

Predictors of Loneliness and Transitions in Loneliness in Ontario Home Care Clients: Before and
During the COVID-19 Pandemic

by
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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Background

Older adults over the age of 65 receiving home care services are particularly vulnerable to experiencing loneliness and social isolation. Loneliness and social isolation have been associated with adverse health outcomes, including depression, cardiovascular disease, and mortality, as well as increased service utilization. Research has widely explored cross-sectional predictors of loneliness, though factors that predict the onset of loneliness, particularly in the home care population remain largely understudied. With the COVID-19 pandemic exacerbating rates of social isolation, loneliness, and exposure to predictors, further research is necessary to understand how the pandemic influenced the risk of loneliness and the onset of loneliness in the Ontario older adult home care population.

Objectives

The goal of this research was to identify predictors of loneliness and the onset of loneliness that were significant prior to and during the first wave of the COVID-19 pandemic in Ontario. The way in which the COVID-19 pandemic modified the relationship between loneliness and predictors was also explored.

Methods

Secondary data analysis was conducted using Ontario interRAI Home Care data collected between September 1, 2018, to August 31, 2020. The sample was divided into two subsamples, the “comparison” and “COVID” sample to conduct respective bivariate and multivariate analyses. Bivariate analyses guided the development of six binary logistic regression models that were selected with modified stepwise selection. The final multivariate models determined cross-sectional predictors of loneliness at T1 and longitudinal predictors of the onset of loneliness at

T2 in both sub-samples. Two additional models explored the main effect and interaction effects of the COVID-19 pandemic on the onset of loneliness across the entire study sample. A social isolation scale was developed to supplement the analysis.

Results

Risk of loneliness and onset of loneliness were found to be associated with several demographic, physical, clinical, psychological, social, and environmental variables. Variations in risk factor significance were present across models, though sex, LHIN region, sleep disturbance, ADL impairment, depressive symptoms and social isolation were consistent across all models indicating that these factors had a considerable association with loneliness prior to and during the pandemic. When significant, depressive symptoms, anhedonia, geographic variations, and social isolation demonstrated the strongest association with loneliness. The first wave of the COVID-19 pandemic led to a slight increase in loneliness rates and significant interactions demonstrated that the pandemic exacerbated the influence of several risk factors on loneliness.

Conclusion

The prevention and reduction of loneliness must be targeted through an integrated approach by practitioners, home care organizations, researchers, and program and policy makers to combat risk factors of all dimensions beyond those that are clinical. Future research should aim to fill the gaps presented in this research and work to develop evidence-based indicators and practice protocols to aid in systematic risk identification and intervention of loneliness.

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Dedication

I dedicate this thesis to my grandparents. You worked so hard to make a better world for me and my generation and I hope I could make a difference for yours.

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List of Abbreviations

ADL – Activities of Daily Living

ADLH – Activities of Daily Living Hierarchy

AOR – Adjusted Odds Ratio

CHESS - Changes in Health, End-stage Disease, Signs, and Symptoms Scale

COR – Crude Odds Ratio

COVID-19 – Coronavirus Disease 2019

CPS – Cognitive Performance Scale

C-Statistic – Concordance Statistic

DBSI – Deaf-Blind Severity Index

DRS – Depression Rating Scale

interRAI HC – interRAI Home Care

P-Value – Probability Value

ROC – Receiver Operating Characteristic

SIS – Social Isolation Scale

95% CI – 95% Confidence Interval

Introduction

Loneliness has been linked to several adverse health outcomes, making it an urgent health concern in today's society (Lee et al., 2019; Leigh-Hunt et al., 2017). It is estimated that 1.4 million older Canadians experience feelings of loneliness, with 30% of older adults at risk of social isolation (Keefe et al., 2006; Ramage-Morin & Gilmour, 2013). With a greater proportion of the population falling into older age categories resulting from an aging population, there are also shifting public health priorities aimed at supporting the health of older adults (National Seniors Council, 2016). The causal pathway to loneliness is complicated with several risk factors falling under demographic, clinical, psychological, social, and environmental domains. Age-related risk factors such as health decline, diminishing social circles, and shifting demographic characteristics put older adults over the age of 65 at a heightened risk of experiencing loneliness and social isolation, especially those residing in community settings (Cohen-Mansfield et al., 2016; Ejiri et al., 2021; Lee et al., 2019). Major health conditions linked to loneliness and social isolation include cardiovascular disease and depression, further amplifying the risk of implications such as disability, premature mortality, and rising health care costs (Cacioppo et al., 2006; Domènech-Abella et al., 2017; Kuiper et al., 2020; Leigh-Hunt et al., 2017; Solmi et al., 2020; Valtorta et al., 2016).

Though the value of incorporating social connectedness into care plans and public health priorities has been recognized, the COVID-19 pandemic is an unexpected challenge that has exacerbated exposure to several risk factors of loneliness (Lei et al., 2020; Sepúlveda-Loyola et al., 2020). Higher comorbidities have contributed to older adults being considered medically vulnerable to COVID-19, subjecting them to more extreme self-imposed and mandated

pandemic-related restrictions (Lawson et al., 2022; Lei et al., 2020; Sepúlveda-Loyola et al., 2020). Pandemic-related restrictions have led to reports of higher rates of loneliness, psychological distress and reduced quality of life among older adults (Huang & Zhao, 2020; Lebrasseur et al., 2021; Lei et al., 2020; Losada-Baltar et al., 2021; Sepúlveda-Loyola et al., 2020; Wu, 2020). Older adult home care clients were vulnerable to loneliness and social isolation prior to the pandemic, so further research is necessary to understand the impact of the pandemic on this subgroup.

Loneliness

Loneliness is a subjective experience that results in distress from social networks not meeting an individual's social needs (Leigh-Hunt et al., 2017). As mentioned, in Canada it is estimated that 1.4 million older adults experience feelings of loneliness (Ramage-Morin & Gilmour, 2013). No known biological mechanisms cause loneliness and it is considered a mental state common to the human experience and highly situationally dependent (Cohen-Mansfield et al., 2016; Weiss, 1973). Transient feelings of loneliness that emerge, for example, when missing a loved one, rarely raise concern as a health threat (Cacioppo et al., 2000). Chronic loneliness, or loneliness persisting for an extended period, is deeper rooted in a person's life and identity and can have social or emotional dimensions of origin (Weiss, 1973). Weiss (1973) describes social loneliness as occurring in the absence of a broad social network and emotional loneliness as occurring in the absence of emotionally fulfilling relationships. Chronic loneliness is of particular concern and has been reported to be a risk factor for several health concerns such as depression, dementia, cardiovascular disease, suicide attempts, and mortality (Bennardi et al., 2017; Domènech-Abella et al., 2017; Kuiper et al., 2015; Solmi et al., 2020; Steptoe et al., 2013; Stravynski & Boyer, 2001; Thurston & Kubzansky, 2009; Valtorta et al., 2016). Loneliness is

generally viewed as a social issue approached to be addressed on a case-by-case basis, through available social and community resources and initiatives (Courtin & Knapp, 2015). Though no treatment is present, it is largely preventable if a broad approach incorporating targeted and community-based interventions is sustained (Cohen-Mansfield et al., 2016; Williams et al., 2022).

Loneliness and Social Isolation

Loneliness is a subjective state that is closely linked to objective social isolation, with social isolation being a primary risk factor for loneliness (Beller & Wagner, 2018; Cornwell & Waite, 2009). Though distinct concepts, they commonly present and are studied in tandem, sometimes posed as two sides of the same coin. Social isolation is an objective concept that considers social contacts, the quantity and quality of relationships, and deficits in mutually rewarding relationships (Keefe et al., 2006). It is estimated that one-quarter of community-dwelling older adults are socially isolated, with 30% of Canadian older adults being at risk (Keefe et al., 2006; National Academies of Sciences, Engineering, and Medicine, 2020). In some cases, social isolation can remain inconsequential. However, in addition to being a risk factor for loneliness, social isolation has been associated with other adverse health outcomes such as depression, sleep, auditory and visual disturbances, cognitive and functional decline, dementia, cardiovascular disease, stroke, frailty, poor self-rated health, and mortality (Andrew et al. 2008; Cho et al., 2019; Coyle et al., 2017; De Koning et al., 2017; Gafarov et al., 2013; Havens et al., 2004; Hirdes & Forbes, 1992; Hirdes & Forbes, 1993; Holt-Lunstad et al., 2015; Kuiper et al., 2015; McLaughlin et al., 2012; Park et al., 2013). Though loneliness and social isolation have been independently linked to several adverse health outcomes, interdependency has also been suggested. A cross-sectional study by Cornwell and Waite (2009) found poor mental health

outcomes in socially isolated older adults only when perceived isolation (loneliness) was also experienced.

Loneliness and Social Isolation in Home Care

Most studies of loneliness and social isolation in older adults deal with the general population rather than home care clients. However, some studies estimate the prevalence of clients that are socially isolated or at high risk of social isolation to be about 35% (Luggen & Rini, 1995; Medvene et al., 2016; Tremethick, 2001). Other community studies report that up to 43% of older adults over 65 experience social isolation, with 10-50% also reporting feelings of loneliness (Freedman & Nicolle, 2020). New aging-in-place initiatives are intended to reduce health care costs, prevent premature institutionalization and promote healthy aging within the community (Medvene et al., 2016). While such initiatives can be beneficial, they can also increase the risk of loneliness and social isolation in older adults who do not have social safety nets (Medvene et al., 2016). There is a broad spectrum of health profiles of home care clients. Some may be relatively healthy enough to sustain autonomy and social participation. Other clients affected by severe functional impairment and that lack physical and social support may be at greater risk (Cheung et al., 2019).

Along with other risk factors of loneliness and social isolation, older adults living in the community may be at risk of reduced network size or living alone due to family transitions, widowhood, limited social opportunities, and a lack of focus on age-friendly communities (Cohen-Mansfield et al., 2016; De Koning et al., 2017; Jeste et al., 2016; Kim et al., 2022; Tomstad et al., 2021). Though dependent on disease severity and the size and nature of one's social network, home care clients generally spend more time alone than their counterparts in institutional settings (Medvene et al., 2016). However, home care visits may also play a role in

providing social engagement and reducing loneliness through visits by home care staff (Tomstad et al., 2021). Mental health and social issues, such as loneliness and social isolation, are historically not valued to the same calibre as physical issues. Also, individuals living at home are often viewed as “healthy enough”, which contributes to loneliness and social isolation among home care clients being understated as immediate public health concerns (Tomstad et al., 2021). However, there has been a growing interest in understanding how the impact of loneliness and social isolation can be reduced for individuals living in the community.

