employees conducting assisted-transport for older adult care-recipients.

The aforementioned time-geographic constraints describe, in binary terms, how fixed or flexible individual's activities are (Hägerstrand, 1970). Cullen and Godson (1975) hypothesized that an individual's travel behavior is constructed based on the activity's fixed/flexibility rating. In other words, the physical travel patterns of the individual are shaped by several factors, including: financial importance of the activity, time of day, and the presence of other individuals. Of interest to this paper, we will use the binary concept of space-time fixity/flexibility to interpret carer-employees' travel behaviour; however, we will need to tailor it towards the caregiving context using McKie *et al.* (2002) "caringscape" terrain.

Caringscape Terrain

Developed by Mckie *et al.* (2002), caringscapes refers to the creation of travel routes that are dictated by daily schedules, combined with paid work and caregiving responsibilities. These routes change and evolve over time and are usually dependent on the demands of the individual's care-recipient. The intensity of demand required corresponds to the care-recipient's health condition. For example, as the care-recipient's health deteriorates over time, it is very likely their

demands will simultaneously increase. Therefore, these increasing demands will reshape the informal caregiver's "caringscape" terrain through having more frequent and fixed routes when compared to when the care-recipient's health was better. Studying an individual's caringscape terrain is subjectively complex, as there are many interweaving factors, including space-time constraints. Fortunately, Bowlby *et al.* (2012, p.2112) presents a list of eight concepts that facilitate research on caringscapes: (1) "Informal caring is a social/relational activity embedded in notions of obligation and reciprocity"; (2) "Informal caring is an ethical activity involving the notions of normative behaviour and desirable or 'appropriate' social relationships"; (3) "Informal caring often involves relationships of unequal power - especially inequalities of class, gender, race, and (dis)ability"; (4) "Informal caring is an embodied activity in which co-presence, bodily separation, and mediated forms of communication affect the caring encounter"; (5) "The performance of informal caring necessarily involves processes that connect across space-time"; (6) "The performance of informal caring involves a person using resources - people, ideas, material objects, as well as time and space to care - accessed through particular places and spaces at particular times"; (7) "The performance of informal caring involves a person reflecting on and/or enacting aspects of past informal caring relationships and/or anticipating future caring relationships", and; (8) "The performance of informal caring involves a person reflecting on and/or anticipating how informal caring relationships link to other actual or anticipated aspects of their lives." In the context of the present study, we focus on the sixth and eighth concepts to analyze the carer-employees' travel behaviour using assisted-transport as the primary variable.

Assisted-transport may either entail the carer-employee transporting ill or immobile/disabled care-recipient(s) to their activities, and/or running errands for their care-recipient(s). Currently, it is the most frequent type of caregiving task performed in Canada and

the United States (Statistics Canada, 2015; National Alliance for Caregiving and AARP, 2004). The recurrence of assisted-transport is directly influenced by the actions of informal caring; thus, it defines the carer-employee's caringscape by accessing specific places at certain times (Bowlby, 2012) to meet the demands of their care-recipient. Hägerstrand's time geography (especially space-time constraints) can shape the carer-employee's processes in managing assisted-transport and other indirectly-related caregiving tasks, and thereby provide practical applications to improved work-life balance (Schwanen *et al.*, 2008). Starting with carescapes, we hypothesize that carer-employees caring for a care-recipient in failing health will experience an increase in the demand to provide assisted-transport. This will therefore shape their carescapes to a more fixed travel behavior, as defined by the capability, coupling, and authority constraints. In the methods section below, our mixed-methods framework is described to explore this hypothesis.

4.4 Data

Recruiting

Data used in the analysis were collected from 25 randomly recruited participants. Approved by McMaster University's ethics board (#2017 035), a multi-pronged recruitment strategy was implemented, and included: postcard-distribution; word of mouth; online newspaper ads, and; messages sent via email lists at two post-secondary institutions. One institution had a compiled database containing employees' names, profession (i.e. professor), and email address. Using this information, Python was used to semi-automatically send 100 pre-written emails to individuals, all of which had the research postcard attached. The second institution had HR distribute the research postcard. Overall, the average response rate using email was

approximately 25%, thus, making it the most successful strategy. The recruiting process took place over a 12-month period from June of 2017 - 2018.

Eligibility Criteria

Eligible participants met all of the following criteria: 1) currently working full-time; 2) identify themselves as the primary caregiver; 3) actively providing informal care to their care-recipient; 4) either reside or commute in the City of Hamilton; 5) care for a care-recipient either residing in the City of Hamilton or within reasonable driving time (≤ 3 hrs. of free-flow time), and; 6) must be conducting at least four caregiving-related trips per week. The four caregiving-related trips per week was set as a reasonable threshold due to the majority of carer-employees conducting assisted-transport once per week, with only 10% on a daily basis (Dardas et al., 2019).

Data

For this study, recruited participants were asked to fill out three questionnaires: the first collected sociodemographic data; the second, trip diary data, and; the third, trip summary data. The socioeconomic questionnaire collected data specific to: age, gender, marital status, education level, income, health condition, and employment characteristics. The trip diary asked the participant to fill in each trip the following characteristics: (1) day of the week; (2) their start and end time including departure location and destination; (3) trip purpose; (4) estimated travel distance, and; (4) if the purpose was caregiving-related to specify the task. The trip summary questionnaire required participants to reflect on their one-week recorded trip diaries. Some of these questions included: which day had the most trips; what trip they found most stressful and why; if the trips were a weekly routine, and; the weekly hours of assisted-transport caregiving.

Data Refinement

Both questionnaires were aggregated, recoded, and missing data was imputed using R via RStudio. Some of the values in the variables were aggregated into larger bins to report results more simply. For example, the values of age 18-30, 31-35, 36-40, and 41-45 were aggregated into one value, 18-45. Values were recoded numerically to develop scores for each space-time constraint (reported in the next section) and to impute missing data. A few participants (28%) chose not to respond to at least one or more variables (i.e. income, health condition of care-recipient) due to privacy concerns specific to disclosure. Imputing is a process that replaces missing data with alternative values and is only appropriate when 30% or less of the variable has missing data (Lodder, 2013). Predictive means matching (PMM), a semi-parametric imputation method, was used to complete missing data as it is a more suitable approach than standard regression methods (Horton and Lipsitz, 2001). All variables, including descriptive statistics, are reported in Table 4.1.

Table 4.1

Variables recoded and categorized to each type of space-time constraint.

Constraint Type & Variable	**Values [Recoded]**
Capability	
Age of Carer-Employee	18 – 45 [0]; 46+ [1]
Age of Care-Recipient	18 – 45 [1]; 46 – 65 [2]; 66+ [3]
Health of Carer-Employee	Excellent [0]; Good [1]; Fair [2]; Poor [3]
Health of Care-Recipient	Excellent [0]; Good [1]; Fair [2]; Poor [3]
Score Details	Flexible [1 – 4] Between Flexible & Fixed [5 – 7] Fixed [8 – 11]
Coupling	
# of Caregiving Tasks	0 [0]; 1-2 [1]; 3 – 4 [2]; 5 – 6 [3]; 7 – 8 [4]

Weekly Hrs. of Caregiving	0 – 5 hrs. [0] 6 – 10 hrs. [1] 11 – 15 hrs. [2] 16 – 20 hrs. [3] 20+ hrs. [4]
Weekly Hrs. of Assisted-Transport	0 – 5 hrs. [0] 6 – 10 hrs. [1] 11 – 15 hrs. [2] 16 – 20 hrs. [3] 20+ hrs. [4]
Total Trips Daily	< 5 [0]; 5 – 10 [1]; 10 – 15 [2]
Trips – Weekly Routine	No [0]; Sometimes [0.5]; Yes [1]
Care-Recipient live w./ Carer-Employee	No / NA [0]; Yes [1]
Duration of Caregiving	0 – 2 yrs. [0]; 2 – 5 yrs. [1]; 6+ yrs. [2]
Distance from Care-Recipient	0 – 8 km [0] 8.1 – 16.1 km [1] 16.2 – 24.1 km [2] 24.2 – 32.2 km [3] 32.2+ km [4]
Make a stop at Care-Recipient	No [0]; Sometimes [0.5]; Yes [1]
Work Commute (Time)	0 – 10 min. [0] 11 – 20 min. [1] 21 – 30 min. [2] 31+ min. [3]
Score Details	Flexible [0 – 8] Between Flexible & Fixed [9 – 17] Fixed [18 – 26]
Authority	
Household Income (Pre-Tax)	30k – 69k [1] 70k+ [0]
Highest Education	College / GCEP or less [1] Bachelors or above [0]

Sex	Female [1] Male [0]
Employment Type	Education / Research [0] Manager [0] Other [1]
Score Details	Flexible [0-1] Between Flexible & Fixed [2] Fixed [3-4]
Total Score	Flexible [1 – 14] Between Flexible & Fixed [15 – 27] Fixed [28 – 41]

Space-time Scales

The three space-time scales used for travel behaviour analyses are: capability, coupling, and authority constraint. Variables are placed in each scale based on how closely they match the constraint's definition. For example, income is placed in the authority constraint because it is a characteristic of social capital. The authority constraint consists of four variables, which include: highest education obtained; household income; sex, and; employment type. The capability constraint includes age and health condition for both the carer-employee and care-recipient. The coupling constraint contains 10 variables, including the general characteristics of caregiving and assisted-transport demand, and work commute time. Table 4.2 (p. 105) displays each constraint, listing the variables and a scoring range. The overall scale scores take up the sum of all the space-time constraint scores. Hypothetically, a carer-employee can score as low as one, indicating the most flexible overall travel behaviour; this is in contrast the maximum score of 41, indicating the most fixed overall travel behaviour.

4.5 Methods

Figure 4.4 illustrates our mixed-methods framework. The aim of this framework is to efficiently shape the carer-employee's caringscape terrain via their travel behaviour, which can then inform the possibly development of CFTPs. As noted above, the travel experience (Bowlby's eighth concept) and space-time fixity/flexibility (Bowlby's sixth concept) summarize the carer-employee's travel behaviour. To do this, we used sentiment analyses and k-means clustering to measure both of these ordered concepts, respectively.

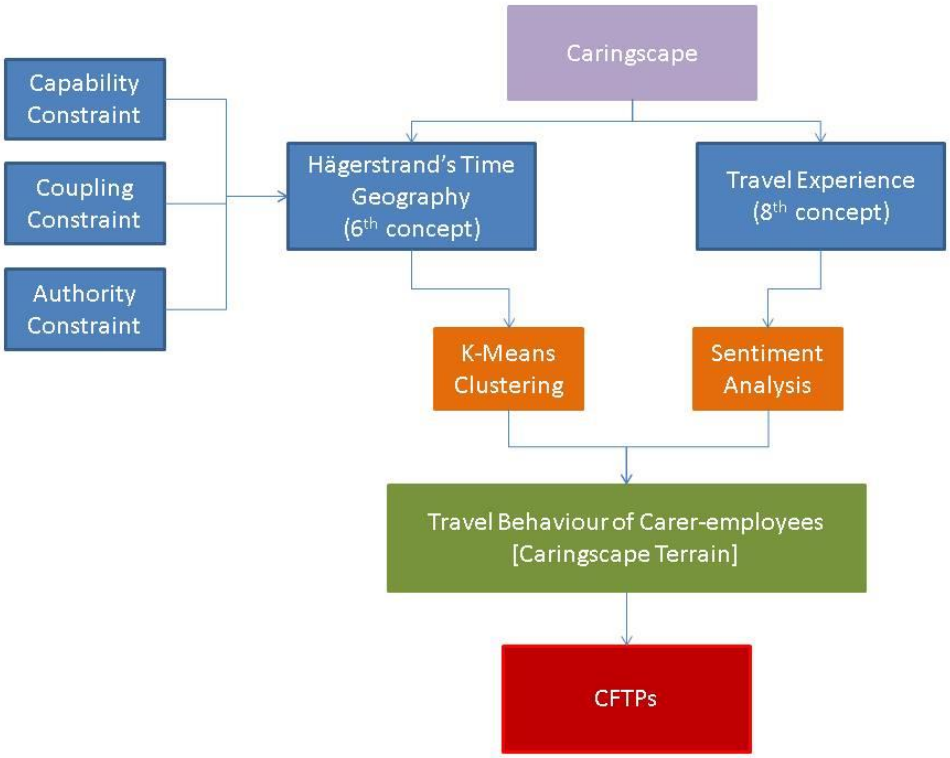

Figure 4.4 Mixed-methods Framework

Sentiment Analysis

Sentiment analysis is a sub-component of natural language processing (NLP) that efficiently extracts and analyzes text. Its main purpose is to collect user-generated content and translate it into qualitative insights for decision-makers, such as performance metrics or

attributes on transit and health care services (Chauhan & Sehgal, 2017; Collins *et al.,* 2012; Jiménez-Zafra *et al.,* 2019). Most text data are collected from countless social media avenues (i.e. Twitter, Yelp, and TripAdvisor). In transportation, Rashidi et al. (2017) investigated the application of sentiment techniques on social media as a low-cost option to extract attributes related to daily travel behaviour. Ali et al. (2017) proposed a fuzzy ontology-based sentiment analysis and semantic web rule language rule-based decision-making framework to systematically gauge transportation activities and develop city scale polarity map for travelers. For this study, we used word clouds and lexicon-based sentiment analysis to analyze the following open-ended questions obtained from the trip summary questionnaire: (1) "Why did [i.e. Tuesday] have the most trips?" (2) "Why was the particular trip you've listed most stressful?", and (3) "If applicable, what has changed your health since caregiving?" Word clouds and lexicon-based sentiment analysis qualitatively reflect trip experiences and travel behavior, and thus cover the eighth concept of caringscapes.

Word cloud is a type of data visualization that efficiently highlights text data points. The sole function of word clouds is to identify words that frequently appear in the text and visually present it as a theme. Although word clouds are most popular in marketing and business sectors, their use can be found in various academic fields including transportation and gender differences (Ahuja & Shakeel, 2017; Abuhay *et al.,* 2017; Sun & Yin, 2017; Hamed *et al.,* 2015; Kastrin & Hristovski, 2019; Wu *et al.,* 2015). We used word clouds to develop themes related to the carer-employees' travel experience and behaviour.

Lexicon-based sentiment analysis is an automated method that measures text polarity (positive or negative) of sentences. It operates by linking each word to a polarity score provided by a dictionary of words or lexicon. For example, the word "good" may have a positive score of

one. While lexicon-based analysis is a basic technique, several transportation studies have used it to solve complex problems. For example, Chen and Krishnan (2013) developed a real-time Twitter monitoring system that would automatically measure transportation safety and concerns using word cloud and text polarity techniques. Cao et al. (2014) used sentiment polarity to produce a traffic sentiment analysis (TSA) tool for Intelligent Transportation Systems, which views traffic-related problems. In the caregiving context, lexicon-based sentiment analysis is used to measure the dichotomy of carer-employees' travel behaviour.

K-means Clustering

K-means clustering is an unsupervised machine learning algorithm that attempts to segregate data into groups with similar attributes and designates them into clusters (Jain, 2010). It is one of the simplest and most commonly used algorithms that iteratively assign each data point to one of the pre-defined number of clusters (*k*) (Jain, 2010). K-means has been widely used in many research topics including behavioral segmentation (i.e. activity monitoring, health care cases) (Raghupathi, 2018). Hildebrand (2003) used the algorithm to describe elderly travel behaviour into six clusters: (1) workers, (2) mobile widows, (3) granny flats, (4) mobility impaired, (5) affluent males, and (6) disabled drivers. More recently, Fugiglando et al. (2019) used k-means to cluster driving behaviour into different groups. We can similarly apply these two cases to the carer-employee context by clustering how fixed/flexible their overall travel behaviour truly is and, thereby, executing the sixth concept of carescapes.

In preparation for k-means clustering, we first implemented principal component analysis (PCA) to reduce the data dimensionality (Fugiglando *et al.,* 2019). While performing PCA, the space-time constraint variables were scaled (normalized) using the *prcomp* function in R. To determine the most appropriate number of clusters for k-means, we used the Elbow method

(Syakur *et al.,* 2018). The Elbow method executes a range of cluster values of *k* (i.e. 1 to 10), and calculates the sum of squared errors (SSE) for each *k.* The SSE is then graphed, where we take the value of *k* on the "elbow" appearing on the line (Syakur *et al.,* 2018). The three k-means cluster values are applied to the dataset, after which three separate travel behaviour profiles were created.

4.6 Results

Descriptive Statistics

Table 4.2 reports the descriptive statistics in the following four categories: 1) sociodemographic; 2) general caregiving characteristics; 3) assisted-transport demand (travel behaviour), and; 4) space-time constraints.