Risk Factors of Loneliness and Social Isolation

Several interconnected risk factors of loneliness and social isolation have been established in the literature. Women are usually reported to be more likely to experience loneliness than men, with men at a higher risk of social isolation (Cohen-Mansfield et al., 2016; De Koning et al., 2017; Ormstad et al., 2020; Pinqart & Sörensen, 2001; Shankar et al., 2011). Gender may also modify the relationship between loneliness, social isolation, and some health conditions (Ramage-Morin, 2016; Mick et al., 2014). For example, Mick et al. (2014) report that women are more likely to feel socially isolated when experiencing hearing difficulties than men. Other risk factors include living alone, relationship status, income, education level, ethnicity, and length of residence (Adams et al., 1989; Bu et al., 2020; Cheung et al., 2019; Cornwell & Waite, 2009; De Koning et al., 2017; Havens et al., 2004; Keefe et al., 2006; Lee et al., 2019; Theeke, 2010; Visser & El Fakiri, 2016). Individuals who live with spouses or family members require less effort to be socially engaged and receive more frequent and proximal support than those who live alone (Sinha, 2014). Individuals with lower education and income levels are more likely to live in areas with higher safety concerns and fewer community resources that facilitate social engagement (Abbott & Sapsford, 2005; Cohen-Mansfield et al., 2016; Keefe et al., 2006; Wister

and McPherson, 2014). In contrast, individuals in higher income brackets may afford to live in safer neighbourhoods for longer periods, which may contribute to having larger social networks than those in lower brackets (Sinha, 2014; Wister and McPherson, 2014). In the same vein, rural versus urban dwelling and community resources and transportation infrastructure also contribute to opportunities for social engagement, ultimately affecting loneliness and social isolation risk (Bu et al., 2020; Cohen-Mansfield et al., 2016; De Koning et al., 2017; Keefe et al., 2006).

Health-related factors also play a large role in loneliness and social isolation risk. Chronic illness and associated symptoms, including pain, cognitive and functional decline, difficulties with balance and mobility, dyspnea, fatigue, and poor quality of life, have been associated with an increased risk of loneliness and social isolation (Kobayashi et al., 2009; Paúl & Ribeiro, 2009; Theeke, 2010; Wister & McPherson, 2014). Individuals dealing with ongoing health issues often have less capacity or desire to prioritize social activity when feeling unwell (Cohen-Mansfield et al., 2016; Gilmour, 2012). Individuals with physical or mobility issues that make them homebound may even lose the ability to be active members of their community and aside from virtual means, social engagement becomes dependent on the volition of others (Tomstad et al., 2021). Mental health conditions are also a risk factor for loneliness and social isolation. About 20% of older adults living in the community report mental health issues, including but not limited to depression, anxiety, delirium, and dementia (Public Health Agency of Canada, 2010). Depression has been strongly linked to loneliness, though several mental health conditions that cause psychological distress may lead to a feedback loop where loneliness and social isolation exacerbate each other (Cheung et al., 2019; Domènech-Abella et al., 2017; Fiske et al., 2009; Kuiper et al., 2020). Notably, mental health difficulties may also hinder the ability to make and maintain strong and meaningful relationships throughout life (Smith & Hirdes, 2008).

In addition to the previously mentioned risk factors, older adults are subject to unique challenges that make them more vulnerable to loneliness and social isolation than other age groups (Cohen-Mansfield et al., 2016; Ejiri et al., 2021; Lee et al., 2019). Older adults experience higher rates of comorbidity, disability, frailty, and conditions related to aging, including vision and hearing loss, sleep disturbances, incontinence, functional impairment, and cognitive decline (Brunes et al., 2019; Griffin et al., 2019; Keefe et al., 2006; Littlejohn et al., 2021; Mick et al., 2014; Nicholson, 2012; Public Health Agency of Canada, 2010; Ramage-Morin, 2016). Age-related experiences such as retirement, widowhood, caregiving responsibilities, reduced community participation and social network sizes have been linked to increased rates of loneliness, social isolation, depression, and diminished well-being (Cohen-Mansfield et al., 2016; De Koning et al., 2017; Havens et al., 2004; Keefe et al., 2006; Panagiotopoulos et al., 2013; Paúl & Ribeiro, 2009; Pinqart & Sörensen, 2001). Low-income levels following retirement, combined with diminishing social support can also contribute to loneliness and higher social isolation (Cohen-Mansfield et al., 2016; Gilmour, 2012; Sinha, 2014).

One should also consider the quality of social networks and personal factors when examining the risk of loneliness and social isolation. Fiori et al. (2006) found that individuals with diverse social networks of family, friends, and community support are less at risk of experiencing depressive symptoms than those with restricted networks where social and familial support is scarce (Fiori et al., 2006). However, even individuals with diverse and large social network sizes are more likely to experience loneliness and mental health implications if the perceived level of support from these relationships is inadequate (Fiori et al., 2006). For example, though marriage is generally protective against loneliness, marital strain is a risk factor

for loneliness (Shiovitz-Ezra & Leitsch, 2010). Loneliness risk does not solely depend on external factors, with personal factors such as value placed on social relationships also introducing a complex, subjective, and individualized outlook (Cornwell & Waite, 2009; Tomstad et al., 2021). Certain traits such as poor self-esteem, anger, shyness, and the tendency to engage in unhealthy behaviours have been found to increase the risk of an individual becoming lonely (Cacioppo et al., 2000; Cohen-Mansfield et al., 2016; Lee et al., 2019; Ormstad et al., 2020).

Public Health Implications of Loneliness and Social Isolation

Loneliness and social isolation exacerbate complexity in many clinical pathways. Both are risk factors for adverse health outcomes but are also consequences of experiencing those adverse health outcomes. Thus, loneliness or social isolation can provoke clinical symptoms, worsening complexity because they may act in ways that are ambiguous, indirect, and cyclical (Courtin & Knapp, 2015). Loneliness and social isolation have been reported as risk factors for poor self-rated health, cognitive decline, dementia, and mortality and have most widely been studied in relation to cardiovascular disease and depression (Courtin & Knapp, 2015; Griffin et al., 2020; Hirdes & Forbes, 1992; Hirdes & Forbes, 1993; Leigh-Hunt et al., 2017; Park et al., 2020; Solmi et al., 2020; Theeke, 2010; Thurston & Kubzansky, 2009; Valtorta et al., 2016). A meta-analysis by Valtorta et al. (2016) found that having poor social relationships increased the risk of having coronary heart disease or a stroke by 29% and 32%, respectively. Moreover, O'Súilleabháin et al. (2019) found emotional loneliness to yield a hazard ratio of 1.19 for all-cause mortality among older adults living alone when adjusted for demographic variables and depressive illness (Weiss, 1973). Loneliness is also thought to have a strong bidirectional relationship with depression fueled by a significant overlap in risk factors or association of

conditions that are risk factors for one another (Blazer, 2003; Domènech-Abella et al., 2017; Fiske et al., 2009; Kendler et al., 2006; Kuiper et al., 2020). The linkage of loneliness and depression is of concern as depression in older adults has been associated with major adverse health outcomes such as functional decline, poor self-rated health, disability, cardiovascular disease, mortality, and increased health service utilization (Blazer, 2003; Gilman et al., 2017; Hays et al., 1997; Hybels et al., 2001; Luber et al., 2001). Without considering social influences on health, the effectiveness of treatments for other adverse health outcomes may be reduced, or recoveries may be delayed, ultimately leading to a reduced quality of life and increased health service utilization and costs (Cournane et al., 2015; Courtin & Knapp, 2015; Theeke, 2012).

Buffering Effects of Social Support

There are several mechanisms by which social support and connectedness may be protective against negative health implications. Cohen & Wills (1986) propose that social connectedness facilitates overall well-being by providing ongoing stability, support, and esteem affirmations. Alternatively, the stress-buffering hypothesis suggests that social support may heighten the threshold at which an event is perceived as a stressor or promote positive coping mechanisms, buffering any consequential effects (Cacioppo & Hawkley, 2003; Cohen & McKay, 1984; Cohen & Syme, 1985; Cohen & Wills, 1986). Cacioppo & Hawkley (2003) suggest that socially connected individuals are more likely to seek social support facilitating active coping and for a stressor to be overcome (Cacioppo et al., 2000; Cacioppo & Hawkley, 2003). Lonely or socially isolated individuals are more likely to withdraw from the stressor, coping passively for only temporary relief (Cacioppo & Hawkley, 2003). With social networks influencing one's behaviour through social modelling and peer pressure, the absence of social connectedness in lonely or socially isolated individuals may contribute to the uptake of maladaptive coping

mechanisms (Leigh-Hunt et al., 2017). Lonely individuals are more likely to engage in behaviours that are risk factors for mental and physical illness, such as smoking, drinking, unhealthy eating, and lack of physical exercise (Hawkley & Cacioppo, 2010; Herbst et al., 2007; Kharicha et al., 2007; Lauder et al., 2006; Leigh-Hunt et al., 2017; Shankar et al., 2011; Whisman, 2010). With loneliness and social isolation functioning as stressors, consequences arising in the absence of social connectedness are recognizable (Cacioppo & Hawkley, 2003).

The Landscape of the First Wave of the COVID-19 Pandemic in Ontario

Ontario's first wave of the COVID-19 pandemic ranged from January 2020 to August 2020 (Canadian Institute for Health Information, 2021). On March 17, 2020, a provincial state of emergency was declared in Ontario, requiring all indoor dining and recreational and public facilities and services close for two weeks, with travel restrictions coming shortly after (Canadian Institute for Health Information, 2022a; Lawson et al., 2022). On March 23, 2020, all non-essential workplaces were mandated to be closed, although several workplaces and educational institutions instated “work-from-home” protocols the week before March 17, 2020 (Canadian Institute for Health Information, 2022a; Lawson et al., 2022). On March 28, 2020, gatherings of more than five people were restricted (Lawson et al., 2022). Two days later, the provincial state of emergency was extended from the initial two weeks, closing public outdoor spaces, including parks, beaches, and sports courts (Lawson et al., 2022). During these closures, visits to long-term care residents were restricted, and the public was advised to limit contact with outside households (Lawson et al., 2022). In May 2020, Stage 1 of the provincial reopening strategy was entered, resulting in the beginning of easing restrictions (Lawson et al., 2022). This strategy stage involved gradually reopening certain services, including non-emergency medical services, construction services, and businesses and activities that could operate outdoors or with

limited contact (Lawson et al., 2022). In June of 2020, stage 2 of the reopening strategy was entered, permitting outdoor dining, personal care services, shopping malls, outdoor recreational activities, film production activities, and gatherings of up to ten people (Lawson et al., 2022). Restrictions on visits to long-term care and retirement homes were also eased (Lawson et al., 2022). Despite the ease in restrictions, the City of Toronto instated a mandatory mask mandate to be obeyed in all indoor public spaces on July 7th, 2020 (Lawson et al., 2022). Starting in July 2020, Ontario entered stage 3 of the reopening strategy, with most businesses being permitted to operate with some limitations (Lawson et al., 2022). Within the home care sector, there was a reduction in completed assessments, admissions and discharges, and personal support and occupational and physical therapy visits during the first wave of the pandemic (Sinn et al., 2022). The second wave of the pandemic began in September 2020 (Canadian Institute for Health Information, 2021).