Table 4.2

Descriptive statistics containing demographics, general caregiving-related, assisted-transport caregiving, and space-time constraints

Type	Value	Proportion (n = 25)
Sociodemographic of Respondent		
Age	18 – 45	40%
	46+	60%
Gender	Male	24%
	Female	76%
Marital	Single	32%
	Married / Common-in law	40%
	Widowed / Divorced	24%
	Prefer Not to Answer	4%
Race	Asian (Chinese, Filipino, Other)	32%
	Black or African / Caribbean	4%
	Latin American	4%
	Caucasian (White) / European	60%

Highest Education	College GCEP or less	20%
	Bachelors or higher	80%
Household Income (Pre-tax)[5]	Less than 70k	40%
	70k+	60%
Place of Residence	Hamilton CMA	72%
	Toronto CMA	20%
	Other	8%
Yrs. at Current Job	Less than 5 yrs.	44%
	5 to less than 10 yrs.	16%
	10 yrs. or greater	36%
	Prefer Not to Answer	4%
Employment Type	Education / Research	48%
	Manager	28%
	Other	24%
Current Health	Excellent	32%
	Good	52%
	Fair	16%
Health Changed since caregiving	No	24%
	Somewhat	4%
	Yes	72%
Caregiving (General)		
Age of Dependent	46 – 65	12%
	66 – 75	20%
	76+	68%
Current Health of Dependent	Good	40%
	Fair	36%
	Poor	20%
	Prefer Not to Answer	4%
Main Caregiving Task(s)	Assisted-Transport	80%

[5] Cut off values were justified based on the cost of living as a family of four in Hamilton including taxes and average cost in taking care of care-recipient annually (https://www.numbeo.com/cost-of-living/in/Hamilton; https://simpletax.ca/calculator; https://www.cbc.ca/news/business/caring-parents-costs-1.4101277)

	House Maintenance	72%
	Personal Care	60%
	Medical Treatments	48%
	Scheduling	44%
	Banking	52%
	Emotional Support	76%
	Other	28%
Most Demanding Task(s)	House Maintenance	12%
	Medical Appointments / Treatments	16%
	Emotional Support	24%
	Assisted-Transport	24%
	Personal Care	12%
	Other	12%
# of Caregiving Tasks	1 – 2	12%
	3 – 4	32%
	5 – 6	36%
	7 – 8	20%
Weekly Hrs. of caregiving	0 – 5 hrs.	20%
	6 – 10 hrs.	32%
	11 – 15 hrs.	28%
	16 – 20 hrs.	0%
	20+ hrs.	20%
Assisted-Transport		
Daily # of Trips (general)	< 5	76%
	5 – 10	20%
	11 – 15	4%
Day(s) w./ most Trips	Mondays	4%
	Tuesdays	8%
	Wednesdays	20%
	Thursdays	8%
	Fridays	16%
	Saturdays	40%
	Sundays	12%

	Varies	8%
Trips Weekly Routine	No	28%
	Sometimes	8%
	Yes	64%
Duration of Work Commute	0 – 10 min.	4%
	11 – 20 min.	36%
	21 – 30 min.	32%
	31+ min.	28%
Dependent live with caregiver	No	32%
	Yes	68%
Distance from dependent	0 – 5 mi.	68%
	5.1 – 10 mi.	12%
	10.1 – 15 mi.	4%
	15.1 – 20 mi.	0%
	20.1+ mi.	16%
Make a stop at dependent	No / NA	52%
	Sometimes	16%
	Yes	32%
Weekly hrs. of assisted-transport	0 – 5 hrs.	76%
	6 – 10 hrs.	20%
	11 – 15 hrs.	4%
Constraints		
Capability	Flexible [1 – 4]	8%
	Between Flexible & Fixed [5 – 7]	64%
	Fixed [8 – 11]	28%
Coupling	Flexible [0 – 8]	12%
	Between Flexible & Fixed [9 – 17]	84%
	Fixed [18 – 26]	4%
Authority	Flexible [0]	52%
	Between Flexible & Fixed [1]	32%
	Fixed [2]	16%
Overall	Flexible [1 – 13]	4%

	Between Flexible & Fixed [14 – 26]	92%
	Fixed [27 – 39]	4%

With respect to sociodemographic, the majority of assisted-transport respondents were: at least 46 years old [60%]; female [76%]; married [40%]; single [32%], and; Caucasian [60%]. Additionally, the majority: had at least a bachelor's degree [80%]; had a pre-tax household income of at least $70k [60%]; lived in the Hamilton metropolitan area [72%], and; had been working less than 5 years at their current job [44%]. More importantly, the current health of most respondents was considered at least "good" [84%]; however, most have indicated that their health has changed for the worse [72%] since the start of caregiving.

With respect to the general caregiving characteristics, respondents' care-recipients were: at least 76 years old [68%], and in "good" health [40%], followed closely by "fair" health status [36%]. The top three most common caregiving tasks in which respondents selected included: assisted-transport [80%]; emotional support [76%], and; household maintenance [72%]. Regarding, the most demanding caregiving tasks, two were tied for first place; the task of providing assisted-transport tied with providing emotional support [24%]. On a weekly basis, the majority of respondents performed at least five different caregiving tasks [56%], while conducting 10 hours or less of caregiving [32%].

Regarding to assisted-transport attributes, most respondents were found to do less than five trips per day [76%]. Saturdays [40%] was found to be the most popular day in which respondents conduct most of their trips, followed by Wednesdays [20%]. Many perform the same number of trips and carried out the same driving schedules [64%] on a weekly basis with little to no change. Sixty percent (60%) had at least a 21-minute work commute each way. Fortunately, most have their care-recipients live with them [68%], preventing the need to make

an additional stop by the care-recipients' home when providing assisted-transport. The majority of those respondents that do not have their care-recipient living with them were within a distance of five miles from their care-recipient; however, a fair proportion of respondents [16%] were at least 20 miles away from their care-recipients. The furthest distance in our sample is 185 miles one way. Similar to the general caregiving tasks, most respondents performed five hours or less of assisted-transport caregiving per week [76%].

Lastly, the space-time constraints are composed of capability, coupling, authority, and total scores. Most respondents were placed between flexible and fixed for both the capability [64%] and coupling [76%] constraints. The authority constraint had two values tied: flexible [44%] and between flexible and fixed [44%]. These statistics are presented at the end of Table 4.2.

Sentiment Analyses

Table 4.3 reveals the overall sentiment score (positive or negative) from all 25 participants. Sentiment score analyzes all the respondents' sentences per question. The first question, "*Why was [i.e. Tuesday] have the most trips?"* indicated a positive sentiment score.

Table 4.3

Assisted-transport sentiment analysis

Variable	Mean Sentiment Value	Polarity Type
Why was [i.e. day] have the most trips?	0.08	Positive
Why was the particular trip you've listed most stressful?	-0.08	Negative
If applicable, what has changed your health since caregiving?	-0.21	Negative

We would expect the result to be more neutral since the content of the variable is relatively less subjective than the other two questions analyzed. The most common words identified were “errands”, “work”, “run”, “mom”, “needed”, “trips”, “time”, and “banking” (Figure 4.5).

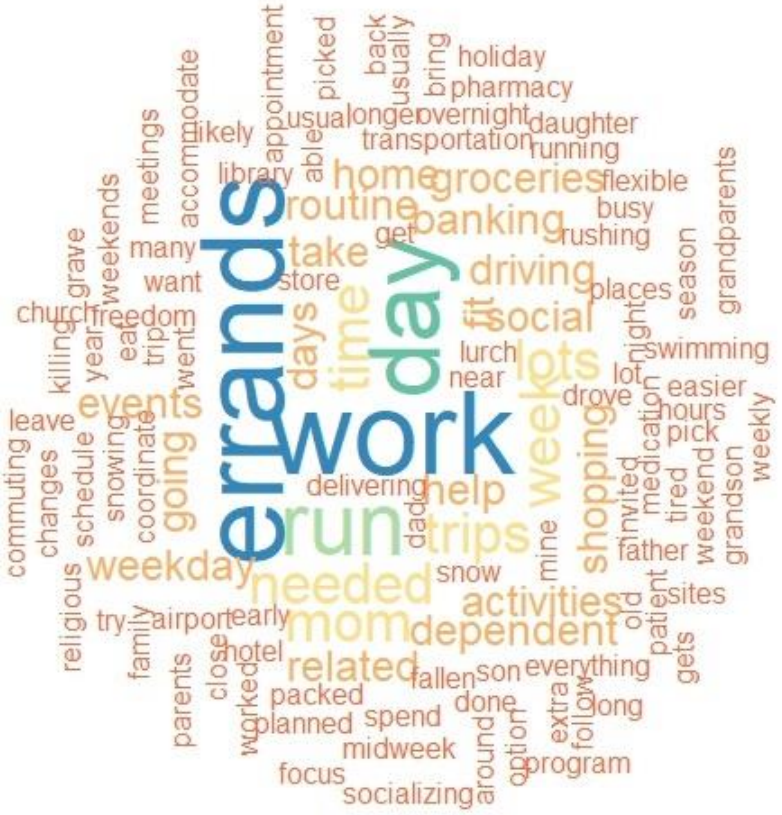

Figure 4.5 Word cloud for “Why was [i.e. day] have the most trips?”

As for the second question, “*Why was the particular trip you’ve listed more stressful?*” resulted to a negative sentiment value (Table 4.3). Reasons for why respondents felt more stressed due to their listed trip is due to lack of “time”, “long” day, feeling “tired”, “frustrated”, and under “pressure”, or dealing with “parents” and “traffic” (Figure 4.6).

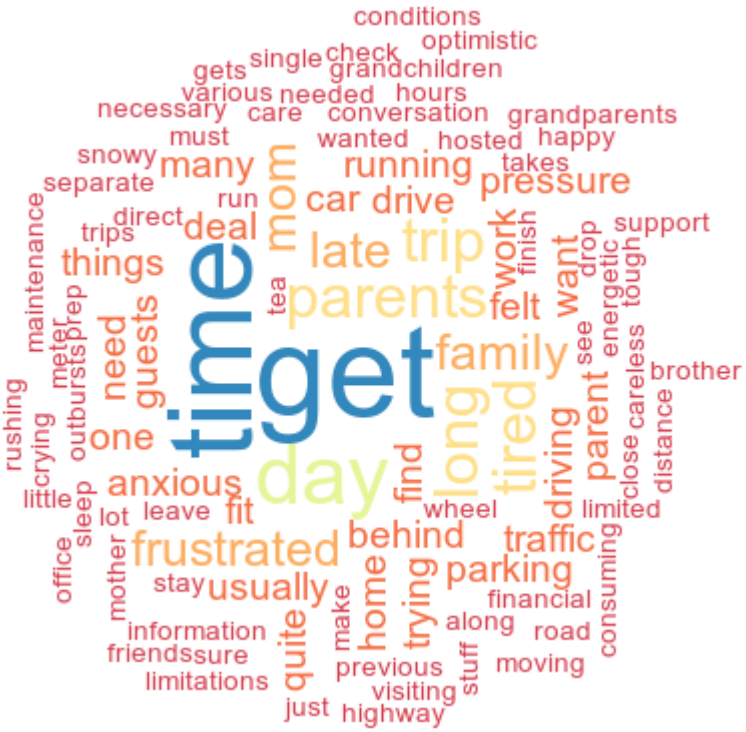

Figure 4.6 Word cloud for "Why was the particular trip you've listed most stressful?"

The last questions, "*If applicable, what has changed your health since caregiving?*" had the most negative sentiment value. "Time", "stress", "physical", "sleep", "exhausted", "depression", and "exhausted" were the most common found of what changed the respondents' health (Figure 4.7).

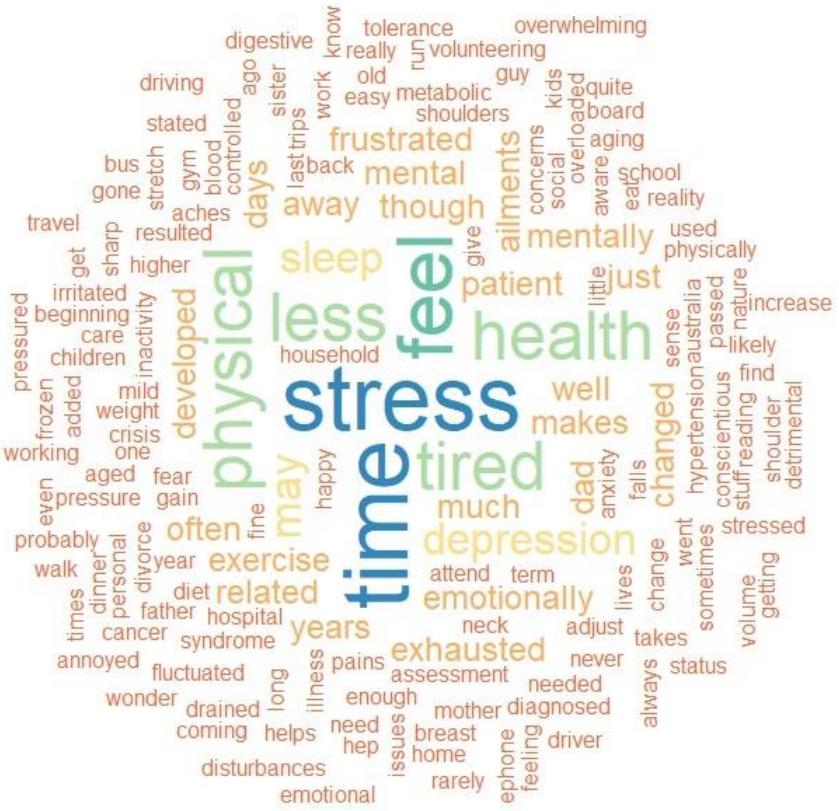

Figure 4.7 Word cloud for "If applicable, what has changed your health since caregiving?"

K-Means Clustering

After PCA, Figure 4.8 illustrates the PCA k-means clustering of the space-time constraints. Table 4.4 summarizes the dataset that corresponds to each cluster. Comparing to all clusters, the green cluster (n = 10) had relatively the most flexible travel behaviour.

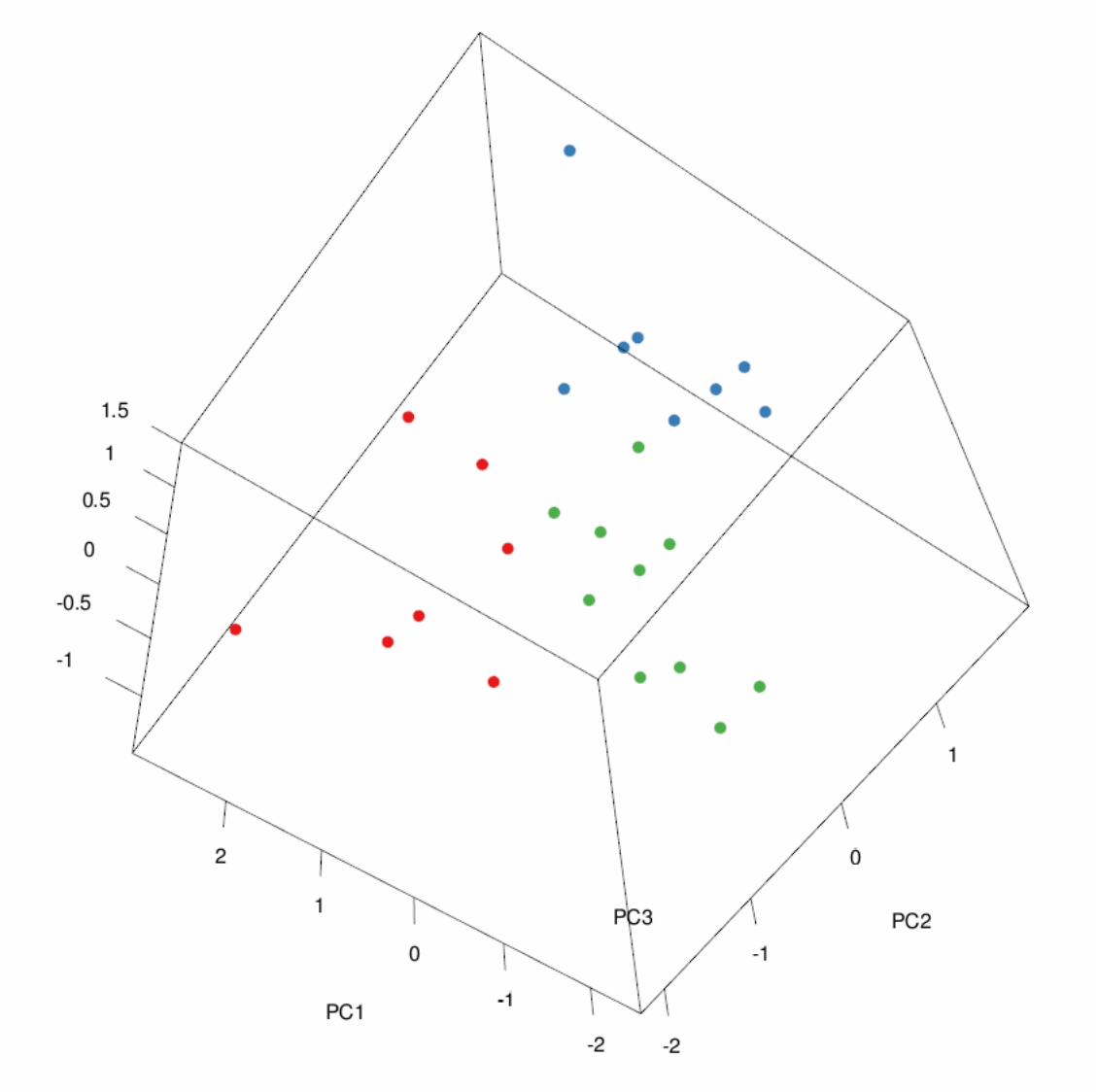

Figure 4.8 K-Means Clustering via PCA of the Space-time constraints (Red – Between Flexible & Fixed [Relatively Most Fixed]; Blue – Between Flexible & Fixed; Green – Between Flexible & Fixed [Relatively Most Flexible])

Table 4.4

Classification of carer-employees' travel behaviour

	Red Cluster (n = 7)	**Blue Cluster (n = 8)**	**Green Cluster (n = 10)**
Age of Carer-employee	≥ 46 yrs.	≥ 46 yrs.	≤ 46 yrs.
Age of Care-recipient	76+ yrs.	76+ yrs.	76+ yrs.
Health of Carer-employee	Good	Good	Excellent
Health of Care-recipient	Towards Fair	Fair	Good
Change in Health of Carer-employee	Yes	Yes	Yes
Capability	7.4	7.7	5.7
Qual. Of Capability	Between Flexible & Fixed [Upper]	Between Flexible & Fixed [Upper]	Between Flexible & Fixed [Lower]
# of caregiving tasks	Towards: 5-6	3-4	3-4
Hrs. of Caregiving	Towards: 15-20 hrs.	6-10 hrs.	6-10 hrs.
Hrs. of assisted-transport	Towards: 6-10 hrs.	0-5 hrs.	0-5 hrs.
Daily trips per week	< 5	< 5	< 5
Weekly Routine	Yes	Yes	Sometimes
Reside w/ Care-recipient	No	No	Half (Yes); Half (No)
Work Commute	21-30 min.	11-20 min.	Towards: 21-30 min.
Stop at Care-recipient's residence	No / NA	No / NA	No / NA
Duration of caregiving	2-5 yrs.	Towards: 2-5 yrs.	2-5 yrs.

Distance to care-recipient	5.1 - 10 mi.	5.1 - 10 mi.	5.1 - 10 mi.
Coupling	12.4	9.5	9.2
Qual. of Coupling	Between Flexible & Fixed [Middle]	Between Flexible & Fixed [Lower]	Between Flexible & Fixed [Lower]
Income	Towards: < $70k	≥ $70k	≥ $70k
Education	Towards: College GCEP or less	Bachelors or above	Bachelors or above
Gender	Female	Half male; Half female	Female
Employment Type	Towards: Other	Education, Research, or Management	Education, Research, or Management
Authority	2.6	0.5	1.7
Qual. of Authority	Towards: Fixed	Flexible	Towards: Between Flexible & Fixed
Combined	22.5	17.6	16.7
Qual. Assessment	Between Flexible & Fixed [Upper]	Between Flexible & Fixed [Middle]	Between Flexible & Fixed [Lower]
Relative Flexibility	Most Fixed	Between Flexible & Fixed	Most Flexible

In the green cluster, we can expect the carer-employee to have towards a flexible capability constraint based on the following attributes: 1) carer-employee younger than 46 years and in excellent health, and; 2) the dependent is in good health. For the coupling constraint, two characteristics completely differentiate from the blue and red cluster: 1) sometimes having the trips as a weekly routine, and; 2) half of their care recipient's live with them. With respect to the authority constraint, we can only expect this group to be completely female. Other characteristics of this constraint are similar to the blue cluster.

Relative to the other clusters, the blue cluster (n = 8) had overall a travel behaviour of between flexible and fixed; however, their coupling and authority constraints are similar to the green cluster. A more fixed capability constraint includes: older (age 46+) carer-employees in good health, who are taking care of care-recipients in fair condition. Similar to the green cluster, coupling constraint highlights the performance of: 3 to 4 caregiving tasks; caregiving 6 to 10 hours per week; conducting 0 to 5 hours of assisted-transport per week, and; 11 to 20-minute one-way work commute. Compared to the other clusters, the blue cluster has the most flexible authority constraint.

In comparison to the other clusters, the red cluster (n = 7) has the most fixed travel behaviour with a placement of between flexible and fixed in its upper range [22 - 26]. Capability constraint is about the same as the blue cluster. The most noticeable differences in the coupling constraint are: 1) carer-employees performing towards 5 to 6 caregiving tasks; 2) devote 15 to 20 hours of caregiving per week, and; 3) allocate 6 to 10 hours per week on assisted-transport. Despite their daily trips are not frequent, this group tends to put more time in assisted-transport than the other clusters. In addition, their authority constraint is the most fixed, thus implying weaker social capital.

4.7 Discussion

The demographic characteristics of the sample of carer-employees confirm similar findings from past caregiving literature: 1) age of the respondent and care-recipient; 2) gender; 3) highest education obtained; 4) health changed since the start of caregiving; 5) main caregiving tasks; 6) most demanding caregiving task, and; 7) weekly hours of caregiving (Duxbury et al., 2012; Employer Panels for Caregivers, 2015). Although the sample size is small, descriptive and sentiment results related to the assisted-transport items contribute to filling the gap in the assisted-transport literature. Until extensive research is conducted with a larger sample size, we can expect most carer-employees will have a work commute longer than 20 minutes, and most of their trips will take place on a Saturday. As shown in all word clouds, *time* seems to be the most crucial element when conducting trips. For instance, Saturdays is when the majority of the respondents conducted the most trips. This is because it is a non-working day, which expands the window of opportunity for respondents to focus on the household tasks and caregiving responsibilities. As evident in the descriptive results (lowest proportions), Mondays and Tuesday are usually the busiest days of the week, since employees are working new assignments, or have scheduled meetings (Molavi, 2014). Interestingly, Wednesdays came in second with the most trips conducted. Perhaps, Wednesdays operate as a window when employees are temporarily winding down with their work tasks since it is the middle of the weekday. Another plausible explanation may entail respondents having compressed work days on Mondays and Tuesdays, which would allow them to perform assisted-transport responsibilities the next day.

Another assumption is most respondents do less than five trips per day and conducted their trips as a weekly routine. The frequency of trips may indicate that the demands of their care-recipient are not high on a daily basis, but rather spread out across the week. Concerning the

weekly routine, most of the respondents' scheduling is between flexible and fixed due to the combination of their work-commute, household tasks, and the caregiving demands of their care-recipient. The coupling constraint seems to be the most critical space-time component for the carer-employee as it involves the care-recipient(s)'s schedule; however, it is determined by the capability constraint, especially the age and health condition of the care-recipient. For example, the older and less healthy the care-recipient is, the more caregiving demand and tasks required for the carer-employee to conduct. Table 4.4 (k-means clustering, p.115) illustrates the coupling constraint in all three clusters, especially the red one. Representing approximately 28% of the sample, the red cluster overall shows the most fixed schedule. The red cluster describes the caregiving demands from the care-recipients to be high, evident with the highest number of caregiving tasks (5 to 6), conducting 15 to 20 hours per week of caregiving, and performing 6 to 10 hours per week of assisted-transport. These characteristics indirectly relate to assisted-transport caregiving, such as going grocery shopping or running errands to the bank; hence, they create a more fixed schedule. "Errands", "bank", "groceries", and "running" are some keywords in Figure 4.5 (p.111) and 4.6 (p.112) that justify these assisted-transport tasks. These listed characteristics may explain how assisted-transport is the most common and the most demanding caregiving task (the latter which is shared with emotional support). As a result, assisted-transport negatively impacts the carer-employee's work-life balance.

The caregiving characteristics are less magnified in the blue and green cluster, thereby further loosening the respondent's scheduling. It is slightly more flexible in the green cluster due to sometimes conducting the trips as a weekly routine. This may be associated to the care-recipient's health condition as "good" in the green cluster's capability constraint, thus less caregiving demand required.

To improve the carer-employee's work-life balance will require processes to reduce assisted-transport demand. One proposed process is the implementation of Caregiver-Friendly Transport Programs (CFTPs). Similar to Caregiver-Friendly Workplace Programs CFWPs, CFTPs would emphasize carer-employees in a transit environment by transforming their travel behaviour from a more "fixed" to a more "flexible" schedule. CFTPs build on our knowledge of CFWPs (Ireson et al., 2016; Ramesh et al., 2016), and could include: telecommuting, compressed work weeks, culture change initiatives, educational workshops, and employee assistance plans. The importance of early intervention is critical given what we now know about the importance of time and place in caregiver's knowledge of caregiver-friendly workplace policies, such as Canada's Compassionate Care Benefit (Dykeman et al., 2013). However, establishing appropriate and effective CFTPs will depend upon a framework that collectively defines the carer-employees' travel behaviour. Fortunately, the framework proposed above fulfills this critical component as it is able to identify relative fixed constraints in each cluster. To illustrate, the green cluster group would not require the immediate implementation of CFTPs, as it is overall classified as "between flexible and fixed" [lower range] and relative to the other clusters, has the most flexible travel behaviour. The blue cluster does not require the immediate implementation of CFTPs either, given its similarity to the green cluster, and especially the coupling constraint. The red cluster requires the most attention as it is the most fixed group with the lowest social capital. Above all, those in the red cluster have a lengthy commute, conduct 15 to 20 hours of caregiving per week, and 6 to 10 hours of assisted-transport. Combining caregiving and assisted transport, the carer-employee conducts a maximum of 120 hours per month. In this situation we can suggest the following three CFTPs to reduce assisted-transport: 1) provide the up to 5 days [40 hrs.] per month of their choice to telecommute; 2) provide 3 days

of telecommuting [24 hrs.] and 4 half-days [16 hrs.], in which the worker would substitute one compressed work day per week, or; 3) if the carer-employee stops for assisted-transport related task while in transit to work, then he/she may arrive work one hour later than usual time (however, the loss of time will have to be allocated in a compressed work week of choice). These are some CFTPs suggestions for the red cluster group. As for any policy recommendation, these CFTPs suggestions will require further tuning, in order that they are beneficial for both the carer-employee and the employer. Nonetheless, appropriate CFTPs have the potential to improve the carer-employee's travel behavior and thereby improve their work-life balance and wellbeing.

Limitations

There are few limitations that may need to be addressed in the near future. First, the sample size may be somewhat small for both sentiment analysis and k-means clustering. Secondly, there is minimal diversity regarding to the respondents' workplace sector. Most of the respondents work in a public post-secondary institution, where they hold educational / research positions, and are more likely to receive some workplace flexibility. Another limitation is the lack in gender variation. The original aim of this study was to have an equal number of males and females in the sample, and thereby be able to identify any significant travel behaviour differences based on sex.

4.8 Conclusion

This research employs the frameworks of Hägerstrand's time geography and McKie et al.'s (2002) caringscapes to develop a mixed-methods framework to classify the travel behaviour of carer-employees. As part of the framework, sentiment analyses provided an outline of carer-employees' overall travel behaviour. Recurring negative trip experiences related to assisted-transport has the potential to inform the work of health planners and decision-makers in creating

specific CFTPs to improve the carer-employee's coupling constraint. K-means clustering allowed the overall travel behaviour of carer-employees to be clustered into groups. Furthermore, the groups can be differentiated by highlighting causal factors through their own space-time constraints (capability, coupling, and authority). This is particularly insightful for employers in developing their own internal policies to enhance work-life balance, as it pertains to transport.

While this can work as a foundation in developing CFTPs, the aforementioned limitations suggest further research is needed. One possible research approach is to link the sentiment data to the already-collected GPS points and trip diaries in order to undertake a space-time analysis (prism or paths). Another approach is to improve the mixed-methods framework by incorporating Decision Trees. Decision Trees is a supervised machine learning algorithm that uses a set of binary rules to meet an ends goal (Pandey, 2018). The algorithm can do either classification (categorical), regression (continuous), or CART (Classification & Regression Trees) (Pandey, 2018). This can be used to detect different travel behaviour patterns which can then guide the carer-employee to appropriate CFTPs. Finally, the development of an interactive online application for external users would gauge the users' space-time constraint, as well as what constraint areas they may have the potential to improve. This would increase public awareness and act as a health-promotion tool for employers to monitor their employees' travel behaviour in order to maintain a healthy work-life balance, and ultimately retain talent.

4.9 References

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Chapter 5 Conclusions and Future Research

5.1 Contributions

The goal of this dissertation is to fill the gap in the assisted-transport literature, specific to CEs, through investigating: the socio-demographic details of assisted-transport carer-employees; how assisted-transport demand impacts their health and wellbeing, and; how can we address this persistent dilemma. This final chapter synthesizes the three contributions.

1) Contributed to closing the gap in the caregiving literature specific to assisted-transport

The current caregiving literature has reported the outcomes of carer-employees work-life balance, the economic impacts amongst employers and national economy, and the development of CFWPs. What has not been covered thoroughly is assisted-transport, which is the most common and second most demanding caregiving task (Statistics Canada, 2016). Chapter 2 to Chapter 4 fulfills the assisted-transport gap through the use of interdisciplinary concepts and methods across geographic scales.

At the national level, Chapter 2 uses in-depth descriptive statistics and logistic regression analyses to create a socioeconomic profile of carer-employees performing assisted-transport tasks. The profile provides a foundation in the assisted-transport caregiving literature, especially the first domain of Pearlin's framework (Pearlin et al., 1990); simultaneously, this profile informs future interdisciplinary research. The profile also provides: gender differences; external factors that cause assisted-transport demand, and; whether assisted-transport CEs are more

overwhelmed than standard CEs. Result s show that CEs conducting assisted-transport have higher social capital (education and income) than standard CEs; however, they feel more tired and overwhelmed.

Chapter 3's main goal is to improve mobility independence of potential care-recipients as a strategy to reduce assisted-transport demand. Therefore, this chapter uses Geographic Information Systems (GIS) to analyze the physical environment and its association with assisted-transport demands at the metropolitan scale (Hamilton). More specifically, it measures accessibility to services from the location of the potential care-recipient (older adult). Correspondingly, most of the older adults are within walkable access to a service; however, many are in underserved areas, and a fair proportion are not within reach. For intervention purposes, areas to add new services are suggested. As a whole, this chapter serves as a GIS framework of assisted-transport demand for health planners to use in other metropolitan areas.

At the community/individual level, Chapter 4 classifies assisted-transport carer-employee's type of travel behaviour using sentiment analysis and k-means clustering. From a collected sample size of 25 participants, the result highlight three types of travel behaviours, each expressing different space-time characteristics. Subsequently, employers can use this framework to identify their own carer-employees and develop their own Caregiver-Friendly Transport Programs.

2) Developed two frameworks for future research and development purposes

Aside contributing to the caregiving literature, this dissertation developed two frameworks by combining two theoretical concepts: Hägerstrand's (1970) time geography, and

Mckie et al. (2002) carescapes. The two developed frameworks adopt similar concepts, but are designed to address distinctive objectives. Chapter 3 uses the physical environment to potentially outline the caringscape terrain at the metropolitan scale; hence, urban and health planners can use it for planning, as an intervention strategy. Figure 1 (p. 57) illustrates how McKie et al. (2002) carescapes can outline the assisted-transport carer-employee's work-life balance using Hägerstrand's (1970) space-time constraints. The space-time constraints are defined by both the individual's (actual) and physical's (potential) characteristics. Theoretically, combining both of the sub-components of the space-time constraints would truly explain the assisted-transport decisions (how, when, where, and why) of the carer-employee. This would therefore mold their caringscape terrain, which would describe their current health (work-life balance). Though doing both simultaneously would be computationally intensive and time consuming, given that it would require a large collection of actual data from qualified individuals across the same study area. Therefore, in the context of Chapter 3, we partially shaped the caringscape terrain by implementing the physical sub-component from the space-time constraint to measure potential accessibility to services across Hamilton CMA. This fundamental concept has not been done before, and especially applying it from a GIS lens perspective.