The Impact of the COVID-19 Pandemic

The COVID-19 pandemic and related restrictions created a unique situation in which most of the world experienced social isolation and a higher risk of loneliness (Kim & Jung, 2020; Lei et al., 2020; Losada-Baltar et al., 2021; Sepúlveda-Loyola et al., 2020). Older adults are subject to comorbidity and weakened immune systems and are a vulnerable population to pandemic-related implications (Hirdes et al., 2020; Lei et al., 2020; Losada-Baltar et al., 2021; Qiu et al., 2020; Sepúlveda-Loyola et al., 2020; Wu, 2020). Efforts to minimize the risk of older adults contracting the virus at institutional, familial, and personal levels during the first wave of the pandemic may have put them at greater risk of experiencing loneliness, social isolation, and mental health implications than usual pre-pandemic levels (Lei et al., 2020; Losada-Baltar et al., 2021; Sepúlveda-Loyola et al., 2020; Wu, 2020). As a result of the pandemic-related restrictions,

there have been reports of higher levels of depression, loneliness, anxiety, sleep disturbances, social decline and withdrawal, and reduced physical activity, instrumental activities of daily living capacity, and quality of life among older adults (Betini et al., 2021; Huang & Zhao, 2020; Lebrasseur et al., 2021; Lei et al., 2020; Losada-Baltar et al., 2021; McArthur et al., 2022a; McArthur et al., 2022b; Sepúlveda-Loyola et al., 2020; Wu, 2020). However, research has also supported alternative perspectives suggesting that older adults had more positive outlooks and less psychological distress resulting from the pandemic than younger age groups and that perceptions of COVID risk and disruptions may influence negative outcomes (Betini et al., 2021; Bruine de Bruin, 2020; Knepple Carney et al., 2020). Notably, data looking at emotional responses to the first wave of the pandemic in Ontario also reported hopefulness, empathy, and content among respondents (Jenkins et al., 2021). These results may be attributed to a sense of community and togetherness that was cultivated particularly during the first wave of the pandemic (Bowe et al., 2021).

New insights regarding the impact of the pandemic are emerging continuously. Losada-Baltar et al. (2021) found that females and those who spent more time tuning in to COVID-19 information were at a greater risk of experiencing loneliness and declining mental health during the initial lockdown of the pandemic. Other factors thought to contribute to the risk of loneliness and mental health decline during the pandemic include increased but involuntary autonomy and caregiving responsibilities, morbidity, concern over health needs, education level, personal and familial resources, and negative self-perceptions of aging (Betini et al., 2021; Huang & Zhao, 2020; Lei et al., 2020; Losada-Baltar et al., 2021; Mazza et al., 2020; Qiu et al., 2020; Steptoe et al., 2013; Wang et al., 2020; Wu et al., 2019; Wu, 2020). Bu et al. (2020) found that individuals experiencing established risk factors for loneliness, such as living alone, were at an even higher

risk of loneliness during the pandemic. With exacerbated rates of loneliness, social isolation, mental health implications, and exposure to related risk factors, further research needs to be conducted to understand how the pandemic has modified these relationships and overall well-being, particularly among the older adult home care population.

Summary and Study Rationale

Existing research has brought a greater awareness of the influence of social well-being on physical outcomes and quality of life, highlighting the importance of maintaining social connections across the lifespan (Cacioppo & Hawkley, 2003). Societal shifts leading to an increase in life expectancy, geographic mobility, lower marriage rates, smaller household sizes, and reduced religious and community participation are factors that have contributed to a rise in levels of loneliness and social isolation from previous generations (Cacioppo & Hawkley, 2003; Cohen-Mansfield et al., 2016; Holt-Lunstad, 2017). The intersection of age-related, demographic, clinical, psychological, environmental, and social factors in the context of societal complexes characterizes older adults as a particularly socially vulnerable population (Cohen-Mansfield et al., 2016; Ejiri et al., 2021; Lee et al., 2019). Efforts to reduce health care costs and promote aging in place have also led to the prioritization of community-based home care, introducing a heightened risk of loneliness and social isolation among adults than seen in more social, institutionalized settings (Medvene et al., 2016).

Though independent risk factors of loneliness have been widely explored, interactions between predictors and which clusters of risk factors pose the greatest threats remain understudied (Cacioppo et al., 2006; Lee et al., 2019; Leigh-Hunt et al., 2017). With a primary focus on cross-sectional analyses, there is also a gap in understanding what makes some older adults prone to experiencing transitions in loneliness, particularly in different contexts. Social

isolation measures brought about by the COVID-19 pandemic are thought to have increased the risk of loneliness among older adults (Lei et al., 2020; Losada-Baltar et al., 2021; Sepúlveda-Loyola et al., 2020). Home care clients may be a particularly vulnerable group given their complex health needs. Lifestyle changes associated with the pandemic allow for further examination of the risk factors of loneliness and transitions in loneliness in older adults at a time when risk factor exposure is likely to be exacerbated (Wu, 2020). In addition, though there is evidence surrounding the implications of loneliness, there is a lack of literature surrounding the direct social needs of older adult home care clients in Ontario and little evidence-based guidance on incorporating these needs into prevention and care plans for older adults (Courtin & Knapp, 2015). Further exploring predictors of loneliness and transitions in loneliness and how the COVID-19 pandemic has affected these relationships will provide a better understanding of how and why loneliness presents in older adults, identify at-risk patients' profiles, and inform preventative strategies, program planning and interventions, and future policy changes that will be considered reactively to the pandemic for years to come (Courtin & Knapp, 2015; Wu, 2020).

Specific Aims

Research Questions and Objectives

The specific aims of the thesis were to understand the characteristics of older adults receiving home care in Ontario that make them prone to experiencing loneliness and becoming lonely over time. The impact of the COVID-19 pandemic on loneliness was also explored. The following research questions were addressed to capture these objectives:

1. What factors were predictive of loneliness cross-sectionally prior to and during the first wave of the COVID-19 pandemic?

2. What factors were predictive of the longitudinal onset of loneliness prior to and during the first wave of the COVID-19 pandemic?
3. How did the COVID-19 pandemic modify these relationships?

Hypotheses

1. A diverse array of demographic, clinical, psychological, social, and environmental risk factors will be associated with loneliness both cross-sectionally and longitudinally.
2. The COVID-19 pandemic exacerbated the effect of several risk factors leading to higher rates of loneliness.

Methods

Data Source

The interRAI HC instrument is a comprehensive assessment tool used to evaluate home care client functioning and quality of life by assessing physical, cognitive, and social domains, also aiding in care and service planning (Carpenter & Hirdes, 2013; Gray et al., 2009; Heckman et al., 2013; Heckman & Jónsson, 2017; Hirdes et al., 2008; Rolfson et al., 2018; Salahudeen & Nishtala, 2019). The instrument is generally completed by a nurse or other regulated health professional (Morris et al., 2009). Embedded within the instrument are several measurement scales and Clinical Assessment Protocols (CAPS) triggered when a client is at risk in a corresponding clinical domain (Morris et al., 2009). The interRAI HC is managed by the Canadian Institute of Health Information as part of the Integrated interRAI Reporting System, which collects data about publicly funded home care services in Canada (Canadian Institute for Health Information, 2022b). However, for these analyses, Ontario interRAI HC data was obtained directly from Ontario Health, the provincial agency managing that system in Ontario.

Ethical clearance for the use of interRAI HC data based on interRAI's agreement with Ontario Health was provided by the University of Waterloo's Office of Research Ethics.

For this analysis, a dataset of 399,090 Ontario home care client assessments collected with the interRAI HC between September 1, 2018, to August 31, 2020 was used. This dataset provides a snapshot of the landscape of home care clients before and during the pandemic. This data set was divided into two samples: the "comparison" sample consisting of 30,714 assessments conducted between September 1, 2018, and August 31, 2019, and the "COVID" sample consisting of 21,955 assessments conducted between September 1, 2019, and August 31, 2020. Each sample group was divided into two subgroups signifying different points in time (i.e., T1, T2). T1 and T2 for the comparison and COVID samples contain assessments from September 1 to February 28 or 29 and March 1 to August 31, respectively, of each respective year. Previous published research based on this dataset includes studies of the effect of COVID-19 on social engagement and instrumental activities of daily living among Ontario home care clients (McArthur et al., 2022a; McArthur et al., 2022b).

Inclusion and Exclusion Criteria

The study population included individuals over 18 receiving home care services within Ontario. Only assessments of individuals living in community settings were included, excluding those who were assessed in congregate settings (e.g., retirement homes, hospitals) to avoid any mediating effects on outcome variables from living in a congregate setting. Individuals with a Cognitive Performance Scale score over 4 at any time period were also excluded to reduce confounding effects that moderate-severe cognitive impairment may have on loneliness and independent variable reporting. When created, the dataset was restricted to the most recent

assessment within the study period with a corresponding follow-up assessment. Variables with missing data had negligible counts and were deleted so as not to skew analyses.

Dependent and Independent Variables

The study's *dependent (outcome) variable* was loneliness. The interRAI HC instrument has a single-item self-report loneliness measure that asks whether the respondent reports feeling lonely (Morris et al., 2009). *Independent variables* were selected by selecting existing variables within the InterRAI HC instrument that were representative of concepts related to loneliness within surrounding literature and were categorized into demographic, clinical, psychosocial, environmental, and service domains. For the purpose of the analysis, several variables were reworked to function as binary and categorical variables. Where applicable, clinical scales were collapsed to represent previously determined cut points. Scales with unestablished cut points had cut points determined by assessing natural grouped distributions within the variable responses or left to be analyzed as continuous variables.