Compared to Chapter 3's framework, Chapter 4 summarizes and classifies the actual individual caringscape terrain. As mentioned earlier in Chapter 4, Bowlby (2010) proposed eight caringscape concepts. Our developed framework takes the sixth and eighth concept to produce a well-detailed travel behaviour of assisted-transport carer-employees. This thereby constructs a comprehensive caringscape terrain. The sixth concept connects with Hägerstrand's (1970) time geography, which outlines the individuals' space-time constraints. All of the information from the recruited participants are aggregated and clustered into groups using k-means clustering. The

groups quantitatively form their own degree of space-time fixity with causal factors. This, thereby, drafts the first half of the caringscape terrain. Sentiment analysis qualitatively structures the second half of the caringscape terrain by extracting the individual's travel experience (Bowlby's eighth concept). This mixed-methods framework has, as its sole purpose, the development of CFTPs.

3) Implemented a multi-pronged knowledge translation strategy

Within the past four years, the skeletal structure of the dissertation was presented and updated three times at the following venues: a) internal prospective graduate students (November 2015); b) Esri Canada User Conference in Toronto (October 2016), and; c) internal research day (April 2018). The entire dissertation, including the results of Chapter 2 and 3 can be viewed on the StoryMap[6], which was submitted for Esri StoryMap Telling Competition in 2018. As for the chapters, each were publicly reported at the following media sources: a) journal publications; b) podium and poster conferences; c) research competition, and; d) a research synopsis, which is included on Dr. Allison Williams's Chair program site, hosted on the PhD candidate's Github page.

As mentioned earlier in the Preface, Chapter 2 has been accepted for publication at the *Journal of Gerontological Social Work* and Chapter 3 has been under consideration for publication in the *Journal of Transport & Health.* Chapter 4 has been submitted for review to the *Journal of Transport Geography.* Regarding podium presentations, Chapter 2 was presented at the AAG Conference in Boston (April 2017), and the CAG Conference at York University (June

[6] https://mcmaster.maps.arcgis.com/apps/Cascade/index.html?appid=02af2bfdbc6c4feda74b1af561b5b814

2017). The methodology from Chapter 4 was, in part, presented by my academic supervisor, Dr. Allison Williams, at the United Nations Conference in Mexico City (September 2018). Regarding poster presentations, Chapter 3 was presented at the McMaster Institute for Research on Aging (MIRA) at McMaster Innovation Park (April 2018). Additionally, Chapter 3 was submitted to the Esri Canada Young Scholars Poster Competition, which placed second in all of Canada. Besides a selection of two Esri GIS books and certificate, Esri Canada has displayed the poster of Chapter 3 to their local and user conferences across Canada.[7] Lastly, a research synopsis including code will be accessible on Dr. Allison Williams's Chair program site, hosted on Github. The intent of a research synopsis is to maximize research awareness by making it available to the general public. Github is an excellent site to host project content and technical code in a markdown format. Additionally, it will be easily accessible for any future researchers that would like to acquire the documentation.

5.2 Future Considerations

This dissertation lays the groundwork for researchers within the fields of health geography and transportation by providing a better understanding of assisted-transport carer-employees and their experiences; however, there are still some improvements for future considerations. Some of the future considerations are highlighted in Chapters 2 through to Chapter 4. Two additional potential projects are proposed for the future: a) space-time prisms of participants, and; b) a research and development pilot platform for assisted-transport carer-employees.

[7] https://www.science.mcmaster.ca/geo/component/content/category/31-gis.html (under Esri Canada Young Scholars Award Winners)

1) Creation of a space-time prism analysis of assisted-transport carer-employees

Chapter 4 represents the first half of analyzing carer-employees' travel behaviour through using Bowlby's sixth and eighth concepts (2010). For the second half, we propose (and currently are in the process of realizing) to interpret the carer-employees' space-time prisms. Developed by Hägerstrand (1970), the space-time prism (STP) maps all possible paths in space, encompassing: time between two locations considering maximum mobility speed, and; applicable stationary times (Lee and Miller, 2019). STP is a robust actual accessibility measure, as it incorporates: the space-time constraints of the individual's key anchor points (i.e. care-recipient's home and work); the spatial variation of opportunities, and; performance metrics of the current transportation system (Lee and Miller, 2019). In our context, we would extend the use of Bowlby's (2010) sixth concept to measure the carer-employees' travel flexibility across space and time. Using the trip diaries and GPS points collected from our 25 participants, we can develop their STPs, link it with the three travel-behaviour profiles from Chapter 4, and collectively take the average STP's size. This would inform the expected actual space-time accessibility of each travel behaviour, thus providing an estimate amount of opportunities. Figure 5.1 (next page) illustrates the expanded framework from Chapter 4 with a list of hypothetical STP size outcomes. An assisted-transport carer-employee that has been grouped in the 'flexible travel behaviour' is expected to have a "wide" STP. A "wide" STP, or large prism volume, would indicate the individual having more time to be mobile than another individual with a "small" STP. A "small" STP volume indicates a short stationary time at the origin, destination,

or both locations. Thereby, we can predict that the assisted-transport carer-employee is running quick errands for their care-recipient.

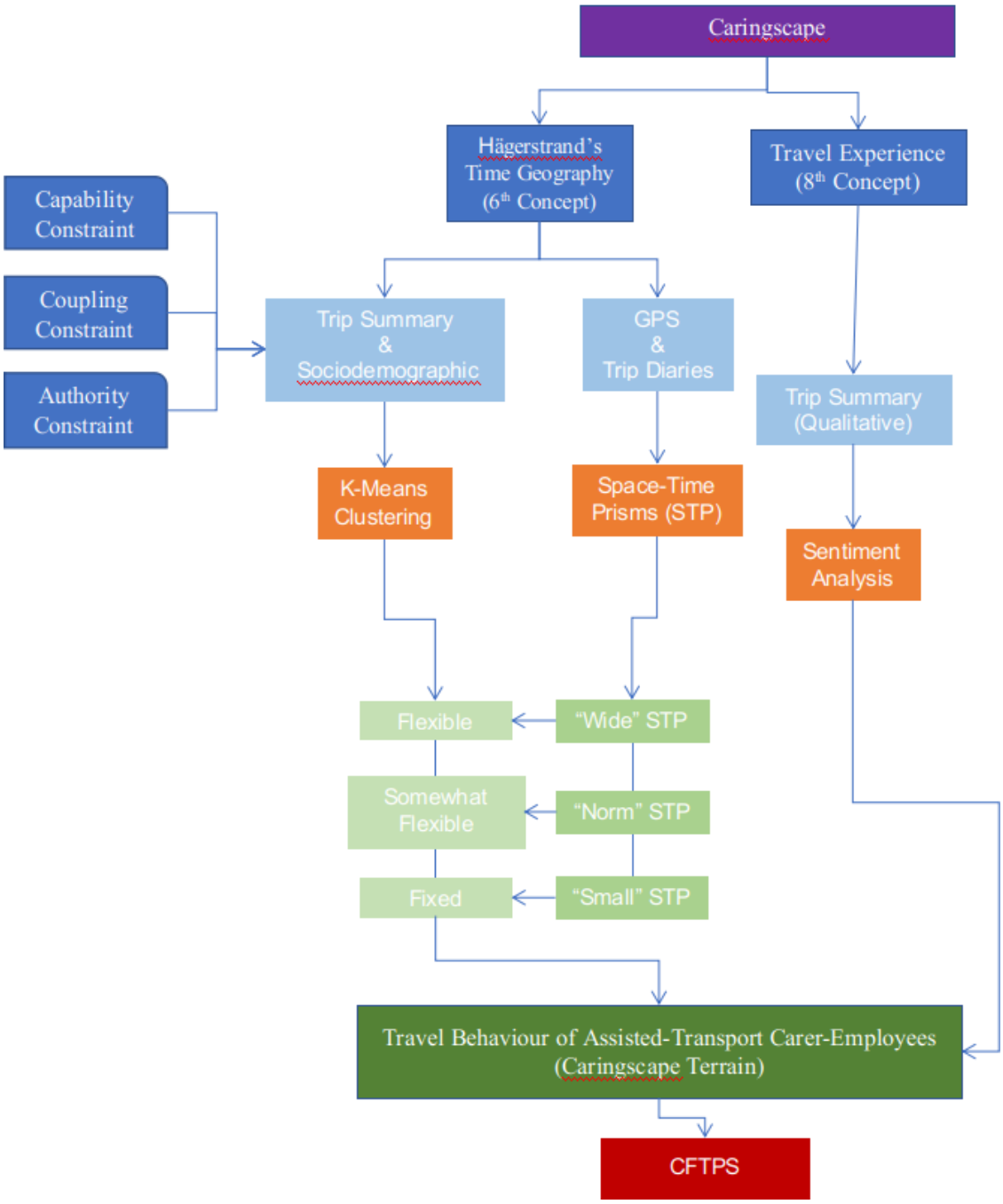

Figure 5.1 Expanded Version of the Mixed-Methods Framework

2) Development of a Pilot Platform for Assisted-Transport Carer-Employees

The core objectives of creating a research and development platform for assisted-transport carer-employees are as follows: a) collect "big data" to predict potential assisted-transport carer-employees at the metropolitan level using the standard travel behaviour profile created from Chapter 2 and Chapter 4; b) perform potential accessibility for all Canadian metropolitan areas; c) create an assisted-transport risk index score; and d) finally develop a platform for assisted-transport carer-employees, dependents, and employers.

As mentioned earlier in Chapter 4, obtaining a large sample size of participants through recruiting conventional methods (i.e. flyers, emails) has been truly difficult. To overcome this dilemma, we would partially adopt Abdulazim et al.'s (2013) data collection framework, particularly from GPS enabled smartphones. In order to obtain GPS data from smartphones, we would either have to: contact telecommunications companies, or; develop a smartphone application, or; randomly recruit individuals across the city regardless if they are a carer-employee or not. Assuming each GPS enabled smartphone has a unique identifier, we can trace each individual's travel behaviour at a minimum of two weeks within Hamilton metropolitan area. Using land use data, a minimum of two weeks should be sufficient to identify each individual's travel patterns, especially since most assisted-transport carer-employees conduct the same trips on a weekly basis (Dardas et al., 2019). Additionally, we can possibly differentiate between assisted-transport carer-employees and non-carer-employees based on frequency of stops and same geographic and type of location. To realize additional accuracy in predicting, we can implement each individual's space-time prisms and identify its volume. If we decide to

collect GPS data from randomly selected individuals, we can validate the prediction by asking whether they identify themselves as a carer-employee or not.

The next objective takes Chapter 3 and applies it across all Canadian metropolitan areas. At this scale, we would have to install ArcGIS Enterprise with GeoAnalytics server to enhance GIS performance. Visual results of each metropolitan area would be hosted and publicly available in a ArcGIS WebApp, in which the external user (i.e. carer-employee) and decision-makers can explore for their own purposes. Additionally, each metropolitan area will have estimate older adult populations that are in underserved or living in inaccessible areas.

Research studies have developed different types of indices, from quality of life to natural disaster to financial risk. Although an ambitious goal, we proposed in developing an assisted-transport risk index score (ATRIS). ATRIS would be a mathematical formula that qualitatively highlights an individual's health risk score (i.e. severe, good) based on their space-time constraints and actual travel behaviour. Similarly, we would apply this in the context of the care-recipient by measuring the potential amount of assisted-transport demand or Potential Assisted-Transport Demand Score (PADS).

Lastly and most importantly, the development of an interactive application encompasses all of the proposed frameworks and contributions. The interactive application has the ability to become an informative and travel behaviour platform, which is split into two types. The first type of platform would be an "early" warning system for an individual that will likely become a carer-employee. Conceptually, the potential care-recipient (i.e. an aging parent) will constantly monitor (i.e. monthly basis) their health and travel behaviour by inputing their space-time constraints in the platform. The platform will return the potential care-recipient's travel behaviour profile, including: how flexible their mobility is; overall space-time prism volume,

and; PADS. Their monthly scores can be graphed over time to estimate when the potential care-recipient will start requiring informal care. This would inform the potential carer-employee, which should give him/her enough time to prepare looking for CFWPs, external resources, and services. As medical professionals would say, “prevention is better than cure.”

The other platform is when the individual is actively caring for their care-recipient; thus, this would be for assisted-transport carer-employees and employers. Assisted-transport carer-employees can login on the platform as employees and insert their space-time constraints. Similar to the first one, this platform will return the carer-employee’s travel behaviour profile, including how flexible their mobility is, overall space-time prism, and ATRIS. Confidentially, the employer would have access to this information for the purpose of awareness and potentially craft CFTPs. The CFTPs would either be tailored to the individual or collectively. These are some of the intervention options to improve our work-life balance. But the ultimate question is how we, as potential caregivers and employers, will take action. As Rosalyn Carter states, “There are only four kinds of people in the world. Those who have been caregivers. Those who are currently caregivers. Those who will be caregivers, and those who will need a caregiver.”

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This reference list only refers to Chapter 1 (Introduction) and Chapter 5 (Conclusion). Chapter 2 through 4 have their own references in the end.

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APPENDIX 1

Research Ethics & Board Form

McMaster University Research Ethics Board (MREB)

FACULTY/GRADUATE/UNDERGRADUATE/STAFF

APPLICATION TO INVOLVE HUMAN PARTICIPANTS IN RESEARCH

[Behavioural / Non-Medical]

Date: 2/15/17	Application Status: New: [X] Change Request: [ ]	Protocol #:

Helpful Hints Mouse over bold blue hypertext links for help with completing this form.

- **Use the most recent version of this form.**
- **Refer to the McMaster University < Research Ethics Guidelines and Researcher's Handbook >, prior to completing and submitting this application.**
- **For <help> with completing this form or the ethics review process, contact the Ethics Secretariat at ext. 23142, or 26117 or ethicsoffice@mcmaster.ca**
- **To change a previously cleared protocol, please submit the "< Change Request >" form.**

PLEASE SUBMIT YOUR APPLICATION PLUS SUPPORTING DOCUMENTS (scanned PDF signature) BY E-MAIL

You can also send the signed signature page to: **Ethics Secretariat, Research Office for Administration, Development and Support (ROADS), Room 305 Gilmour Hall, ext. 23142**, ethicsoffice@mcmaster.ca.

SECTION A – GENERAL INFORMATION

1. Study Titles: (Insert in space below)

Title: Assessing Activity-Travel Behavior of Caregiver Employees & Health-Risk Areas in Hamilton, Canada
1a: **Grant Title:** *(Required for funded research. Click this < link > to determine your "grant title").* CG1 126585

2. **Investigator Information:** **This form is not to be completed by < Faculty of Health Science researchers > .**

***Faculty and staff information should be inserted above the black bar in this table.**

Student researcher and faculty supervisor information should be inserted below the black bar in the table below.

	Full Name	**Department** *& or name of university if different from McMaster*	**Telephone Number(s) & Extension(s)**	**McMaster E-mail Addresses**
Principal Investigator*	Anastassios Dardas	School of Geography & Earth Sciences	905-525-9140 x28617	dardasa@mcmaster.ca
Co-Investigator(s) *(Insert additional rows as required.)*	Allison Williams	School of Geography & Earth Sciences	905-525-9140 x24334	awill@mcmaster.ca
	Bruce Newbold	School of Geography & Earth Sciences	905-525-9140 x27948	newbold@mcmaster.ca
	Darren Scott	School of Geography & Earth Sciences	905-525-9150 x24953	scottdm@mcmaster.ca
	Amanda Grenier	Department of Health, Aging & Society	905-525-9140 x26540	grenier@mcmaster.ca
Research Assistants or Project Coordinators*				
Student Investigator(s)*				
Faculty Supervisor(s)*	Allison Williams	(same as above)	(same as above)	(same as above)

3. **Study Timelines:** *(Contact the Ethics Secretariat at X 23142 or ethicsoffice@mcmaster.ca for urgent requests.)*

(a) What is the date you plan to begin recruiting participants or obtain their permission to review their private documents (Provide a specific date)?

March 2017 – November 2017

(b) What is the estimated last date for data collection with human participants?

4. **Location of Research**: List the location(s) where research will be conducted. Move your mouse over this < **Helpful Hint >** for more information on foreign country or school board reviews and contact the Ethics Office at X 23142 or 26117 for information on possible additional requirements:

(a) McMaster University **[X]**

(b) Community **[ ]** Specify Site(s)

(c) Hospital **[ ]** Specify Site(s)

(d) Outside of Canada **[ ]** Specify Site(s)

(e) School Boards **[ ]** Specify Site(s)

(f) Other **[ ]** Specify Site(s)

5. **Other Research Ethics Board Clearance**

(a) Are researchers from outside McMaster also conducting this research? If **yes**, please provide their information in Section 2 above. **[ ] Yes [X] No**

(b) Has any other institutional Research Ethics Board already cleared this project? **[ ] Yes [X] No**

(c) If **Yes** to (5b), complete this application and provide a copy of the ethics clearance certificate /approval letter.

(d) Please provide the following information:

Title of the project cleared elsewhere:
Name of the other institution:
Name of the other board:
Date of the other ethics review board's decision:
Contact name & phone number for the other board:

(e) Will any other Research Ethics Board(s) or equivalent be asked for clearance? **[ ] Yes [X] No**

If yes, please provide the name and location of board(s*).*

GENERAL INSTRUCTIONS AND HELPFUL TIPS (Please read first):

*Please be as **clear** and **concise** as possible and **avoid technical jargon**. Keep in mind that your protocol could be read by reviewers who may not be specialists in your field. Feel free to use headings, bolding and bullets to organize your information. Content boxes on this application expand.*

6. **Research Involving Canadian Aboriginal Peoples** i.e., First Nations, Inuit and Métis (Check all that apply)

(a) Will the research be conducted on Canadian Aboriginal lands? **[ ] Yes [X] No**

(b) Will recruitment criteria include Canadian Aboriginal identity as either a factor for the entire study or for a subgroup in the study? **[ ] Yes [X] No**

(c) Will the research seek input from participants regarding a Canadian Aboriginal community's cultural heritage, artifacts, traditional knowledge or unique characteristics? **[ ] Yes [X] No**

(d) Will research in which Canadian Aboriginal identity or membership in an Aboriginal community be used as a variable for the purpose of analysis of the research data? **[ ] Yes [X] No**

(e) Will interpretation of research results refer to Canadian Aboriginal communities, peoples, language, history or culture? **[ ] Yes [X] No**

If "Yes" was selected for any questions 6.a-6.e above, please note that the TCPS (Chapter 9) requires that researchers shall offer the option of engagement with Canadian Aboriginal communities involved in the research. http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/chapter9-chapitre9/. For advice regarding TCPS guidelines for conducting research with Canadian Aboriginal peoples, please contact Karen Szala-Meneok at X 26117 or szalak@mcmaster.ca

(f) Please describe the nature and extent of your engagement with the Aboriginal community(s) being researched. The nature of community engagement should be appropriate to the unique characteristics of the community(s) and the research. The extent of community engagement should be determined jointly by the researchers and the relevant communities. Include any information/advice received from or about the Aboriginal community under study. ***The TCPS notes; "although researchers shall offer the option of engagement, a community may choose to engage nominally or not at all, despite being willing to allow the research to proceed". If conducted research with several Aboriginal communities or sub-groups, please use headings to organize your information.***

ATTACHMENTS: Provide copies of all documents that indicate how community engagement has been or will be established (e.g., letters of support), where appropriate.

N.A.

(g) Has or will a research agreement be created between the researcher and the Aboriginal community?

[ ] Yes [X] No

If **Yes**, please provide details about the agreement below (e.g., written or verbal agreement etc.).

***ATTACHMENTS:* Submit a copy of any written research agreements, if applicable. See the MREB website for a sample customizable research agreement *https://reo.mcmaster.ca/educational-resources* or visit the CIHR website http://www.cihr-irsc.gc.ca/e/29134.html**

N.A.

(h) Are you are seeking a waiver of the community engagement requirement? (A waiver may be granted if the REB is satisfied that, Aboriginal participants will not be identified with a community or that the welfare of relevant communities will not be affected by the research.) **[ ] Yes [X] No**

If **yes,** please provide the rationale for this waiver request in the space below.

N.A

7. **Level of the Project** (Check all that apply)

[ ] Faculty Research **[ ]** Post-Doctoral **[X]** Ph.D. **[ ]** Staff/Administration

[ ] Master's (Major Research Paper - MRP) **[ ]** Master's (Thesis)

[ ] Undergraduate (Honour's Thesis) **[ ]** Undergraduate (Independent Research)

[ ] Other (specify)

8. **Funding of the Project**

(a) Is this project currently being funded? **[X] Yes [ ] No**

(b) If **No**, is funding being sought? **[ ] Yes [ ] No**

(c) Period of Funding: **From: [09/2015]** **To: [05/2019]**

(mm/dd/yyyy) (mm/dd/yyyy)

(d) Funding agency (funded or applied to) & agency number (i.e., number assigned by agency), if applicable.

Click this < link > to determine your "*agency number*". (This is not your PIN number).

[X] CIHR & agency # 126585 **[ ]** NSERC & agency #

[ ] SSHRC & agency # **[ ]** ARB

[ ] Health Canada & agency # **[ ]** CFI & agency #

[ ] Canada Graduate Scholarship & Agency # **[ ]** Post Graduate Scholarship & Agency #

[ ] USRA **[ ]** Other agency & # (*Specify*)

(e): Are you requesting ethics clearance for a research project that was not originally designed to collect data from human participants or their records (i.e., your research project originally did not involve collecting data from humans or their records) but you now intend to do so? **[ ] Yes [X] No**

9. **Conflicts of Interest**

(a) Do any researchers conducting this study, have multiple roles with potential participants (e.g., acting as both researcher and as a therapist, health care provider, family member, caregiver, teacher, advisor, consultant, supervisor, student/student peer, or employer/employee or other dual role) that may create real, potential, or perceived conflicts, undue influences, power imbalances or coercion, that could affect relationships with others and affect decision-making processes such as consent to participate?

[ ] Yes [X] No

(i) If **yes**, please describe the multiple roles between the researcher(s) and any participants.

N.A.

(ii) Describe how any conflicts of interest identified above will be avoided, minimized or managed.

N.A.

(b) Will the researcher(s), members of the research team, and/or their partners or immediate family members:

(i) receive any personal benefits (for example a financial benefit such as remuneration, intellectual property rights, rights of employment, consultancies, board membership, share ownership, stock options etc.) as a result of or being connected to this study? **[ ] Yes [X] No**

(ii) If **yes**, please describe the benefits below. (Do not include conference and travel expense coverage, possible academic promotion, or other benefits which are integral to the conduct of research generally).

N.A.

(c) Describe any restrictions regarding access to or disclosure of information (during or at the end of the study) that the sponsor has placed on the investigator(s), if applicable.

N.A.

SECTION B – SUMMARY OF THE PROPOSED RESEARCH

10. **Rationale**

For the proposed research, please describe the *background* and the *purpose* concisely and in lay terms, as well as any overarching research questions or hypotheses to be examined.

***Please do not cut and paste full sections from your research proposal*.**

Caregiver-employees (CEs) are people that provide informal care to a care recipient, particularly an immediate family member, with a disability while juggling family and work-related tasks. Canada, long-term informal caregivers play a major role in taking care of the senior population while receiving little or no support from employers and the government. Due to inadequate support, recent studies have shown that caregivers are vulnerable to ill health; thus, potentially straining and threatening the Canadian universal healthcare system and weakening the economy. Currently, Canada has no long-term policy to support long-term caregivers and to address the arising health dilemmas. One of them not addressed in policy is understanding the activity-travel behavior of caregivers and specific characteristics of CEs, such as health status, that strongly impacts their well-being. Therefore, the goal of this study is to convey valuable information about informal caregivers, especially caregiver-employees, in terms of potential accessibility to the nearest support services of the dependent's needs and how they can improve their activity-travel behavior via a temporal and spatial analysis, and in so doing, maintain their health.

11. **Participants**

Please use the space below to describe the:

(a) approximate number of participants required for this study

(b) salient participant characteristics (e.g., age, gender, location, affiliation, etc.)

If researching several sub-populations, use headings to organize details for items (a) and (b).

a) 25 participants

b) Age: 18+; Gender: 12 - Male & 13 - Female; Location: Hamilton Metropolitan Area

12. **Recruitment**

Please describe in the space below:

(a) how each type of participant will be recruited,

(b) who will recruit each type of participant,

(c) relationships (if any) between the investigator(s) and participant(s) (e.g. instructor-student; manager-employee, family member, student peers, fellow club members, no relationship etc.),

(d) permission you have or plan to obtain, for your mode of recruitment for each type of participant, if applicable.

If researching several sub-populations, use headings to organize details for items (a) – (d). Click "Tips and Samples" to find the "How to Unpack the Recruitment Details" worksheet and other samples.

ATTACHMENTS: Provide copies of all recruitment posters, advertisements letters, flyers, and/or email scripts etc. and label these as appendices (e.g., Appendix A or 1).

a) Emails to participants from my advisor's previous caregiver studies – this I will only be using the names (and emails) of the people who have previously agreed to being solicited to participate in this type of research; Mass emails to Employers

b) primary investigator

c) N.A.

d) Letter of Intent & Consent

13. **Methods**

Describe sequentially, and in detail all data collection procedures in which the research participants will be involved (e.g., paper and pencil tasks, interviews, focus groups, lab experiments, participant observation, surveys, physical assessments etc. —*this is not an exhaustive list*). Include information about who will conduct the research, how long it will take, where data collection will take place, and the ways in which data will be collected (e.g., computer responses, handwritten notes, audio/video/photo recordings etc**.).**

If your research will be conducted with several sub-populations or progress in successive phases; use sub-headings to organize your description of methodological techniques.

ATTACHMENTS: Provide copies of all questionnaires, interview questions, test or data collection instruments etc. Label supporting documents as appendices (e.g., Appendix A or 1) and submit them as separate documents - not pasted into this application.

Click "Tips and Samples" to find the "How to Unpack the Methods" worksheet and other samples.

Details: Each recruited CE (caregiver-employee) will carry a GPS unit and record their

commute and dependent-related trips for one week. The logged GPS information will acquire specific activity-travel behavior information, such as stop locations, routes chose, and areas where driving time is spent the most (i.e. traffic congestion). Sociodemographic information from each participant will be collected as part of the activity-travel behavior data for predictive analysis. Additionally, the recruited CE will log in details about their trip, such as how they feel and what they want to see improve in the trip diary. This part will be used to perform space-time coding (i.e. location A, amount time taken). The CE will be asked to incorporate detailed parts of the route where they feel it negatively impacts their well-being. Each CE will be required to log in for seven days or one week. The combination of GPS data and trip diaries renders a complete picture of the activities and trip over the 7 days for each CE participant.

Length (including recruiting): March 2017 – June 2018.

Who Will Conduct: Primary Investigator (myself)

Data Collection (place): Trip Diary including demographic and overview trip diary questionnaire, GPS Unit;

Format: Paper & Electronic; Final dataset will be electronic

14**. Secondary Use of Identifiable Data** *(e.g. the use of personally identifiable data of participants contained in records that have been collected for a purpose other than your current research project)*:

(a) Do you plan on using identifiable data of participants in your research for which the original purpose that data was collected is different than the purpose of your current research project? **[ ] Yes [X] No**

If **yes**, please answer the next set of questions:

(b) Do you plan to link this identifiable data to other data sets? **[ ] Yes [X] No**

If **yes,** please describe in the space below:

N.A.

(c) What type of identifiable data from this data set are you planning to access and use?

[ ] Student records (please specify in the space below)
[ ] Health records/clinic/office files (please specify in the space below)

[ ] Other personal records (please specify in the space below)

N.A.

(d) What personally identifiable data (e.g., name, student number, telephone number, date of birth etc.) from this data set do you plan on using in your research? Please explain why you need to collect this identifiable data and justify why each item is required to conduct your research.

N.A.

(e) Describe the details of any agreement you have, or will have, in place with the owner of this data to allow you to use this data for your research. ***ATTACHMENTS: Submit a copy of any data access agreements.***

N.A.

(f) When participants first contributed their data to this data set, were there any known preferences expressed by participants at that time about how their information would be used in the future? **[ ] Yes [ ] No**

If **yes**, please explain in the space below.

N.A.

(g) What is the likelihood of adverse effects happening to the participants to whom this secondary use of data relates? Please explain.

N.A.

(h) Will participants whose information is stored in this data set (which you plan to use for secondary purposes) consent to your use of this data? **[ ] Yes [ ] No**

Please explain in the space below.

N.A.

15. **Research Database**

Does your research involve the creation and/or modification of a research database (databank) containing human participant information? A research database is a collection of data maintained for use in ***future*** research. The human participant information stored in the research database can be identifiable or anonymous.

[ ] Yes [X] No

If "Yes" was answered to the above question, you will need to fill out and submit MREB's "Supplementary Form for Creating or Modifying a Research Database Containing Human Participant Information" along with this application.

NOTE: If you intend to collect or store personally-identifying health information, now or at a later stage in your research, your protocol must be cleared by Hamilton Integrated Research Ethics Board (HiREB) rather than MREB. For further advice contact MREB at x 23142 or X 26117 or HIREB x 905 521-2100 X 44574.

16. **Experience**

What is your experience with this kind of research? Include information on the experience of all **individual**(s) who will have contact with the research participants or their data. ***For example, you could mention your familiarity with the proposed methods, the study population(s) and/or the research topic.***

While qualitative research approaches are not my strength, I achieved an A grade in a graduate qualitative methods class last year, in addition to having some past experience interviewing as an Research Assistant.

17. **Compensation**

		Yes	No
(a) Will participants receive compensation for participation?		**[X]**	**[ ]**
	Financial	**[X]**	**[ ]**
	Other (specify)	**[ ]**	**[ ]**

(b) If yes was answered for any of the above choices, please provide details. **See < Helpful Hints > for funded research projects.**

Each participant will receive $100 cash as compensation for their time and taking part in the research. Each participant will be asked to sign the receipt of the payment form at the end of their individual research.

(c) If participants choose to withdraw, how will you deal with their compensation?

This amount will be paid to the participant even in the case that for any reason he/she decides to withdraw from research.

SECTION C – DESCRIPTION OF THE RISKS AND BENEFITS OF THE PROPOSED RESEARCH

18. **Possible Risks**

(a) Indicate if the participants might experience any of the following risks:

i.) Physical risk (including any bodily contact or administration of any substance)? **[ ] Yes [X] No**

ii.) Psychological risks (including feeling demeaned, embarrassed worried or upset)? **[X] Yes [ ] No**

iii.) Social risks (including possible loss of status, privacy and / or reputation as well as economic risks)? **[ ] Yes [X] No**

iv.) Are any possible risks to participants greater than those the participants might encounter in their everyday life? **[ ] Yes [X] No**

(b) If you checked **yes** for any of questions **i – iv** above, please describe the risk(s) in the space below.

Psychological Risks: There may be some questions in the trip diary (such as talking about their caregiving duties and health state of dependent) that may make them feel emotionally distressed.

(c) Management of Risks: Describe how each of the risks identified above will be managed or minimized. Please, include an explanation regarding why alternative approaches cannot be used.

Psychological Risks: The letter of information will inform the participant that he/she should not feel obligated to answer any questions that may make them uncomfortable or do not want to answer. They have the right to skip the questions that can give them emotional distress. This should minimize psychological risks involved.

(d) Deception: Is there any deception involved in this research? **[ ] Yes [X] No**

i.) If deception is to be used in your methods, describe the details of the deception (including what information will be withheld from participants) and justify the use of deception.

ii.) Please describe when participants will be given an explanation about why deception was used and how they will be debriefed about the study (for example, a more complete description of the purpose of the research).

ATTACHMENTS: Please provide a copy of the written debriefing form or script, if applicable.

N.A.

19. **Possible Benefits**

Discuss any potential benefits to the participants and or scientific community/society that justify involvement of participants in this study. (***Please note: benefits should not be confused with compensation or reimbursement for taking part in the study*).**

The benefits of this research is twofold, and includes: 1) filling the obvious CE literature gap and 2) informing policy and programming through a multi-pronged knowledge translation strategy. Literature lacks the activity-travel behavior of CE, which is one of the key elements known to impact health. The research project will close the gap and potentially open new research opportunities in the near-future with new methods and models. Second, knowledge translation (KT) strategies will help move the research findings into policy, programs, and interventions, particularly in the areas of transportation, urban, and health planning. These areas may use the KT strategies to implement effective changes, such as optimizing routes, changing zoning and transportation laws, and improving the CCB national policy. Additionally, the KT strategies can inform epidemiologists and

health planners by identifying vulnerable populations / geographic areas that are more susceptible to chronic illnesses and likely require caregiving. These effective strategies would reduce caregiving burden amongst caregiver-employees.

Participants will benefit from time management strategies, such as multipurpose trips or alternative routes that may optimize their health and behavior.

SECTION D – THE INFORMED CONSENT PROCESS

20. **The Consent Process**

(a) Please describe how consent will be documented. Provide a copy of the Letter of Information / Consent Form (if applicable). If a written consent form will not be used to document consent, please explain why and describe the alternative means that will be used. While oral consent may be acceptable in certain circumstances, it may still be appropriate to provide participants with a Letter of Information to participants about the study.