Seven interRAI scales derived from the interRAI HC assessment were included in the analyses. The Depression Rating Scale (DRS) is a 14-item scale that measures the presence of clinically significant depressive symptoms, whereby a score of 3+ signifies a problem with depression (Burrows et al., 2000). The Cognitive Performance Scale (CPS) ranges from 0-6 with a higher score signifying greater cognitive impairment (Landi et al., 2000; Morris et al., 2000). Impairment in activities of daily living (ADL) is measured by the ADL Hierarchy Scale (ADLH). The ADLH ranges from 0-6 with a higher score indicating greater ADL impairment and dependence (Landi et al., 2000; Morris et al., 2000). The Pain Scale ranges from 0-4 with an increase in score indicating worsening pain severity (Morris et al., 2000; Fries et al., 2001). The Changes in Health, End-stage Disease, Signs, and Symptoms Scale (CHESS) measures health

instability, ranging from 0-5, where an increase in score signifies greater health instability (Hirdes et al., 2003; Hirdes et al., 2014). The Deaf-Blind Severity Index (DBSI) ranges from 0-5 with a higher score indicating greater impairment in both senses (Dalby et al., 2009). The communication scale measures ability in making self-understood and understanding others in a range of 0-8 with a higher score indicating greater difficulty communicating (Morris et al., 2000).

Social Isolation Scale

In the absence of an existing measure of objective social isolation within the interRAI HC instrument, a 6-item social isolation scale (SIS) was developed. A preliminary list of potential indicators of social isolation was derived from the interRAI HC instrument with reference to significant predictors and indicators of social isolation found in the literature. In addition, the item content of the Lubben Social Network Scale and Berkman-Syme Social Network Index was also considered (Berkman & Syme, 1979; Lubben, 1988).

Table 1. Potential indicators and final scale items of the social isolation scale	
Potential Indicators	Final Scale Items
1. Marital status	1. Single
2. Living arrangement	2. Lives alone
3. Withdrawal from activities of interest	3. Change in social activities in last 90 days
4. Reduced social interactions	4. Alone for 8+ hours during the day
5. Participation in social activities of long-standing interest	5. Unsupportive friend and family network
6. Visit with long-standing social relation or family member	6. No informal helper
7. Other interaction with long-standing social relation or family member	
8. Change in social activities in last 90 days	
9. Length of time alone during the day	
10. Days of formal care (last 7 days)	
11. Presence of first informal helper	
12. Presence of second informal helper	
13. Hours of informal care (last 3 days)	
14. Strong and supportive relationship with family	

Where necessary, categorical indicator variables were collapsed into binary variables. For continuous variables such as “hours of informal care” and “days of formal care” a cut point was first chosen using the median value for non-lonely individuals. A binary variable was then created representing whether the individual reached this cut point or not. All variables were coded so that a value of “1” versus “0” was indicative of greater social isolation to allow a summative scale to be produced at which a higher value indicates greater social isolation. The independent relationships between these preliminary variables and loneliness were assessed at the bivariate level generating exploratory chi-square statistics and associated p-values and further through unadjusted odds ratios. Chi-square statistics with a p-value of $<.05$ and odds ratios with confidence intervals that did not include “1” were considered significant. To ensure a meaningful contribution, independent variables with odds ratios that were insignificant or had a magnitude greater than 0.83 or less than 1.2 were eliminated from the final scale. The remaining independent variables were added together to create a summative scale with three additional scale variants being created after assessing for scale complexity, collinearity, and computing compatibility with additional interRAI scales.

Logistic regression was used to examine how well each scale variant was able to predict loneliness. Each variant had comparable c-statistics. The final variant was selected based on the greatest interoperability between other interRAI assessments (e.g., community mental health) and the lowest complexity while still maintaining a c-statistic of 0.69. Though eligible to be used as a continuous scale, a Receiver Operating Characteristic (ROC) curve analysis was performed to determine appropriate cut-points for the association with loneliness (Unal, 2017). Three criterion tests were used: “distance to 0,1,” “sensitivity-specificity,” and “Youden Index” which unanimously identified an optimal cut point of “2,” indicating that an individual with a score of 2

or higher on the social isolation scale can be considered to be at a threshold of social isolation that results in greater odds of loneliness.

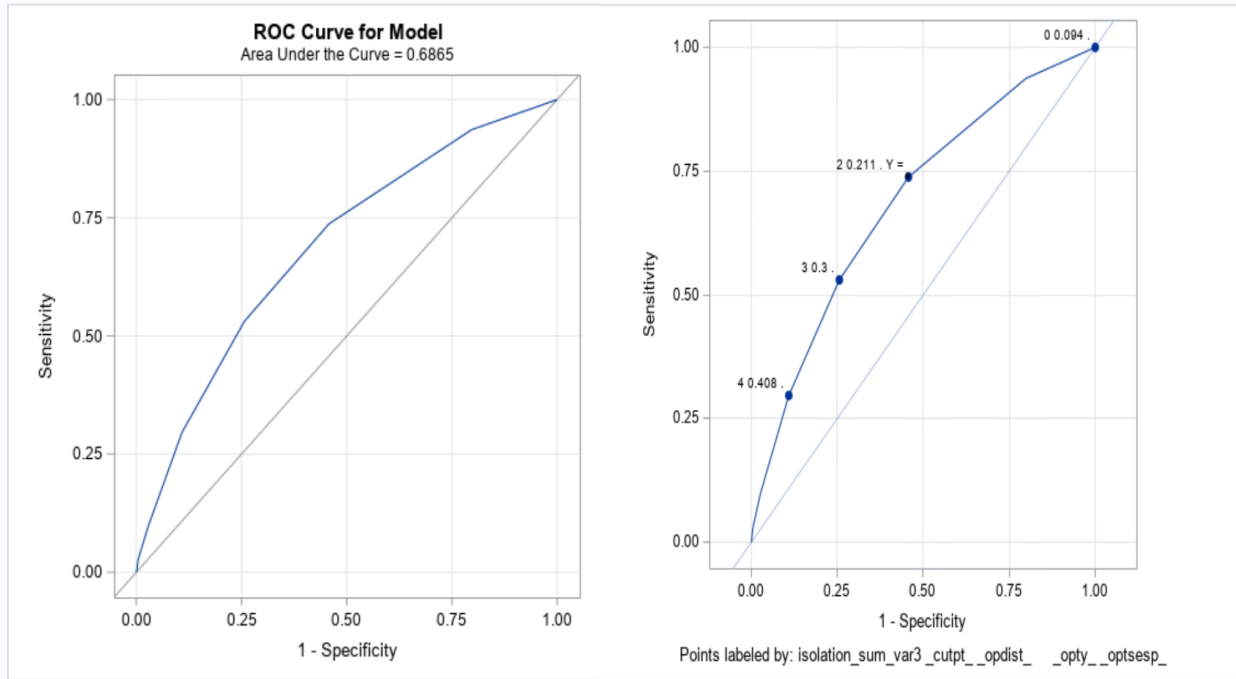


Figure 1. ROC Curves for Social Isolation Scale Modeled Against Loneliness in Comparison Sample at T1 (n= 26,492)

Table 2. Optimal scale cutpoints based on social isolation scale modeled against loneliness in comparison sample at T1 (n=26,492)			
Criterion	Cutpoint	Label	Value
Dist to 0,1	0.21129	2 0.211 . Y =	0.52782
Sens-Spec	0.21129	2 0.211 . Y =	0.19462
Youden	0.21129	2 0.211 . Y =	0.27937

Needs Assessment Framework

The Quality Improvement and Innovation Partnership's Needs Assessment Resource Guide (2009) was consulted as a framework to ensure that this thesis serves as an effective assessment of needs pertaining to loneliness in the older adult Ontario home care population. The

framework outlines six steps that entail defining the scope of the assessment, the stakeholders and information sources, identifying needs, identifying opportunities to address needs, developing recommendations, and implementing recommendations and monitoring their impact (Quality Improvement and Innovation Partnership, 2009). The scope of the assessment and information sources were defined through the development of the thesis proposal. The analyses, results, and discussion identified at-risk subgroups to aid in service use planning and the development of future interRAI home care-based interventions. The involvement of stakeholders and the final step of implementing recommendations and monitoring their impact is beyond the scope of this thesis.

Analysis

Using the described interRAI HC dataset, secondary data analysis was conducted using SAS 9.4 to address the research questions (SAS Institute, 2013). The research questions were explored through three main analytical objectives, 1. Assessing clinical patterns in individuals experiencing loneliness prior to and during the COVID-19 pandemic, 2. Determining predictors of loneliness and the onset of loneliness over time prior to and during the COVID-19 pandemic and 3. Determining how the COVID-19 pandemic modified rates of loneliness, onset loneliness, and predictors.

Univariate and Bivariate Analyses

The dataset was separated to perform analyses for the comparison and COVID samples independently. For each sample, cross-sectional univariate descriptive statistics were generated to describe the respective populations and understand the distribution of loneliness and associated demographic variables at the beginning of the study period (T1). Univariate frequency

distributions were computed to demonstrate the population distribution of age group, sex, living arrangement, marital status, disease diagnoses, loneliness, and social isolation.

Subsequently, bivariate analyses were computed for both samples to understand how the dataset is distributed and the basic relationships between loneliness and the selected independent variables. Chi-square statistics, crude odds ratios (COR), and associated p-values were generated, showing the magnitude and direction of associations between variables and their statistical significance. The same criteria used for developing the social isolation scale were used for the remainder of the analysis; chi-square values with a p-value of less than or equal to 0.05 and odds ratios with a 95% confidence interval that did not include 1 were deemed significant. Variables that showed significant chi-square associations and COR estimates that were less than 0.83 or greater than 1.2 were thought to have an effect size large enough to have a meaningful impact within a multivariate relationship and were considered candidate loneliness predictors to be included in the logistic regression models outlined below.

Multivariate Analyses: Logistic Regression

Logistic regression is a statistical analysis technique used to measure the association between outcome and independent variables, testing the main effects of the independent variables on the outcome of interest and interaction effects between independent variables (Kleinbaum et al., 2013). Four binary logistic regression models were developed with loneliness as the outcome variable, exploring cross-sectional and longitudinal predictors of loneliness in both the comparison and COVID samples. Two additional models were developed to test the main effect and interaction effects of the COVID-19 pandemic.