Click "Tips and Samples" for the McMaster REB recommended sample "Letter of Information / Consent Form", to be written at the appropriate reading level. The "*Guide to Converting Documents into Plain Language" is also found under *"Tips and Samples".

ATTACHMENTS: Provide a copy of the Letter of Information and Consent form(s) or oral or telephone script(s) to be used in the consent process for each of your study populations, where applicable.

Before handing the GPS units and trip diaries, I will talk with the potential participant and discuss the purpose, risks, and benefits of participation with him/her. Then, I will ask each participant to read the letter of information. After the participant has read the letter of information, he/she will be asked to sign and date the consent form. I will keep a signed copy of the consent form for records and will provide a copy for his/her records.

(b): Please describe the process the investigator(s) will use to obtain informed consent, including who will be obtaining informed consent. Describe plans for on-going consent, if applicable.

The process has been mentioned above. He/she will be asked to sign the consent form with their signature and date. They will receive an electronic copy of it for their records.

21. **Consent by an authorized person**

If participants are minors or for other reasons are not competent to consent, describe the proposed alternate consent process. ***ATTACHMENTS: Attach the Letter of Information and Consent form(s) to be provided to the person(s) providing the alternate consent. Click "Tips and Samples" to find samples.***

N.A.

22. **Alternatives to prior individual consent**

If obtaining written or oral documentation of an individual participant's consent prior to start of the research project is not appropriate for this research, please explain and provide details for a proposed alternative consent process. ***ATTACHMENTS**: **Please provide any Letters of Information and or Consent Forms.***

N.A.

23. **Providing participants with study results**

How will participants be able to learn about the study results (e.g., mailed/emailed brief summary of results in plain language; posting on website or other appropriate means for this population)?

Participants will learn the study results via hard copy and online. A lay Research Brief will be emailed to them or, by request can be sent via post. They can also keep up to date with Dr. Williams' Caregiving website (https://www.ghw.mcmaster.ca) that lists the different projects and KT tools.

24. **Participant withdrawal**

a) Describe how the participants will be informed of their right to withdraw from the project. Describe the procedures which will be followed to allow the participants to exercise this right.

The letter of information will have a statement that informs the participant that he/she has the right to withdraw from the project at any time, even after signing the form or during/after GPS & trip diary logging. Before handing the GPS units and trip diary, I will ask the participant: "Do you understand that you can withdraw from the study at any time?" If they seem to be reluctant during the trip diary and GPS recording process, I will remind him/her that they have the right to withdraw from the study at any time, without any consequences.

b) Indicate what will be done with the participant's data and any consequences which withdrawal might have on the participant, including any effect that withdrawal may have on the participant's compensation or continuation of services (if applicable).

The data will be destroyed, unless they do not wish otherwise. They will still receive the $100 compensation for

their time.

c) If the participants will not have the right to withdraw from the research, please explain.

N.A.

25**. SECTION E – CONFIDENTIALITY & ANONYMITY**

Confidentiality concerns the protection, privacy and security of research data. Consult the Data Security Checklist at http://reo.mcmaster.ca/educational-resources for best practices to secure electronic and hard copy versions of data and study documents.

(a) Will the data you collect be kept protected, private and secure from non-research team members?

[X] Yes [ ] No

If **No**, then explain why not, and describe what steps you be put in place to advise participants that data will not be kept protected, private and secure from non-research team members.

(b) Describe the procedures to be used to ensure that the data you collect in your research will be kept protected, private, and secure from non-research team members. In your description, explain who will have access to the data and what data security measures will be put in place during data transfer and data storage.

Data will be secure on the personal computer and backed-up in an external hard drive in case of hardware failures or corruption of files occur. They will also be encrypted, which will require a decryption key to unlock via the command line. Hard copy trip diaries will be locked away in a desk drawer as well as interview notes. Names will not be used in my dissertation / publications. To display results of specific participants, pseudonames will be used to protect their identity.

(c) Will the research data be kept indefinitely or will it be deleted after a certain time period? Please explain. In your answer, describe why you plan to keep data indefinitely or not. If deleting data after a certain time period, explain why you chose the time period you did. Describe how participants will be informed whether their data will be deleted or not.

After completion of study, all physical notes and copies will be destroyed via shredded. Electronic data and notes from all drives saved will be permanently deleted.

Anonymity concerns whether participant identities are made known or not. The anonymity promised to participants can be different during different stages of research (i.e., during recruitment, during data collection, during data storage, and during the dissemination of research findings).

(d) Describe the extent to which participant identities will be made known in each of the following activities: during recruitment, during data collection, during data storage, and during the dissemination of research findings. In your description, explain what steps or procedures you plan to put in place to keep participant identities unknown in each of those activities.

Recruitment: Name written down and locked away until interviewing the participant and conducting data analyses.

Data collection: Name becomes pseudoname with an ID#.

Data storage: Data stored in an encrypted folder and drive. Requires password. This can be stored in the Linux operating system, which can make hacking significantly more difficult comparing with Windows and Mac iOS.

Dissemination: Pseudonyms will be used for quotes and any data will be paraphrased to maximized identity confidentiality.

SECTION F -- MONITORING ONGOING RESEARCH

26. **Adverse Events, Change Requests and Annual Renewal/Project Status Report**

a) **Adverse events** (Unanticipated negative consequences or results affecting participants) must be reported by faculty researcher or supervisor to the REB Secretariat (Ethics Office – Ext. 23142) and the MREB Chair, as soon as possible and in any event, no more than 3 days after they occur.
See: https://reo.mcmaster.ca/policies/copy_of_guidelines#12-0-adverse-events

b) **Changes to cleared research**: To obtain clearance for a change to a protocol that has already received ethics clearance, please complete the "**< Change Request >**" form available on the MREB website or by clicking this link. Proposed changes may not begin before they receive ethics clearance.

c) **Annual Renewal/Project Status Report** Ethics clearance is for only one year.

The minimum requirement for renewing clearance is the completion of a "Annual Renewal/Project Status Report" in advance of the (1 year) anniversary of the original ethics clearance date. "

PLEASE NOTE:

It is the investigator's responsibility to complete the Annual Project Status Report that is sent each year by email 8 weeks in advance of the anniversary of the original ethics clearance to comply with the Research Integrity Policy. If ethics clearance expires the Research Ethics Board is obliged to notify Research Finance who in accordance with university and funding agency regulations will put a hold on funds.

27. **Additional Information:** Use this section or additional page(s) to complete any part of this form, or for any other information relevant to this project which you wish to provide to the Research Ethics Board.

N.A.

28. **POSTING OF APPROVED PROTOCOLS ON THE RESEARCH ETHICS WEBSITE**

a) It is the policy of MREB to post a list of cleared protocols on the Research Ethics website. Posted information usually includes: title, names of principal investigators, principal investigator department, type of project (i.e. Faculty; PhD; Masters, Undergraduate etc.)

b) You may request that the title be deleted from the posted information.

c) Do you request that the title be eliminated from the posted information? **[ ] Yes [X] No**

d) The ethics board will honour your request if you answer **Yes** to the above question **27 c**) but we ask you to provide a reason for making this request for the information of the Board. You may also use the space for any other special requests.

e) < List of MREB Cleared Protocols > < List of Undergraduate SREC Cleared Protocols >

N.A.

Supporting Materials Checklist:

Instructions:

Complete this checklist to identify and describe your supporting materials to ensure your application form is complete

- *When supplying supporting materials, ensure that they are properly labeled (e.g., "Appendix C: Interview Guide for Teachers") and referenced in your protocol (e.g., "The interview guide for teachers – see Appendix C – is...").*
- *<u>Do not cut and paste</u> supporting materials directly into the application form; submit each as a separate appendix.*
- *If you have multiple supporting materials of the same type (e.g., multiple letters of information that target different populations), list each supporting material on a separate row in this checklist. Add a new row to the table if necessary.*

Supporting Materials Checklist	**I will use this type of material in my study** ***(Insert X below)***	**I have attached a copy of this material in my protocol** ***(Insert X below)***	**This is how I labeled and titled this material in my protocol** **(e.g., *Appendix A – "Email Recruitment Script for Organizational Workers"*)**
Recruitment Materials			
Study Information Brochure			
Video/audio recording that explains study details			
Participant Screening Form			
Recruitment Advertisements	X	X	Appendix A – Recruitment Advertisement
Recruitment Poster			
Recruitment Script – Verbal/Telephone			
Recruitment Script – Email (direct to participant)	X	X	Appendix B – Email Recruitment Script
Recruitment Script – Email (From holder of participant's contact information)			
Recruitment for follow-up interview			
Snowball Recruitment script			
Reminder/thank you/ card/script/email			
Appreciation Letter/certificate – For Participants			
Other			
Informed Consent Materials			
Consent Log (to record oral consent)			
Oral/Telephone Consent Script			
Letter of Information & Consent Form – **Participants**	X	X	Appendix C – Letter of Information & Consent Form
Letter of Information & Consent Form – **Parent**			

Supporting Materials Checklist	**I will use this type of material in my study** *(Insert X below)*	**I have attached a copy of this material in my protocol** *(Insert X below)*	**This is how I labeled and titled this material in my protocol** **(e.g., *Appendix A – "Email Recruitment Script for Organizational Workers"*)**
Letter of Information & Consent Form - **Guardian** or **Substitute Decision Maker**			
Letter of Information & Assent Form – **Minors**			
Online survey brief information/consent and implied consent buttons			
Letter of Support for Study			
Research Agreement			
Other			
Data Collection Materials			
Information Sharing/Data Access/Transfer Agreement (for secondary use of data)			
Demographic form - Participant's	X	X	Appendix D – Demographic
Instructions for participants			
Interview Guide – (Questions for face to face, telephone, Internet/email interview)			
Interview Guide – Questions for Focus Groups			
Questionnaire or Survey questions & instructions (Paper and pencil or online formats)	X	X	Appendix E – Trip Diary & Summary
Rating Scales/inventories/Assessment Instruments			
Role-play/simulation scripts			
Stimuli used to elicit responses			
Images (photos, diagrams etc.) depicting instruments, equipment, exercises etc.			
Other			
Debriefing Materials			
Debriefing Form			
Deception Study - Debriefing Letter & post debriefing			

Supporting Materials Checklist	**I will use this type of material in my study** *(Insert X below)*	**I have attached a copy of this material in my protocol** *(Insert X below)*	**This is how I labeled and titled this material in my protocol** (e.g., *Appendix A – "Email Recruitment Script for Organizational Workers"*)
consent form			
Deception Study- Debriefing script – verbal			
Other			
Confidentiality Materials			
Confidentiality Oath/ Agreement			
Confidential Study Code Key Log			
Other			
Materials for previous review by other REBs			
Application form –Other REBs (Original)			
Application form – Other REBs (Revised)			
Communication between REB & researcher (letters, emails, faxes etc.)			
Clearance Certificate (Other REBs)			
Other			
Other Supporting Materials			
Compensation Log			
List of support services for participants			
Participant Appreciation - letter, script, email or certificate etc.			
Researcher Training Certificates			
Scientific Licenses			
Other			

29. Researcher Assurance: < SECTION G – SIGNATURES >

[AZD] I confirm that I have read the McMaster University Research Integrity Policy http://www.mcmaster.ca/policy/faculty/Research/Research%20Integrity%20Policy.pdf , and I agree to comply with this

and other university policies, guidelines and the Tri-Council Policy Statement (TCPS) and of my profession or discipline regarding the ethical conduct of research involving humans.

[AZD] *In addition*, I understand that the following *all constitute violations of the McMaster University's Research Integrity Policy*:

- failure to obtain research ethics clearance;
- carrying out research in a manner that was not cleared by one of the university's REBs;
- failure to submit a **Change Request** to obtain ethics clearance prior to implementing changes to a cleared study;
- failure to report an **Adverse Event** (i.e., an unanticipated negative consequence or result affecting participants) by the investigator or faculty supervisor of student research to the MREB secretariat and the MREB chair, as soon as possible and in any event, no more than 3 days after the event occurs;
- failure to submit an **Annual Renewal/Project Status Report** in advance of the 1 year anniversary of the original ethics clearance date.

Anastassios Dardas **/ /2017**

Signature of Faculty, Student or Staff Researcher **PLEASE PRINT NAME HERE** **Date**

(Add lines for additional researchers.)

Supervisor Assurance for Graduate or Undergraduate Student Research:

[ ] "I am the supervisor for this proposed student research and have read this ethics application and supporting documents and deem the project to be valid and worthwhile, and I will provide the necessary supervision of the student(s) researcher(s) throughout the project including ensuring that the project will be conducted as cleared and to make myself available should problems arise during the course of the research.

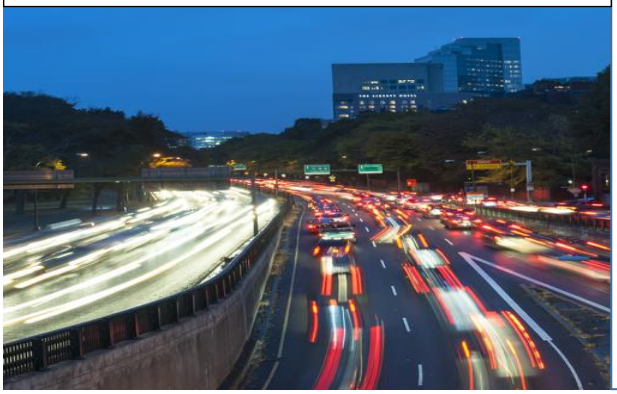
Signature of Faculty Supervisor of Student Research **PLEASE PRINT NAME HERE** **Date**

(Add lines for additional supervisors.)

The signature page may also be emailed as a scanned PDF or be sent by campus mail to GH-305

Appendix A: Recruitment Postcard

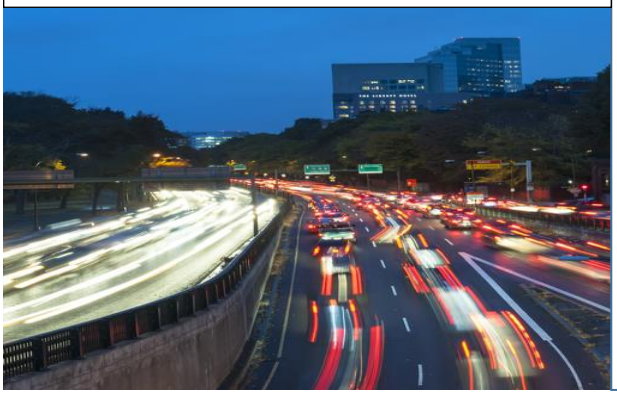
Invitation to Participate:



Are you ***employed*** and providing ***informal caregiving*** to an elderly person? Are you interested in sharing your travel behavior?

Please consider

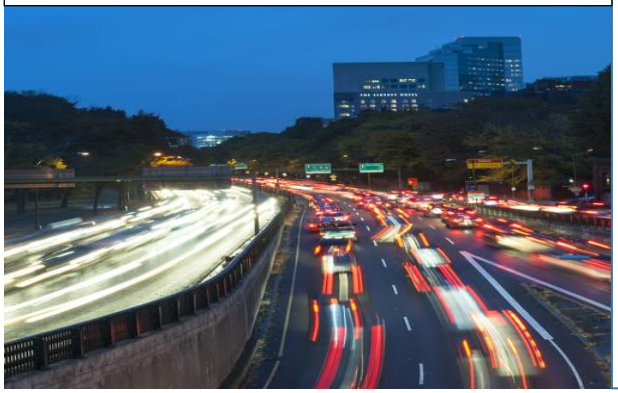
Invitation to Participate:



Are you ***employed*** and providing ***informal caregiving*** to an elderly person? Are you interested in sharing your travel behavior?

Please consider

Invitation to Participate:



Are you ***employed*** and providing ***informal caregiving*** to an elderly person? Are you interested in sharing your travel behavior?

Please consider

We are exploring the activity-travel behavior patterns and experiences of people who are employed and also providing unpaid care to a friend or family member. We want to understand how travelling for work when you are involved in a caregiving role impacts your health and ability to manage.

As a participant in this study, you will be asked to take part by carrying a GPS unit and logging a trip diary for one week and a demographic & overview trip questionnaire. The questionnaire will take approximately 30 minutes to fill in. You will receive a $100 honorarium for your participation.

For more information, or to volunteer in this study, please contact:

Anastassios Dardas
Project Investigator
Tel: 905-525-9140 x28617
E: dardasa@mcmaster.ca

This study received ethics clearance through the McMaster Research Ethics Committee.