Model Selection

Model 1 (Table 9) determines which independent variables were cross-sectionally predictive of loneliness in the comparison sample at T1. Variables deemed significant through bivariate analyses with a COR on the outside bounds of 0.83 and 1.20 were grouped into a logistic regression model as independent variables with loneliness at T1 as a binary outcome variable. Variables that did not meet fall within this COR criteria but had robust theoretical backing were included. Stepwise selection was then used to develop a candidate logistic regression model that could be used to predict loneliness. Stepwise selection is an automated model selection technique that retains independent variables in a final model based on if they maintain a defined significance level at the multivariate level (Kleinbaum et al., 2013; Stoltzfus, 2011). Variables that are excluded can be later reintroduced into the model, an advantage against alternative automated model selection techniques such as forward and backward selection (Kleinbaum et al., 2013; Stoltzfus, 2011). An inherent limitation of stepwise selection, however, is variables are assessed with the influence of random chance factors and without theoretical logic which may exclude otherwise meaningful variables (Stoltzfus, 2011). To circumvent this limitation, additional variables that were excluded from the model but known to be associated with loneliness (i.e., sex) were manually forced into the model and included in the final model if they attained a significance level of $p < 0.05$. Collinearity among variables and the model's c-statistic were considered when adding additional variables. Sex interactions among variables and interaction terms achieving the same significance level of $p < 0.05$ remained in the model.

Models 1 and 2 (Table 10) were matched identically to allow for a comparison of the factors that influenced loneliness at T1 in the comparison and COVID samples. Before finalizing model 1, all selected variables were tested in the COVID sample for significance. Any variables

that were not significant in the COVID sample or predictive longitudinally were dropped from model 1. Model 2 was built by fitting model 1 to the COVID sample to determine which independent variables remained significant for the COVID sample at T1. When fitted to the COVID sample, the CPS scale and being fearful of their caregiver lost significance. Models 1 and 2 were then tested to see if these variables remained significant longitudinally (refer below for further detail on longitudinal models). The CPS scale remained significant longitudinally, though being fearful of one's caregiver did not and was ultimately dropped from both models 1 and 2 to maintain consistency.

Model 3 (Table 11) is a main effects model derived from model 1 to determine what factors were predictive of a transition in loneliness in the comparison sample. Specifically, if an individual was not lonely at T1, what factors contributed to them becoming lonely at T2. The dependent variable was set to lonely at T2 when loneliness was not present at T1. Variables that lost significance were removed from the model and additional variables that were thought to have a potential impact on loneliness longitudinally, based on the literature and bivariate analyses, were forced into the model. These were tested for significance, again considering collinearity and testing for interactions. Similarly, **Model 4** (Table 12) was derived from model 3, to determine which factors were predictive of the same transition in loneliness but in the COVID sample. Any variables that lost significance when fitted to the COVID sample were removed from the model. Again, additional variables were forced into the model and tested for significance while adjusting for collinearity and testing for interactions.

Model 5 (Table 13) was created to determine what was predictive of the same transition in loneliness (not lonely to lonely) in the entire study sample (comparison and COVID). All significant variables and interactions from models 3 and 4 were included as independent

variables and then tested for significance in the combined sample. The significant variables from these models were combined to ensure that variables of significance were captured from both time periods, also providing a basis of which variables might interact with the “COVID” variable signifying existence during the first wave of the pandemic to be tested in the final model. Any variables that became insignificant in the combined sample were removed. Once the final model was determined, the “COVID” variable was added to the model to test the main effect of COVID on loneliness. *Model 6* (Table 14) is the same as model 5, simply with the addition of interaction terms to test both the main and interaction effects of the pandemic. All plausible variables were tested for an interaction with the COVID variable, starting with those whose significance was discordant between models 3 and 4.

Results

Sample Characteristics

Upon applying exclusion criteria, the overall population sample size was $n=43,619$. The comparison sample size was $n=25,293$ and the COVID sample size was $n=18,326$. Among the comparison sample, 62.6% of respondents were female and 37.4% were male. This is comparable to the COVID sample where 62.2% were female and 37.8% were male at T1. The average age of the comparison and COVID samples was 79 though most respondents fell within the 85+ age category. Within the comparison sample, an equal percentage of individuals were married or widowed (40.7%), while 40.5% and 39.7% of individuals in the COVID sample were married or widowed, respectively. The remainder of individuals were single (i.e., never married, separated or divorced), at 18.7% and 19.8% in the comparison and COVID samples, respectively. Most individuals in both samples lived with a family member and in urban settings

with only 12.9% in the comparison sample and 14.3% in the COVID sample living in a rural setting. Coronary heart disease, diabetes, and depression were the most common disease diagnoses at 30.5%, 32.3%, and 24.9% in the comparison sample, respectively. The corresponding values were 32.6%, 32.4%, and 25.4% in the COVID sample, respectively. 23.4% of the comparison sample and 22.3% of the COVID sample had a score of 3+ on the DRS.

As demonstrated in **Figure 2**, loneliness rates were comparable across both samples at T1 and T2. About a quarter of both sample populations reported feeling lonely at 22.5% in the comparison sample and 23.9% in the COVID sample and 52.7% of individuals within the comparison sample and 52.9% in the COVID sample experienced social isolation at T1. 69.6% and 69.4% of lonely individuals were female in the comparison and COVID samples, respectively, at T1. Additionally, the transition rate in which an individual became lonely at T2 when not lonely at T1 was 6.7% in the comparison sample and 7.6% in the COVID sample.

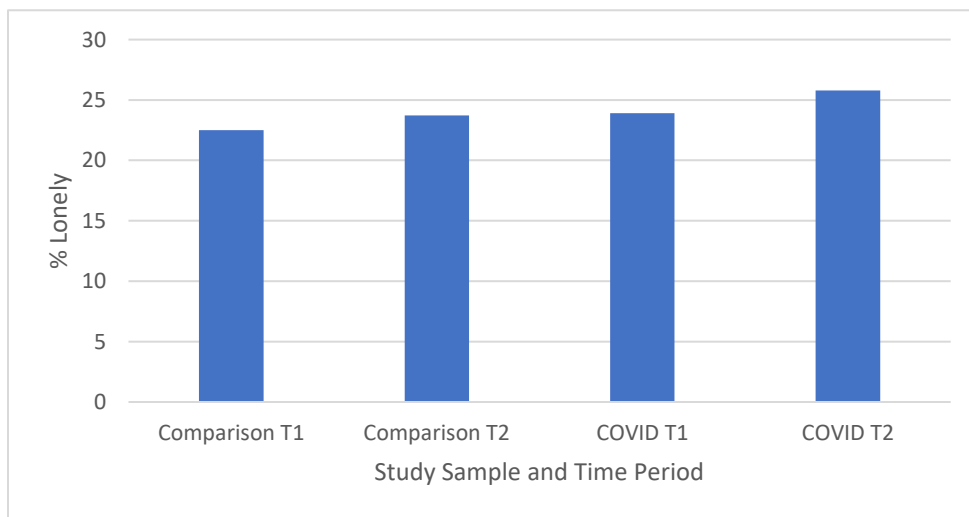


Figure 2. Loneliness Rates at T1 and T2 in Comparison Sample (n= 25,293) and COVID Sample (n= 18,326)

Bivariate Analyses

Bivariate analyses for the relationship between loneliness and demographic, environmental, clinical, physical, and psychological variables are presented below. Relevant variables selected based on the literature were grouped together. Each table displays the percent frequency and the number of individuals in which each independent variable presents among those who are lonely. The COR and 95% confidence interval (CI) are also presented, along with the c-statistic for the relationship between each independent variable.

Variables	Level	Comparison Sample			COVID Sample		
		% (n)	COR (95% CI)	C	% (n)	COR (95% CI)	C
<i>Age group</i>	16 – 44	2.1 (118)	1.17 (0.94 – 1.44)	0.53	1.9 (85)	0.94 (0.74 – 1.20)	0.53
	45 – 64	13.9 (790)	1.59 (1.44 – 1.75)***		14.3 (625)	1.46 (1.31 – 1.62)***	
	65 – 74	17.0 (968)	1.15 (1.06 – 1.26)**		16.5 (722)	1.07 (0.97 – 1.18)	
	75 – 84	31.0 (1,761)	1.03 (0.96 – 1.11)		31.8 (1,392)	1.08 (0.99 – 1.17)	
	85+	36.1 (2,053)	Reference		35.5 (1,555)	Reference	
<i>Female</i>	No	30.4 (1,730)	Reference	0.55	30.6 (1,339)	Reference	0.55
	Yes	69.6 (3,960)	1.49 (1.40 – 1.59)***		69.4 (3,040)	1.52 (1.41 – 1.63)***	
<i>Marital status</i>	Married	25.1 (1,430)	Reference	0.61	25.0 (1,096)	Reference	0.61
	Single [†]	24.7 (1,403)	2.62 (2.41 – 2.85)***		25.7 (1,127)	2.60 (2.36 – 2.86)***	
	Widowed	50.2 (2,857)	2.38 (2.22 – 2.56)***		49.2 (2,156)	2.44 (2.25 – 2.64)***	
<i>Living Arrangement</i>	Lives alone	54.2 (3,086)	Reference	0.62	54.4 (2,383)	Reference	0.62
	Lives with family member(s)	42.7 (2,429)	0.37 (0.35 – 0.39)***		42.3 (1,853)	0.37 (0.34 – 0.39)***	
	Lives with others	3.1 (175)	0.68 (0.57 – 0.81)***		3.3 (143)	0.57 (0.47 – 0.69)***	
<i>Alzheimer's Disease</i>	No	95.7 (5,447)	Reference	0.51	96.7 (4,229)	Reference	0.51
	Yes	4.3 (243)	0.75 (0.65 – 0.87)***		3.4 (150)	0.62 (0.52 – 0.74)***	
<i>Other Dementia</i>	No	80.5 (4,582)	Reference	0.52	81.2 (3,555)	Reference	0.52
	Yes	19.5 (1,108)	0.83 (0.77 – 0.90)***		18.8 (824)	0.82 (0.75 – 0.90)***	
<i>COPD</i>	No	82.8 (4,711)	Reference	0.51	82.3 (3,604)	Reference	0.51
	Yes	17.2 (979)	1.24 (1.15 – 1.34)***		17.7 (775)	1.20 (1.10 – 1.31)***	