We are exploring the activity-travel behavior patterns and experiences of people who are employed and also providing unpaid care to a friend or family member. We want to understand how travelling for work when you are involved in a caregiving role impacts your health and ability to manage.

As a participant in this study, you will be asked to take part by carrying a GPS unit and logging a trip diary for one week and a demographic & overview trip questionnaire. The questionnaire will take approximately 30 minutes to fill in. You will receive a $100 honorarium for your participation.

For more information, or to volunteer in this study, please contact:

Anastassios Dardas
Project Investigator
Tel: 905-525-9140 x28617
E: dardasa@mcmaster.ca

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We are exploring the activity-travel behavior patterns and experiences of people who are employed and also providing unpaid care to a friend or family member. We want to understand how travelling for work when you are involved in a caregiving role impacts your health and ability to manage.

As a participant in this study, you will be asked to take part by carrying a GPS unit and logging a trip diary for one week and a demographic & overview trip questionnaire. The questionnaire will take approximately 30 minutes to fill in. You will receive a $100 honorarium for your participation.

For more information, or to volunteer in this study, please contact:

Anastassios Dardas
Project Investigator
Tel: 905-525-9140 x28617
E: dardasa@mcmaster.ca

This study received ethics clearance through the McMaster Research Ethics Committee.

Appendix B
Email Recruitment Script

Anastassios Dardas, Dr. Allison Williams
Professor, School of Geography and Earth Sciences, McMaster University

Assessing Activity-Travel Behavior of Caregiver Employees & Health-Risk Areas in Hamilton, Canada

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CAREGIVER-EMPLOYEE RECRUITMENT EMAIL

E-mail Subject line: McMaster study needs your input on nurturing a caregiver-friendly workplace

Dear Participant,

You have been contacted about a research study on caregiving and commuting. Volunteers are needed to take part in a study about their experiences working full time while also providing unpaid care to a friend or family member. This study is part of a Canadian Institutes of Health Research (CIHR) research program examining Gender, Health and Caregiver Friendly Workplaces.

The study is exploring work commute and care-related trip experiences of people while also providing unpaid care to a friend or family member. The researchers want to analyze each different commute experience and understand the level of impact on health and well-being.

As a participant in this study, you will be asked to carry with you a GPS unit (provided by us) and trip diaries to record for 7 days. You will also receive a 1 hour support session of how to use the devices and fill in the trip diaries. For your time and effort, you will receive a $100 honorarium.

A copy of the Letter of Information and Consent detailing this study has been attached to this email. If you are interested in getting more information about participating in this study, please CONTACT ANASTASSIOS DARDAS DIRECTLY AT: 289-877-8407 or dardasa@mcmaster.ca.
Involvement in this study will not negatively affect your status or any services you receive at McMaster University. Any information you provide will be anonymous and will only be used for research purposes. You may withdraw from the study at any point during the process.

This study has received approval by the McMaster Research Ethics Board. If you have questions or concerns about your rights as a participant or about the way the study is being conducted you may contact:

McMaster Research Ethics Board Secretariat
Telephone: (905) 525-9140 ext. 23142
Gilmour Hall – Room 305 (ROADS)
E-mail: ethicsoffice@mcmaster.ca

Sincerely,
Anastassios Dardas
2nd Year PhD Student

Appendix C: Letter of Information & Consent Form

Letter of Information and Consent for Caregiver-Employees

Allison Williams, Ph.D.

Professor, School of Geography and Earth Sciences, McMaster University

Letter of Information and Consent Form for Caregiver-Employees

Title of the Study**:** Assessing Activity-Travel Behavior of Caregiver Employees and Health-Risk Areas in Hamilton, Canada

Investigators:

Anastassios Dardas, PhD Candidate, Primary Investigator

School of Geography & Earth Sciences

McMaster University

Hamilton, Ontario, Canada

905-525-9140 ext. 28617

dardasa@mcmaster.ca

Dr. Allison Williams, CIHR Research Chair in Gender, Work and Health

School of Geography & Earth Sciences

McMaster University

Hamilton, Ontario, Canada

905-525-9140 ext. 24334

awill@mcmaster.ca

Purpose of the Study*:*

The purpose of this study is to look at daily travel, behavior, and health of individuals who are employed and are also providing informal care to a friend or family member who is ill/ elderly. The dissertation project is projected to start in March 2017 and will be completed by April 2019 (27 months). Results for this study will be published and online on the Gender, Health and Caregiver Friendly Workplaces Chair project website (http://ghw.mcmaster.ca). Participants may request a summary report of the findings. Final findings are projected to be available by May 2019.

Procedure*:*

Research Sponsor: Canadian Institutes of Health Research (CIHR) – CG1 126585

Please read this information form carefully. You have been asked to participate in filling in trip diaries and the carrying a GPS unit to assess your activity-travel behavior for seven days each time you travel for an activity. For every activity-travel trip, the GPS unit needs to be on the entire trip until you've reached your destination. Once you've reached your destination, kindly fill out the trip diary. Each trip diary should take approximately 2 – 5 minutes of your time. The GPS unit logs in every 5 seconds of your activity-travel path. This can be repetitive depending on the amount of trips you do each day. Additionally, you will be asked to fill out a demographic and summary survey trip diary (after 7 days are up) questionnaire, which will take no more than 30 minutes of your time. Once seven days have passed, you will be asked to hand in the GPS unit and trip diary for data collection.

Use of GPS Units

Although trip diaries contain detailed information, it lacks the spatial and temporal content. Therefore, collecting GPS data will give us visual information of each route, length of trip, stops, and specific areas that take longer than usual to travel (i.e. traffic congestion, physical access). This will verify of what is tracked in the trip diaries. Additionally, the GPS will allow us to measure any impacts your activity-travel behavior has on your health and wellbeing over time and space.

Potential Risks:

Particularly when filling in the trip diary, you may feel uncomfortable (anxious) with some of the questions that are asked, as they address personal stresses and strains that caregiver employees often experience. If you feel uncomfortable at any time, you may choose to skip the question and/or end the participation in this study with no obligations. If you choose, all answers will not be saved and thus, destroyed.

Potential Benefits*:*

By contributing your information on activity-travel and caregiving-related activity, the end result of this dissertation research is to convey valuable information to caregiver-employees by suggesting effective intervention programs to state-policy makers and displaying vulnerable areas to urban, transportation, and health planners. This will increase awareness and in the long-term will sustain Canada's healthcare system, economy, and most importantly alleviate its caregiver and care-receiving population. Participants will benefit from time management strategy suggestions, such as multipurpose trips or alternative routes that may optimize their health and behavior.

Payment or Reimbursement:

For your participation in this study, you will receive an honorarium of $100 for GPS logging and trip diary. If, for any reason, you decide that you would like to withdraw during the survey interview or afterwards, you will still receive the $100 honorarium.

Confidentiality:

The data collection from GPS logging and trip diaries are completely anonymous. Hard copies from the trip diary will be kept in a locked filing cabinet in the primary investigators' office for up to 5 years. These will be scanned electronically to be stored on the personal computer and secure server, and then will be destroyed through confidential shredding following the final publication of the work, but no more than 5 years after data collection. All data will be stored in an encrypted folder in a personal computer with a Linux operating system. To open the encrypted file, it will need to be open in the terminal with a decrypt key, which I, as the primary researcher, will be the only one to have access to. Linux is also known to be the most secure operating system. These files will also be backed-up in a virtual machine environment and external hard drive as precautions.

As an addition security layer, there is no identifying information that will link you to your particular data set; though in any written publication, sometimes your identity may be revealed based on the stories you tell. Therefore, complete confidentiality cannot be guaranteed. As the primary researcher, I will take the steps to protect your identity as much as possible by assigning you a random participant code. The data collected is purely for research purposes.

The trip diary contains a section to provide the address of the 3rd party individual, in this case the dependent and name of Employer. This information will only be used to validate the GPS data and will not be used for any other purpose. Therefore, it will be destroyed after validation. Additionally, the trip diary asks for your contact information (last question) for any further questions. This information will be anonymized using their participant code in a separated encrypted file.

Rights of Research Participants:

Your participation in this study is voluntary. It is your choice to be part of the study or not. If you decide to be part of the study, you can withdraw from participation for whatever reason up until approximately November 31st, 2017. If you decide to withdraw, there will be no consequences to you. In cases of withdrawal, any data you have provided will be destroyed unless you indicate otherwise. If there are any questions asked which you would prefer not to answer, you are not obligated to do so. If you have any questions or concerns about the research study, please feel free to contact Anastassios Dardas or Allison Williams at the contact information provided above.

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

Michael J. Wilson, McMaster Research Ethics Officer

Telephone: (905) 525-9140 ext. 23142

c/o Research Office for Administrative Development and Support

E-mail: ethicsoffice@mcmaster.ca

I_____, consent to participate in *Evaluation of Caregiver-friendly Workplace Policy (CFWP) Interventions on the Health of Caregiver-Employees* conducted by Allison Williams. I understand the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature _____ **Date**

Participant

Signature _____ **Date**

Principal Investigator

1. Yes, I would like to receive a summary of the study's results.

Please send them to this email address _____

Or to this mailing address:

_____

_____

2. No, I do not want to receive a summary of the study's results.

3. I agree to be contacted to be made aware of future research studies conducted by the investigators, and understand that I can always decline the request.

- Yes
- No

Appendix D: Demographic Questionnaire [1]

Section	A – Demographic
# of Questions	12
Participant Code	

Basic Questions about who you are

A1. What is your age?

○ 18 - 30 ○ 31 - 35 ○ 36 - 40 ○ 41 - 45 ○ 46 - 50 ○ 51 - 55 ○ 56 - 60 ○ 61 - 65

○ 66 - 70 ○ 71 - 75 ○ 76+ ○ Prefer not to answer

A2. What city or town do you live in? _____

A3. What is your postal code? _____

A4. Gender: ○ Male Female Transgendered ○ Prefer not to answer

A5. Marital Status:

○ Single ○ Married or Common law ○ Widowed ○ Divorced/Separated ○ Prefer not to answer

○ Other (specify): _____

[1] Part of survey interview design originated from the Caregiver Friendly Workplace Policy Survey (Williams, A. and Atanackovic, J.) via Chair in Gender, Health and Caregiver Friendly Workplaces, McMaster University.

A6. With which ethnic or racial group or groups do you most identify?

- ○ Aboriginal (First Nations, Inuit, Métis)
- ○ Arab
- ○ Korean
- ○ European
- ○ Black or African/Caribbean
- ○ Asian
- ○ Japanese
- ○ Caucasian (White)
- ○ Latin American
- ○ Southeast Asian
- ○ Chinese
- ○ Other:
- ○ Filipino
- ○ West Asian (Middle East and the Near East)
- ○ Pacific Islander

A7. Are you a:

- ○ Canadian citizen
- ○ Landed immigrant or permanent citizen
- ○ Refugee
- ○ Other (specify):

A8. What is the highest level of formal education that you have completed:

- ○ Primary school or some high school/secondary school
- ○ High school diploma or equivalency certificate (GED)
- ○ Registered Apprenticeship or other trades certificate or diploma
- ○ College, GCEP, or other non-university certificate or diploma
- ○ University degree, certificate or diploma: If yes,
  - ○ High school diploma or equivalency certificate (GED)
  - ○ Bachelor's degree
  - ○ Graduate Degree

A9. During the past 12 months, what is your main caregiving task(s)? You may choose more than one.

☐ Transportation ☐ House Maintenance ☐ Personal Care ☐ Medical Treatments ☐ Scheduling

☐ Banking ☐ Emotional Support

☐ Other

B. Which one is the most time-consuming?

C. On average how much time (weekly) have you spent helping the care-recipient with this task (from B)?

○ Less than an Hour ○ 1 hour to Less than 3 hours ○ 3 Hours to Less than 5 Hours ○ 5 Hours to Less than 10 Hours ○ 10 Hours or more

A10. Please describe to us your current full-time job (job title) in the past 12 months:

B. Name of current employer

A11. How long have you been working in the current job? years months

A12. May I ask you what your estimated annual household income is before taxes:

- ○ < $15,000
- ○ $30,000 - $49,999
- ○ $50,000 - $69,999
- ○ $70,000 - $99,999
- ○ $100,000+
- ○ Prefer not to answer

Appendix D: Demographic Questionnaire (Sample) [2]

Section	A – Demographic
# of Questions	12
Participant Code	**23**

Basic Questions about who you are

A1. What is your age?

○ 18 - 30 ● 31 - 35 ○ 36 - 40 ○ 41 - 45 ○ 46 - 50 ○ 51 - 55 ○ 56 - 60 ○ 61 - 65

○ 66 - 70 ○ 71 - 75 ○ 76+ ○ Prefer not to answer

A2. What city or town do you live in? Hamilton

A3. What is your postal code? L8S 0D2

A4. Gender: ◉ Male ○ Female ○ Transgendered ○ Prefer not to answer

A5. Marital Status:

○ Single ● Married or Common law ○ Widowed ○ Divorced/Separated ○ Prefer not to answer

○ Other (specify):

[2] Part of survey interview design originated from the Caregiver Friendly Workplace Policy Survey (Williams, A. and Atanackovic, J.) via Chair in Gender, Health and Caregiver Friendly Workplaces, McMaster University.

A6. With which ethnic or racial group or groups do you most identify?

- ○ Aboriginal (First Nations, Inuit, Métis)
- ○ Black or African/Caribbean
- ○ Latin American
- ○ Filipino
- ○ Arab
- ○ Asian
- ○ Southeast Asian
- ○ West Asian (Middle East and the Near East)
- ○ Korean
- ○ Japanese
- ○ Chinese
- ○ Pacific Islander
- ○ European
- ● Caucasian (White)
- ○ Other:

A7. Are you a:

- ● Canadian citizen
- ○ Landed immigrant or permanent citizen
- ○ Refugee
- ○ Other (specify):

A8. What is the highest level of formal education that you have completed:

- ○ Primary school or some high school/secondary school
- ○ High school diploma or equivalency certificate (GED)
- ○ Registered Apprenticeship or other trades certificate or diploma
- ○ College, GCEP, or other non-university certificate or diploma
- ○ University degree, certificate or diploma: If yes,
  - ○ High school diploma or equivalency certificate (GED)
  - ○ Bachelor's degree
  - ● Graduate Degree

A9. During the past 12 months, what is your main caregiving task(s)? You may choose more than one.

☑ Transportation ☑ House Maintenance ☐ Personal Care ☐ Medical Treatments ☐ Scheduling

☐ Banking ☐ Emotional Support

☐ Other

B. Which one is the most time-consuming?

Transportation

C. On average how much time (weekly) have you spent helping the care-recipient with this task (from B)?

○ Less than an Hour ○ 1 hour to Less than 3 hours ○ 3 Hours to Less than 5 Hours ● 5 Hours to Less than 10 Hours ○ 10 Hours or more

A10. Please describe to us your current full-time job (job title) in the past 12 months:

Professor

B. Where did you last worked during the past 12 months?

McMaster Education Center

A11. How long have you been working in the current job? 7 years 2 months

A12. May I ask you what your estimated annual household income is before taxes:

- ○ < $15,000
- ○ $30,000 - $49,999
- ○ $50,000 - $69,999
- ○ $70,000 - $99,999
- ● $100,000+
- ○ Prefer not to answer

Appendix E: Trip Diary[3]

Name: _____ **Home Address:** _____ _____ **City/State/Zip:** _____ _____ **Diary Date:** _____	**I did not leave the house today:** ☐ **Is it just you or other people in your household using the motor vehicle?** _____ **If using motor vehicle, list odometer reading:** At beginning of day: _____ At end of day: _____	**Information:** Everytime you conduct a trip that is at least 5 minutes long, please record it.

[3] Trip diary design originated from the Trip Diary Survey Community Travel Patterns Report (City of Flagstaff, AZ and Flagstaff Metropolitan Planning Organization - http://www.smartgrowthamerica.org/documents/cs/impl/az-fmpo-surveyreport.pdf) with modifications.

Trip #	Starting / Departure Point (if home, please state "Home")	Trip Start Time		Trip arrival time		What was the purpose of this trip?		What was the mode of travel you used?	Destination Point (if home, please state "Home")	Est. trip (km / mi)	If Caregiving related, specify location, activity
		Hr: min	am/pm	Hr: min	am/pm						
	Name: _____ _____ **Address:** _____ _____ _____	__:__		__:__		Participant-Related 1. Go Home 2. Work Commute 3. Social / Recre. 4. Other Work/Busi. 5. Other: _____	Caregiving-Related 1. Shopping (i.e. grocery, pharmacy) 2. Health appt. 3. Social / Recre. 4. Other: _____	1. Car/truck (d) 2. Car/truck (p) 3. HSR: Route(s): _____ 4. GoBus Megabus/Coach or Canada/Greyh. 5. Train 6. Taxi 7. Walk 8. Bicycle 9. Other: _____	**Name:** _____ _____ **Address:** _____ _____ _____		
	Name: _____ _____ **Address:** _____ _____ _____	__:__		__:__		Participant-Related 1. Go Home 2. Work Commute 3. Social / Recre. 4. Other Work/Busi. 5. Other: _____	Caregiving-Related 1. Shopping (i.e. grocery, pharmacy) 2. Health appt. 3. Social / Recre. 4. Other: _____	1. Car/truck (d) 2. Car/truck (p) 3. HSR: Route(s): _____ 4. GoBus Megabus/Coach or Canada/Greyh. 5. Train 6. Taxi 7. Walk 8. Bicycle 9. Other: _____	**Name:** _____ _____ **Address:** _____ _____ _____		

Appendix E: Trip Diary (Sample)[4]

Name: John Smith **Home Address:** 1280 Main St. **City/State/Zip:** Hamilton / ON **Diary Date:** 2/15/2017	**I did not leave the house today:** ☐ **Is it just you or other people in your household using the motor vehicle?** Myself **If using motor vehicle, list odometer reading:** At beginning of day: ___20000 km_____ At end of day: _____20050 km_____	**Information:** Everytime you conduct a trip that is at least 5 minutes long, please record it.

[4] Trip diary design originated from the Trip Diary Survey Community Travel Patterns Report (City of Flagstaff, AZ and Flagstaff Metropolitan Planning Organization - http://www.smartgrowthamerica.org/documents/cs/impl/az-fmpo-surveyreport.pdf) with modifications.

Trip #	Starting / Departure Point (if home, please state "Home")	Trip Start Time		Trip arrival time		What was the purpose of this trip?		What was the mode of travel you used?	Destination Point (if home, please state "Home")	Est. trip (km / mi)	If Caregiving related, specify location, activity
		Hr: min	am/pm	Hr: min	am/pm						
1	**Name:** Home **Address:**	**7:45 AM**		**8:00 AM**		Participant-Related 1. Go Home 2. Work Commute 3. Social / Recre. 4. Other Work/Busi. 5. Other: _____	Caregiving-Related 1. Shopping (i.e. grocery, pharmacy) 2. Health appt. 3. Social / Recre. 4. Other: _____	1. Car/truck (d) 2. Car/truck (p) 3. HSR: Route(s): _____ 4. GoBus Megabus/Coach or Canada/Greyh. 5. Train 6. Taxi 7. Walk 8. Bicycle 9. Other: _____	**Name: McMaster Education Center** **Address: 1 James St N. Hamilton**	**5 Km**	**N/A**
2	**Name: McMaster Education Center** **Address: 1 James St N. Hamilton**	**4:30 PM**		**5:15 PM**		Participant-Related 1. Go Home 2. Work Commute 3. Social / Recre. 4. Other Work/Busi. 5. Other: _____	Caregiving-Related 1. Shopping (i.e. grocery, pharmacy) 2. Health appt. 3. Social / Recre. 4. Other: Dependent's home	1. Car/truck (d) 2. Car/truck (p) 3. HSR: Route(s): _____ 4. GoBus Megabus/Coach or Canada/Greyh. 5. Train 6. Taxi 7. Walk 8. Bicycle 9. Other: _____	**Name: Care Recipient's Home** **Address: 100 Main St. Grimsby, ON**	**20 Km**	**Care Recipient's home**

Appendix E: Summary Trip Diary

Section	B – Trip-Diary & Caregiving
# of Questions	13
Participant Code	

B1. On average, how many trips would you say you do on a daily basis?

○ < 5 ○ 5 - 10 ○ 10 - 15 ○ 15+

B2. Which day of the week has the most trips?

B. Why?

C. Is this a weekly routine?

B3. From your trip diary, what trip is the most stressful? Please list trip #.

Please describe why that trip # gives you high stress.

Caregiving-related / Care-recipient Questions (B5 – B12)

B5. Does the carerecipient live with you?

○ Yes ○ No

i. If no, what mode of transportation does the care recipient use?

○ Public Transit ○ Personal Car ○ Bicycling ○ Walk ○ Taxi

If you selected public transit, please answer the following below:

A) Select one or more public transit systems the care recipient uses:

☐ HSR ☐ Burlington Transit ☐ GoTransit (Bus) ☐ GoTransit (Train) ☐ Coach Canada ☐ Greyhound
☐ Megabus ☐ Other (specify):

i. How far does the dependent live from you?

- ○ 1 - 5 mi. (1.6 - 8 km)
- ○ 5.1 - 10 mi. (8.2 - 16 km)
- ○ 10.1 - 15 mi (16.2 - 24 km)
- ○ 10.1 - 15 mi (16.2 - 24 km)
- ○ 15.1 - 20 mi. (24.2 - 32 km)
- ○ 25.1 mi + (40.2 km +)

ii. How long does it take for you to travel from home to work?

○ 2 - 5 min ○ 6 - 10 min ○ 11 - 15 min ○ 16 - 20 min ○ 21 - 25 min
○ 26 - 30 min ○ 46 - 59 min ○ 60 min +

iii. While commuting to work or back home, do you make a stop at the care recipient's home?

○ Yes ○ No

B6. How old is the care recipient?

○ 18 - 30	○ 31 - 35	○ 36 - 40	○ 41 - 45	○ 46 - 50	○ 51 - 55	○ 56 - 60	○ 61 - 65	
○ 66 - 70	○ 71 - 75	○ 76+	○ Prefer not to answer					

B7. What is the address of the care recipient live in?

….town?

…postal code?

B8. How many hours per week do you spend taking care of the care-recipient?

What is the estimated time for caregiving related trips?

B9. What would you say is the current health condition of the care recipient?

○ Poor ○ Fair ○ Good ○ Excellent ○ Prefer not to answer

B10. What would you say is your current health condition?

○ Poor ○ Fair ○ Good ○ Excellent ○ Prefer not to answer

B11. How long have you've been taking care of the care recipient?

○ < 0.5 yr ○ 0.5 - 1 yr ○ 1.1 - 1.5 yr ○ 1 - 1.5 yr ○ 1.6 - 2 yr ○ 2 - 5 yrs ○ 6 - 10 yrs ○ 11 - 15 yrs

B12. Ever since you've been taking care of your dependent – has your health status changed over time?

○ Yes ○ No If you answered “Yes”, please describe below what has changed your health (i.e. physical, emotional):
B13. If there are any further questions or points of clarification needed, may I contact you? If so, what is the best way to do so?

Thank You for Your Time! If you are doing this electronically, please send it to Anastassios Dardas at dardasa@mcmaster.ca

Appendix E: Summary Trip Diary (Sample)

Section	B – Trip-Diary & Caregiving
# of Questions	13
Participant Code	**23**

B1. On average, how many trips would you say you do on a daily basis?

(●) < 5 ( ) 5 - 10 ( ) 10 - 15 ( ) 15+

B2. Which day of the week has the most trips?

Most of the weekdays are the same with the exception of Friday.

B. Why?

Friday, I bring my care-recipient to the primary care physician for a weekly check-up and then drive to the pharmacy to pick up the new prescribed drugs.

C. Is this a weekly routine?

Yes

B3. From your trip diary, what trip is the most stressful? Please list trip #.

Friday - #30

Please describe why that trip # gives you high stress.

A lot of destination points, far and few in between, and occasional traffic congestion.

Caregiving-related / Care-recipient Questions (B5 – B12)

B5. Does the carerecipient live with you?

○ Yes ● No

i. If no, what mode of transportation does the care recipient use?

● Public Transit ○ Personal Car ○ Bicycling ○ Walk ○ Taxi

If you selected public transit, please answer the following below:

A) Select one or more public transit systems the care recipient uses:

☐ HSR ☐ Burlington Transit ☑ GoTransit (Bus) ☐ GoTransit (Train) ☐ Coach Canada ☐ Greyhound
☐ Megabus ☐ Other (specify):

i. How far does the dependent live from you?

- ○ 1 - 5 mi. (1.6 - 8 km)
- ○ 5.1 - 10 mi. (8.2 - 16 km)
- ○ 10.1 - 15 mi (16.2 - 24 km)
- ● 10.1 - 15 mi (16.2 - 24 km)
- ○ 15.1 - 20 mi. (24.2 - 32 km)
- ○ 25.1 mi + (40.2 km +)

ii. How long does it take for you to travel from home to work?

○ 2 - 5 min ○ 6 - 10 min ● 11 - 15 min ○ 16 - 20 min ○ 21 - 25 min
○ 26 - 30 min ○ 46 - 59 min ○ 60 min +

iii. While commuting to work or back home, do you make a stop at the care recipient's home?

● Yes ○ No

B6. How old is the care recipient?

○ 18 - 30 ● 31 - 35 ○ 36 - 40 ○ 41 - 45 ○ 46 - 50 ○ 51 - 55 ○ 56 - 60 ○ 61 - 65

○ 66 - 70 ○ 71 - 75 ○ 76+ ○ Prefer not to answer

B7. What is the address of the care recipient live in? 100 Main St

….town? Grimsby

…postal code? L4E 0D1

B8. How many hours per week do you spend taking care of the care-recipient? 17

What is the estimated time for caregiving related trips? 12 hrs

B9. What would you say is the current health condition of the care recipient?

○ Poor ● Fair ○ Good ○ Excellent ○ Prefer not to answer

B10. What would you say is your current health condition?

○ Poor ○ Fair ● Good ○ Excellent ○ Prefer not to answer

B11. How long have you've been taking care of the care recipient?

○ < 0.5 yr ○ 0.5 - 1 yr ○ 1.1 - 1.5 yr ○ 1 - 1.5 yr ● 1.6 - 2 yr ○ 2 - 5 yrs ○ 6 - 10 yrs ○ 11 - 15 yrs

B12. Ever since you've been taking care of your dependent – has your health status changed over time?

● Yes ○ No

If you answered "Yes", please describe below what has changed your health (i.e. physical, emotional):

Mainly physical due to lack of time to exercise and maintain my well-being.

B13. If there are any further questions or points of clarification needed, may I contact you? If so, what is the best way to do so?

You certainly may. Contact on my cell - (888)888-8888 or email - johnsmith@mcmaster.ca

Thank You for Your Time! If you are doing this electronically, please send it to Anastassios Dardas at dardasa@mcmaster.ca

APPENDIX 2

McMaster University
Inspiring Innovation and Discovery

McMaster University Research Ethics Board (MREB)

c/o Research Office for Administrative Development and Support, MREB Secretariat, GH-305/H, e-mail: ethicsoffice@mcmaster.ca

CERTIFICATE OF ETHICS CLEARANCE TO INVOLVE HUMAN PARTICIPANTS IN RESEARCH

Application Status: ☑ **New** ☐ **Addendum | Project Number:** 2017 035

TITLE OF RESEARCH PROJECT:

Assessing Activity-Travel Behaviour of Caregiver Employees & Health-Risk Areas of Hamilton, Canada

Faculty Investigator(s)/ Supervisor(s)	Dept./Address	Phone	E-Mail
A. Williams	Geography	24334	awill@mcmaster.ca

Co-Investigator(s):
B. Newbold, D. Scott, A. Grenier

Student Investigator(s)	Dept./Address	Phone	E-Mail
A. Dardas	Geography	28617	dardasa@mcmaster.ca

Co-Investigator(s):

The application in support of the above research project has been reviewed by the MREB to ensure compliance with the Tri-Council Policy Statement and the McMaster University Policies and Guidelines for Research Involving Human Participants. The following ethics certification is provided by the MREB:

☐ The application protocol is cleared as presented without questions or requests for modification.

☑ The application protocol is cleared as revised without questions or requests for modification.

☐ The application protocol is cleared subject to clarification and/or modification as appended or identified below:

COMMENTS AND CONDITIONS: Ongoing clearance is contingent on completing the annual completed/status report. A "Change Request" or amendment must be made and cleared before any alterations are made to the research.

Reporting Frequency:	Annual: Apr-11-2018	Other:

Date: Apr-11-2017 **Vice Chair, Dr. S. Watt** Susan Watt

Chair in Gender, Health and Caregiver Friendly Workplaces

McMaster University

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

RESEARCH BRIEF

Funding No.: CG1 1265885

Assessing Health Risk & Activity-Travel Behaviour of Carer-Employees

KEY POINTS

- Assisted-transport is the most common and one of the most demanding caregiving tasks.
- Carer-employees doing assisted-transport are more overwhelmed than those not performing the task.
- A multi-pronged framework was designed to provide guidance in developing prevention strategies, such as caregiver-friendly transport programs. The framework includes:
  - Phase I – National (Canada) analysis
  - Phase II – Metropolitan (Hamilton) Geographic Information Systems (GIS) analysis
  - Phase III – Individual analysis (n = 25)

What is the topic of this research?

Carer-employees struggle with work-life balance due to juggling full-time paid work with their caregiving responsibilities. Caregiver-friendly workplace programs (CFWPs), such as unpaid leave or telecommuting, are designed to improve the carer-employees' work-life balance. However, CFWPs are rarely available and often do not recognize the strain of one of the most common caregiving tasks, that being the provision of assisted-transport for care-recipients.

Assisted-transport involves running errands related to the care-recipient's needs, such as transporting the care-recipient to health care appointments. Despite being the most common and one of the highest demanding tasks, not much is known about it. This is particularly true with respect to how assisted-transport alters the carer-employees' travel behaviour. Travel behaviour is a direct measurement of wellbeing.

Research Objectives

The following research objectives address this issue:

1. How can we identify the national differences between carer-employees who provide assisted-transport, and those carer-employees who don't?
2. From an urban and health planning perspective (i.e. Hamilton), how does the location of the care-recipient's residence potentially impact the carer-employee's work-life?
3. Individually and collectively, how can we efficiently highlight the actual travel behaviour of carer-employees?

How was the study done?

Phase I

- Data: General Social Survey Cycle 26 (Statistics Canada)
- Methods: Statistical analysis

Phase II

- Data: Locations of vital services and public transit stops in Hamilton.
- Methods: multi-GIS analysis

Phase III

- Data: Individual GPS, Trip Diaries & Questionnaires from eligible participants (n = 25)
- Methods: Mixed-Methods

Chair in Gender, Health, and Caregiving Studies (Project #9) | School of Geography & Earth Sciences, McMaster University | e: dardasa@mcmaster.ca

What did the researchers find?

(1) Addressing the **first research objective**, carer-employees conducting assisted-transport are:

1. more likely to be female;
2. have higher education and household income;
3. provide **more** caregiving hours per week, and;
4. feel more tired and overwhelmed than those carer-employees who don't provide assisted-transport.

(2) Addressing the **second research objective**, GIS results show that, in the Hamilton Metropolitan area:

1. 62% (71.6k) of the older adult (age 65+) population are within 10 min. walk to nearest vital service, whereas 82% (94.6k) are within a 10 min. walk to the nearest public transit stop. This leaves 20-25% situated in underserved areas.

2. Implementation of new services in suggested areas would improve access for older adults, ranging from:
    a) 62% to 80% (vital services)
    b) 82% to 86% (public transit stops)

3. Additional info including maps can be viewed on this StoryMap.

(3) Addressing the **third research objective**, the classification of travel behaviour identifies the carer-employee's level of time flexibility, while outlining specific factors that impact it.

1. Qualitative results – Several thematic keywords describe the carer-employees' travel behaviour; they include: "time", "pressure", "parents", "run", and "long"
2. Quantitative results – three types of carer-employees' travel behaviour were identified.
    a) Flexible (n = 10)
    b) Between flexible & fixed (n = 8)
    c) Fixed (n = 7)

Key Message

There is a need to develop caregiver-friendly transport programs (CFTPs) as it is shown that carer-employees performing assisted-transport are more overwhelmed than those carer-employees who don't. City planners need to ensure access to vital services for both older adults and their caregivers.

Who are the researchers?

Anastassios Dardas, PhD Candidate & Primary Researcher, School of Geography & Earth Sciences, McMaster University

Patrick DeLuca, MSc, GIS Specialist & Sessional Faculty, School of Geography & Earth Sciences, McMaster University

Peter Kitchen, PhD, Analyst, Statistics Canada Research Data Centre at McMaster University

Darren Scott, PhD, Professor, TransLAB, School of Geography & Earth Sciences, McMaster University

Li Wang, PhD, Analyst, Statistics Canada Research Data Centre at McMaster University

Allison Williams, Supervisor, PhD, Professor, CIHR Research Chair in Gender, Work and Health, School of Geography & Earth Sciences, McMaster University
awill@mcmaster.ca

Want to learn more? Please visit the Chair in Gender, Health, and Caregiver Friendly Workplaces site!