<i>Hemiplegia</i>	No	96.7 (5,504)	<i>Reference</i>	0.50	96.4 (4,222)	<i>Reference</i>	0.50
	Yes	3.3 (186)	0.81 (0.69 – 0.95)*		3.6 (157)	0.87 (0.73 – 1.04)	
<i>Depression</i>	No	63.3 (3,601)	<i>Reference</i>	0.58	62.9 (2,754)	<i>Reference</i>	0.58
	Yes	36.7 (2,089)	2.13 (1.99 – 2.27)***		37.1 (1,625)	2.13 (1.98 – 2.30)***	
<i>Anxiety</i>	No	74.3 (4,229)	<i>Reference</i>	0.56	73.7 (3,228)	<i>Reference</i>	0.56
	Yes	25.7 (1,461)	2.00 (1.86 – 2.14)***		26.3 (1,151)	1.99 (1.83 – 2.16)***	
<i>Bipolar Disorder</i>	No	97.2 (5,533)	<i>Reference</i>	0.51	97.5 (4,268)	<i>Reference</i>	0.50
	Yes	2.8 (157)	1.80 (1.48 – 2.18)***		2.5 (111)	1.38 (1.10 – 1.72)**	
<i>Rural dwelling</i>	No	86.0 (4,891)	<i>Reference</i>	0.51	86.1 (3,771)	<i>Reference</i>	0.50
	Yes	14.0 (799)	1.13 (1.04 – 1.24)**		13.9 (608)	0.96 (0.87 – 1.05)	
<i>Any home hazards</i>	No	75.1 (4,272)	<i>Reference</i>	0.53	72.3 (3,164)	<i>Reference</i>	0.53
	Yes	24.9 (1,418)	1.36 (1.27 – 1.46)***		27.8 (1,215)	1.34 (1.24 – 1.45)***	
<i>Resource accessibility</i>	No	90.2 (5,130)	<i>Reference</i>	0.51	93.5 (4,096)	<i>Reference</i>	0.51
	Yes	9.8 (560)	0.79 (0.72 – 0.87)***		6.5 (283)	0.80 (0.70 – 0.92)**	
<i>Financial trade-offs[‡]</i>	No	94.8 (5,396)	<i>Reference</i>	0.51	94.4 (4,135)	<i>Reference</i>	0.52
	Yes	5.2 (294)	2.23 (1.92 – 2.59)***		5.6 (244)	2.49 (2.10 – 2.95)***	

Note. % = percentage of individuals with self-reported loneliness. COR = crude odds ratio; CI = confidence interval. *p < .05, **p < .01, ***p < .0001, † Single includes never married, separated, or divorced, ‡Within last 30 days.

Table 3 displays the COR's for demographic and environmental independent variables with loneliness as the outcome variable for both the comparison and COVID samples. In the comparison sample, when compared to individuals in the 85+ age group, being in the 45-64 age group (COR=1.59, 95% CI: 1.44 – 1.75) and 65-84 age group (COR=1.15, 95% CI: 1.06 – 1.26) showed greater odds of loneliness. Females had greater odds of loneliness than males (COR=1.49, 95% CI: 1.40 – 1.59) and being single (i.e., never married, separated or divorced) (COR=2.62, 95% CI: 1.40 – 1.59) or widowed (COR=2.38, 95% CI: 2.22 – 2.56) showed greater odds of loneliness when compared to individuals who are married or in partnerships. When compared to living alone, living with family members or other individuals was protective against loneliness. Comparable associations were present in the COVID sample, with the only difference being the 65-84 age group losing significance. Disease diagnoses found to have significant

associations with loneliness included Alzheimer’s disease, other dementias, COPD, depression, anxiety, and bipolar disorder, increasing the odds in both samples. For both samples, living in a rural dwelling had an insignificant association with loneliness, though external and home environments had a considerable association. Exposure to any of the following home hazards: home disrepair, squalid conditions, inadequate heating/cooling, lack of safety, and limited accessibility, increased the odds of loneliness, while accessibility to the following external resources including grocery stores, grocery delivery services, and emergency services was protective. Having to make financial trade-offs within the last 30 days had the strongest association with loneliness, increasing the odds of loneliness in both samples (Comparison sample: COR=2.23, 95% CI: 1.92 – 2.59; Covid sample: COR=2.49, 95% CI: 2.10 – 2.95).

Table 4. Clinical and physical variables by loneliness among Ontario home care clients, T1 comparison sample (n=25,293) 2019, and T1 COVID sample (n= 18,326) 2020							
Variable	Level	Comparison Sample			COVID Sample		
		% (n)	COR (95% CI)	C	% (n)	COR (95% CI)	C
<i>Poor self-rated health</i>	No	71.3 (4,057)	Reference	0.56	72.2 (3,163)	Reference	0.56
	Yes	28.7 (1,633)	1.94 (1.81 – 2.08)***		27.8 (1,216)	2.04 (1.88 – 2.21)***	
<i>Difficulty clearing airway</i>	No	90.9 (5,173)	Reference	0.51	90.6 (3,968)	Reference	0.51
	Yes	9.1 (517)	1.28 (1.15 – 1.42)***		9.4 (411)	1.22 (1.08 – 1.37)**	
<i>Chest pain</i>	No	86.8 (4,938)	Reference	0.53	85.4 (3,739)	Reference	0.53
	Yes	13.2 (752)	1.87 (1.70 – 2.05)***		14.6 (640)	2.03 (1.83 – 2.25)***	
<i>Dizziness</i>	No	49.9 (2,837)	Reference	0.57	46.8 (2,051)	Reference	0.57
	Yes	50.1 (2,853)	1.72 (1.62 – 1.82)***		53.2 (2,328)	1.82 (1.70 – 1.95)***	
<i>Dyspnea</i>	No	44.8 (2,550)	Reference	0.55	39.8 (1,744)	Reference	0.55
	Yes	55.2 (3,140)	1.48 (1.39 – 1.57)***		60.2 (2,635)	1.54 (1.44 – 1.65)***	
<i>Peripheral edema</i>	No	52.4 (2,983)	Reference	0.53	51.3 (2,246)	Reference	0.53
	Yes	47.6 (2,707)	1.29 (1.21 – 1.37)***		48.7 (2,133)	1.25 (1.17 – 1.34)***	
<i>Other skin conditions[†]</i>	No	68.8 (3,916)	Reference	0.53	64.6 (2,828)	Reference	0.53
	Yes	31.2 (1,774)	1.38 (1.29 – 1.47)***		35.4 (1,551)	1.29 (1.20 – 1.39)***	
<i>Sleep disturbance</i>	No	50.8 (2,889)	Reference	0.58	44.7 (1,956)	Reference	0.59
	Yes	49.2 (2,801)	1.93 (1.82 – 2.05)***		55.3 (2,423)	2.05 (1.91 – 2.19)***	
	No	50.0 (2,846)	Reference	0.55	45.1 (1,974)	Reference	0.55

<i>Fatigue</i>	Yes	50.0 (2,844)	1.48 (1.40 – 1.57)***		54.9 (2,405)	1.51 (1.41 – 1.62)***	
<i>Visual disturbance</i>	No	51.6 (2,938)	Reference	0.53	51.0 (2,232)	Reference	0.53
	Yes	48.4 (2,752)	1.26 (1.19 – 1.34)***		49.0 (2,147)	1.29 (1.21 – 1.38)***	
<i>Difficulty with balance</i>	No	34.9 (1,985)	Reference	0.52	30.9 (1,351)	Reference	0.53
	Yes	65.1 (3,705)	1.21 (1.14 – 1.28)***		69.2 (3,028)	1.28 (1.19 – 1.38)***	
<i>Unsteady gait</i>	No	15.7 (894)	Reference	0.53	13.7 (599)	Reference	0.53
	Yes	84.3 (4,796)	1.41 (1.31 – 1.53)***		86.3 (3,780)	1.55 (1.41 – 1.71)***	
<i>Foot problems</i>	No	88.2 (5,018)	Reference	0.52	86.1 (3,769)	Reference	0.52
	Yes	11.8 (672)	1.47 (1.34 – 1.62)***		13.9 (610)	1.58 (1.43 – 1.76)***	
<i>Fall within last 90 days</i>	No	51.3 (2,921)	Reference	0.53	52.1 (2,283)	Reference	0.53
	Yes	48.7 (2,769)	1.24 (1.17 – 1.32)***		47.9 (2,096)	1.26 (1.17 – 1.34)***	
<i>Hours of exercise in last 3 days</i>	0	21.9 (1,246)	Reference	0.52	24.1 (1,057)	Reference	0.53
	< 1 hour	39.8 (2,262)	0.96 (0.88 – 1.03)		41.0 (1,793)	0.88 (0.81 – 0.96)**	
	1-2 hours	27.6 (1,570)	0.84 (0.78 – 0.92)***		27.4 (1,198)	0.76 (0.69 – 0.83)***	
	3-4 hours	7.6 (434)	0.81 (0.72 – 0.92)**		5.7 (248)	0.65 (0.56 – 0.76)***	
	> 4 hours	3.1 (178)	0.95 (0.79 – 1.14)		1.9 (83)	0.67 (0.52 – 0.86)**	
<i>Alcohol use</i>	< 1 drink [‡]	89.6 (5,100)	Reference	0.51	90.3 (3,956)	Reference	0.50
	> 1 drink [‡]	10.4 (590)	1.27 (1.15 – 1.40)***		9.7 (423)	0.97 (0.87 – 1.09)	
<i>Daily tobacco use</i>	No	89.2 (5,075)	Reference	0.52	88.2 (3,863)	Reference	0.52
	Yes	10.8 (615)	1.61 (1.45 – 1.78)***		11.8 (516)	1.57 (1.40 – 1.75)***	

Note. % = percentage of individuals with self-reported loneliness. COR = crude odds ratio; CI = confidence interval. *p < .05, **p < .01, ***p < .0001. [†]Other skin conditions refer to skin conditions other than pressure ulcers, lesions, burns, and wounds. [‡] In a single sitting within last 14 days

Table 4 displays the relationship between loneliness and physical and clinical independent variables. Poor self-rated health considerably increased the odds of loneliness in the comparison (COR=1.94, 95% CI: 1.81 – 2.08) and COVID samples (COR=2.04, 95% CI: 1.88 – 2.21). In both the comparison and COVID samples, physical conditions including chest pain, dizziness, dyspnea, peripheral edema, skin conditions (excluding ulcers, lesions, burns, and wounds), difficulty clearing airways, visual disturbance, difficulty balancing, unsteady gait, foot problems, and experiencing at least one fall within the last 90 days were found to increase the

odds of loneliness significantly. The odds of loneliness increased when experiencing both sleep disturbance (Comparison sample: COR=1.93, 95% CI: 1.82 – 2.05; Covid sample: COR=2.05, 95% CI: 1.91 – 2.19) and fatigue (Comparison sample: COR=1.48, 95% CI: 1.40 – 1.57; COVID sample: COR=1.51, 95% CI: 1.41 – 1.62). In the comparison sample, having 3-4 hours of exercise within the last three days had a protective effect on loneliness (COR=0.81, 95% CI: 0.72 – 0.92); in the COVID sample, all levels of exercise greater than 0 had a significant protective effect with the greatest association seen with 3-4 hours (COR=0.65, 95% CI: 0.56 – 0.76). Having at least one drink in a single sitting within the last 14 days increased the odds of loneliness in the comparison sample (COR=1.27, 95% CI: 1.15 – 1.40) but was insignificant in the COVID sample, while daily tobacco users had greater odds of loneliness in both samples (Comparison sample: COR=1.61, 95% CI: 1.45 – 1.78; COVID sample: COR=1.57, 95% CI: 1.40 – 1.75).

Table 5. Clinical scales by loneliness among Ontario home care clients, T1 comparison sample (n=25,293) 2019, and T1 COVID sample (n=18,326) 2020

Variable	Level	Comparison Sample			COVID Sample		
		% (n)	COR (95% CI)	C	% (n)	COR (95% CI)	C
<i>Cognitive Performance Scale</i>	0	12.4 (708)	Reference	0.53	10.3 (450)	Reference	0.53
	1-2	77.1 (4,385)	1.22 (1.11 – 1.33)***		78.2 (3,422)	1.41 (1.26 – 1.57)***	
	3	10.5 (597)	0.79 (0.70 – 0.89)**		11.6 (507)	1.00 (0.87 – 1.15)	
<i>ADL Hierarchy</i>	0	36.8 (2,092)	Reference	0.54	34.5 (1,509)	Reference	0.52
	1-2	33.8 (1,922)	0.72 (0.67 – 0.78)***		36.7 (1,609)	0.84 (0.78 – 0.91)***	
	3+	29.5 (1,676)	0.73 (0.68 – 0.79)***		28.8 (1,261)	0.82 (0.75 – 0.89)***	
<i>Pain Scale</i>	0	19.5 (1,107)	Reference	0.57	16.8 (735)	Reference	0.58
	1-2	55.6 (3,164)	1.51 (1.40 – 1.63)***		56.8 (2,488)	1.62 (1.48 – 1.78)***	
	3+	24.9 (1,419)	2.37 (2.17 – 2.60)***		26.4 (1,156)	2.70 (2.42 – 3.00)***	
<i>CHESS Scale</i>	0	12.2 (692)	Reference	0.56	10.0 (438)	Reference	0.57
	1-2	55.1 (3,136)	1.52 (1.39 – 1.66)***		54.6 (2,389)	1.60 (1.43 – 1.79)***	
	3+	32.7 (1,862)	2.16 (1.96 – 2.38)***		35.4 (1,552)	2.36 (2.10 – 2.66)***	
	0	29.3 (1,665)	Reference	0.53	27.6 (1,207)	Reference	0.54

<i>Deaf-Blind Severity Index</i>	1-2	40.0 (2,273)	1.14 (1.06 – 1.22)**		40.8 (1,787)	1.20 (1.10 – 1.30)***	
	3+	30.8 (1,752)	1.30 (1.21 – 1.41)***		31.6 (1,385)	1.41 (1.29 – 1.54)***	
<i>Communication Scale</i>	0	40.6 (2,312)	Reference	0.52	40.5 (1,773)	Reference	0.52
	1	18.4 (1,046)	1.13 (1.04 – 1.23)**		19.5 (852)	1.14 (1.03 – 1.25)**	
	2	25.7 (1,461)	1.01 (0.94 – 1.09)		25.5 (1,116)	1.07 (0.98 – 1.17)	
	3	7.7 (438)	1.02 (0.91 – 1.15)		7.7 (338)	1.00 (0.88 – 1.15)	
	4+	7.6 (433)	0.87 (0.78 – 0.98)*		6.9 (300)	0.83 (0.71 – 0.95)**	
<i>Depression Rating Scale</i>	0	27.6 (1,572)	Reference	0.67	26.8 (1,174)	Reference	0.67
	1-2	30.9 (1,758)	2.30 (2.13 – 2.48)***		32.8 (1,434)	2.45 (2.25 – 2.67)***	
	3+	41.5 (2,360)	4.56 (4.23 – 4.91)***		40.4 (1,771)	5.07 (4.65 – 5.53)***	
<i>Social Isolation Scale</i>	0	6.2 (350)	Reference	0.69	6.6 (288)	Reference	0.68
	1	19.7 (1,121)	1.91 (1.69 – 2.17)***		20.0 (875)	1.92 (1.67 – 2.21)***	
	2	20.5 (1,166)	3.33 (2.93 – 3.78)***		19.2 (841)	3.10 (2.69 – 3.58)***	
	3	23.7 (1,347)	5.03 (4.43 – 5.71)***		23.2 (1,016)	4.71 (4.09 – 5.43)***	
	4	20.2 (1,148)	7.96 (6.96 – 9.09)***		21.2 (928)	7.97 (6.87 – 9.25)***	
	5	7.1 (402)	9.51 (8.01 – 11.29)***		7.1 (312)	9.39 (7.72 – 11.43)***	
	6	2.7 (156)	19.88 (14.97 – 26.38)***		2.7 (119)	15.74 (11.52 – 21.51)***	
<i>Note.</i> % = percentage of individuals with self-reported loneliness. COR = crude odds ratio; CI = confidence interval. *p < .05, **p < .01, ***p < .0001							

Table 5 reports the associations of interRAI scale scores with loneliness. Cognition has a curvilinear relationship with loneliness. A CPS score of 1-2 increased the odds of loneliness in both samples though an increased score of 3 had a protective effect in the comparison sample (COR=0.79, 95% CI: 0.70 – 0.89) and was insignificant in the COVID sample. There was little variation between both levels of the ADLH, showing lower odds of loneliness with any level of ADL impairment in both samples, while the CHES scale demonstrated an increase in odds with greater health instability. The pain scale showed that the odds of loneliness increased with pain level, with the greatest odds experienced with a score of 3+ (Comparison sample: COR=2.37,

95% CI: 2.17 – 2.60; COVID sample: COR=2.70, 95% CI: 2.42 – 3.00). Auditory and visual impairment was significant for both samples at all levels, though it did not fall within the cut-off range for the comparison sample when mild at levels 1-2. Similarly, a score of 1 on the communication scale showed a slight increase in the odds of loneliness for both samples but did not fall within the cut-off range. A score of 4 had a protective effect in the COVID sample (COR=0.83, 95% CI: 0.71 – 0.95) but had a negligible effect in the comparison sample. The DRS and SIS showed the strongest associations with loneliness. Depressive symptoms were significant at all levels for both samples, with the strongest association seen at level 3+ (Comparison sample: COR=4.56, 95% CI: 4.23 – 4.91; COVID sample: COR=5.07, 95% CI: 4.65 – 5.53). Similarly, all levels of the SIS were significant, increasing substantially as the score increased, with the greatest odds of loneliness being at level 6 (Comparison sample: COR=19.88, 95% CI: 14.97 – 26.38; COVID sample: COR=15.74, 95% CI: 11.52 – 21.51).

Table 6. Mental health variables by loneliness among Ontario home care clients, T1 comparison sample (n=25,293) 2019, and T1 COVID sample (n=18,326) 2020							
Variable	Level	Comparison Sample			COVID Sample		
		% (n)	COR (95% CI)	C	% (n)	COR (95% CI)	C
<i>Anhedonia</i>	No	83.6 (4,756)	Reference	0.56	85.6 (3,750)	Reference	0.55
	Yes	16.4 (934)	3.70 (3.36 – 4.06)***		14.4 (629)	3.33 (2.97 – 3.73)***	
<i>Abnormal thought process</i>	No	95.5 (5,437)	Reference	0.51	96.0 (4,202)	Reference	0.50
	Yes	4.5 (253)	1.41 (1.22 – 1.64)***		4.0 (177)	1.28 (1.08 – 1.53)**	
<i>Recurrent statements of fear</i>	No	93.8 (5,338)	Reference	0.52	94.7 (4,147)	Reference	0.52
	Yes	6.2 (352)	3.30 (2.85 – 3.83)***		5.3 (232)	3.10 (2.59 – 3.72)***	
<i>Feels anxious/restless/uneasy</i> [†]	No	58.3 (3,316)	Reference	0.59	55.9 (2,448)	Reference	0.59
	Yes	41.7 (2,374)	2.32 (2.18 – 2.47)***		44.1 (1,931)	2.33 (2.17 – 2.50)***	
<i>Feels sad/depressed/hopeless</i> [†]	No	41.9 (2,386)	Reference	0.65	39.8 (1,744)	Reference	0.66
	Yes	58.1 (3,304)	3.65 (3.43 – 3.88)***		60.2 (2,635)	3.74 (3.48 – 4.01)***	
<i>Reduced pleasure</i> [†]	No	72.1 (4,100)	Reference	0.56	73.4 (3,216)	Reference	0.56
	Yes	27.9 (1,590)	2.14 (2.00 – 2.30)***		26.6 (1,163)	2.15 (1.98 – 2.34)***	
	No	75.0 (4,266)	Reference	0.54	71.9 (3,148)	Reference	0.55

<i>Major life stressors</i> [‡]	Yes	25.0 (1,424)	1.69 (1.57 – 1.81)***		28.1 (1,231)	1.72 (1.59 – 1.86)***	
<i>Note.</i> % = percentage of individuals with self-reported loneliness. COR = crude odds ratio; CI = confidence interval. *p < .05, **p < .01, ***p < .0001, [†] Within last 30 days, [‡] Within last 90 days.							

Table 6 displays the associations of mental health variables with loneliness, all of which had significant CORs for both samples. Experiencing major life stressors within the last 90 days, anhedonia, abnormal thought processes, recurrent statements of fear, and self-reported mood of feeling anxious, sad, and a reduced pleasure in life were all found to increase the odds of loneliness in both samples. Anhedonia and self-reportedly feeling sad, depressed, or hopeless showed the strongest associations with loneliness for the comparison (Anhedonia: COR=3.70, 95% CI: 3.36 – 4.06; Feels sad: COR=3.65, 95% CI: 3.43 – 3.88) and COVID sample (Anhedonia: COR=3.33, 95% CI: 2.97 – 3.73; Feels sad: COR=3.74, 95% CI: 3.48 – 4.01).

Variable	Level	Comparison Sample			COVID Sample		
		% (n)	COR (95% CI)	C	% (n)	COR (95% CI)	C
<i>Reduced social interactions</i>	No	66.4 (3,776)	Reference	0.58	67.9 (2,973)	Reference	0.58
	Yes	33.6 (1,914)	2.40 (2.25 – 2.56)***		32.1 (1,406)	2.44 (2.25 – 2.63)***	
<i>Social activity participation</i>	< 30 days	51.6 (2,937)	Reference	0.54	52.6 (2,305)	Reference	0.54
	> 30 days	48.4 (2,753)	1.39 (1.31 – 1.47)***		47.4 (2,074)	1.37 (1.28 – 1.46)***	
<i>Social visit from family or friend</i>	< 30 days	85.3 (4,853)	Reference	0.52	88.7 (3,882)	Reference	0.51
	> 30 days	14.7 (837)	1.31 (1.20 – 1.42)***		11.4 (497)	1.38 (1.24 – 1.55)***	
<i>Withdrawal from social activities</i>	No	75.9 (4,318)	Reference	0.56	76.8 (3,363)	Reference	0.56
	Yes	24.1 (1,372)	2.33 (2.16 – 2.51)***		23.2 (1,016)	2.38 (2.18 – 2.59)***	
<i>Conflict with family or friends</i> [†]	No	83.2 (4,733)	Reference	0.52	84.7 (3,709)	Reference	0.52
	Yes	16.8 (957)	1.44 (1.33 – 1.56)***		15.3 (670)	1.36 (1.23 – 1.49)***	
<i>Fearful of family or acquaintance</i> [†]	No	95.4 (5,426)	Reference	0.51	95.9 (4,199)	Reference	0.51
	Yes	4.6 (264)	1.57 (1.36 – 1.83)***		4.1 (180)	1.35 (1.13 – 1.61)**	
	No	95.4 (5,427)	Reference	0.51	95.5 (4,182)	Reference	0.51

<i>Neglected/ abused/ mistreated</i> [†]	Yes	4.6 (263)	1.56 (1.35 – 1.81)***		4.5 (197)	1.37 (1.16 – 1.63)**	
<i>Note.</i> % = percentage of individuals with self-reported loneliness. COR = crude odds ratio; CI = confidence interval. *p < .05, **p < .01, ***p < .0001, [†] Within last 30 days.							

Table 7 reports the associations of independent variables related to social relationships and interaction with loneliness. Individuals that did not participate in social activities of long-standing interest or a visit with family or friends within the last 30 days had greater odds of loneliness. Reduced social interactions and withdrawal from social activities also increased the odds of loneliness in the comparison (Reduced interaction: COR=2.40, 95% CI: 2.25 – 2.56; Social withdrawal: COR=2.33, 95% CI: 2.16 – 2.51) and COVID samples (Reduced interaction: COR=2.44, 95% CI: 2.25 – 2.63; Social withdrawal: COR=2.38, 95% CI: 2.18 – 2.59). Having a conflict with family or friends, being fearful of a family member or close acquaintance or neglected, abused, or mistreated, increased the odds of loneliness, though the comparison sample had a greater effect size for all three independent variables.

Table 8. Informal and formal care variables by loneliness among Ontario home care clients, T1 comparison sample (n=25,293) 2019, and T1 COVID sample (n=18,326) 2020

Variable	Level	Comparison Sample			COVID Sample		
		% (n)	COR (95% CI)	C	% (n)	COR (95% CI)	C
<i>Informal helper relationship (1)</i>	No helper	7.5 (429)	<i>Reference</i>	0.61	7.6 (331)	<i>Reference</i>	0.62
	Child	55.5 (3,155)	0.49 (0.43 – 0.56)***		54.2 (2,375)	0.49 (0.42 – 0.57)***	
	Spouse/ Partner	17.7 (1,009)	0.20 (0.17 – 0.23)***		18.2 (795)	0.20 (0.17 – 0.23)***	
	Family member	11.0 (627)	0.47 (0.41 – 0.55)***		11.6 (507)	0.45 (0.38 – 0.53)***	
	Not family	8.3 (470)	0.72 (0.61 – 0.85)**		8.5 (371)	0.68 (0.56 – 0.82)***	
<i>Informal helper relationship (2)</i>	No helper	41.1 (2,341)	<i>Reference</i>	0.54	41.5 (1,815)	<i>Reference</i>	0.54
	Child	43.2 (2,457)	0.74 (0.70 – 0.79)***		43.1 (1,885)	0.74 (0.69 – 0.79)***	
	Spouse/ Partner	1.1 (61)	0.50 (0.38 – 0.66)***		1.0 (43)	0.51 (0.36 – 0.70)***	
	Family member	9.0 (514)	0.85 (0.76 – 0.95)**		9.1 (399)	0.75 (0.66 – 0.85)***	

	Not family	5.6 (317)	1.17 (1.01 – 1.34)*		5.4 (237)	1.03 (0.88 – 1.20)	
<i>Live-in caregiver</i>	No	59.1 (3,364)	<i>Reference</i>	0.61	60.7 (2,660)	<i>Reference</i>	0.62
	Yes	40.9 (2,326)	0.40 (0.38 – 0.42)***		39.3 (1,719)	0.38 (0.35 – 0.41)***	
<i>Family/friends overwhelmed</i>	No	59.0 (3,356)	<i>Reference</i>	0.53	52.6 (2,305)	<i>Reference</i>	0.54
	Yes	41.0 (2,334)	1.29 (1.22 – 1.38)***		47.4 (2,074)	1.33 (1.24 – 1.42)***	
<i>Homemaking services (days/week)</i>	None	71.1 (4,047)	<i>Reference</i>	0.52	67.8 (2,968)	<i>Reference</i>	0.52
	1-3	22.9 (1,202)	1.25 (1.16 – 1.34)***		26.1 (1,144)	1.29 (1.16 – 1.40)***	
	4-7	6.0 (340)	1.07 (0.94 – 1.22)		6.1 (267)	1.08 (0.94 – 1.25)	
<i>Meal service (days/week)</i>	None	87.9 (4,999)	<i>Reference</i>	0.51	87.5 (3,832)	<i>Reference</i>	0.51
	1-3	3.6 (202)	1.58 (1.33 – 1.87)***		3.5 (152)	1.28 (1.06 – 1.55)*	
	4-7	8.6 (489)	1.07 (0.96 – 1.19)		9.0 (395)	1.20 (1.06 – 1.36)**	
<i>Less than 9 hours of informal care (last 3 days)</i>	No	35.8 (2,039)	<i>Reference</i>	0.57	36.1 (1,582)	<i>Reference</i>	0.57
	Yes	64.2 (3,651)	1.80 (1.70 – 1.92)***		63.9 (2,797)	1.70 (1.59 – 1.83)***	
<i>Medication adherence</i>	Adherent / N/A	81.3 (4,625)	<i>Reference</i>	0.54	80.6 (3,530)	<i>Reference</i>	0.54
	80% or less	18.7 (1,065)	1.94 (1.79 – 2.10)***		19.4 (849)	1.95 (1.77 – 2.13)***	
<i>Note.</i> % = percentage of individuals with self-reported loneliness. COR = crude odds ratio; CI = confidence interval. *p < .05, **p < .01, ***p < .0001							

Table 8 shows the association of formal and informal care with loneliness. For both samples having a family member as a primary informal helper decreased the odds of loneliness. Having a spouse or partner as a primary informal helper was the most protective, with an equal effect size for both samples (COR=0.20, 95% CI: 0.17 – 0.23). The associations of the relationship of a secondary informal helper with loneliness followed similar trends, though to a lesser magnitude. Notably, the effect size of a secondary informal helper that was not a family member, though not in the cut-off range, changed direction, increasing the odds of loneliness in the comparison sample and was not significant in the COVID sample. Having a live-in caregiver decreased the odds of loneliness in both samples (Comparison sample: COR=0.40, 95% CI: 0.38 – 0.42; COVID sample: COR=0.38, 95% CI: 0.35 – 0.41) while family or friends being

overwhelmed by a person's illness had the opposite effect (Comparison sample: COR=1.29, 95% CI: 1.22 – 1.38; COVID sample: COR=1.33, 95% CI: 1.24 – 1.42). Of the formal care services reported in the interRAI HC, homemaking and meal services were significantly associated with loneliness. In both samples, having 1-3 days of homemaking services per week was protective (Comparison sample: COR=1.25, 95% CI: 1.16 – 1.34; COVID sample: COR=1.29, 95% CI: 1.16 – 1.40), but 4 days or more per week had an insignificant association. Receiving meal services 1-3 times per week in both samples and 4-7 times in the COVID sample increased the odds of loneliness, though only 12% of the population in both samples received meal services which should be considered. Individuals who received informal care for less than 9 hours a day within the last 3 days or were less than 80% adherent to medication had much greater odds of loneliness than their counterparts, magnitudes of which were comparable in both the comparison (Informal care: COR=1.80, 95% CI: 1.70 – 1.92; Medication adherence: COR=1.94, 95% CI: 1.79 – 2.10) and COVID sample (Informal care: COR=1.70, 95% CI: 1.59 – 1.83; Medication adherence: COR=1.95, 95% CI: 1.77 – 2.13).

Multivariate Analyses

The following section outlines the multivariate logistic regression analyses that were conducted. Six final binary logistic regression models were built to determine cross-sectional predictors of loneliness in the comparison and COVID samples, longitudinal predictors of loneliness in both samples, and the main and interaction effects of the COVID-19 pandemic on the onset of loneliness. The parameter estimates, corresponding p-values, adjusted odds ratios (AOR) and c-statistics are provided for each model. The concordance statistic or c-statistic speaks to a model's goodness of fit or ability to discriminate between outcome levels (LaValley,

2008). A c-statistic of 0.5 is considered a poor fit, and the closer it ranges to 1, the better the fit (LaValley, 2008).

Models 1 and 2 (Tables 9 and 10) display the independent variables associated with loneliness within the cross-sectional comparison and COVID samples, respectively, at T1. When comparing individuals aged 16-44 versus 85+ and 45-64 versus 85+, the odds of loneliness were 1.53 times greater for individuals aged 16-44 and 1.35 times greater for individuals aged 45-64 in the comparison sample. The remaining age groups did not have a significant AOR. For the COVID sample, only belonging to the 45-64 age category was significantly associated with loneliness, increasing the odds by 1.22 times when compared to the 85+ age group. In the comparison sample, seven out of nine examined LHIN regions had significantly different odds of loneliness when compared to Toronto Central (7). Living in the North East (13) and North West (14) regions yielded the greatest increase in odds of loneliness (1.53 and 1.43 times, respectively). In the COVID sample, four out of nine LHIN regions had a significant association with loneliness, with residing in Erie St. Clair (5) and North East (13) yielding increased odds of loneliness by 1.55 and 1.49 times when compared to Toronto Central (7).

In the comparison sample, compared to those who scored a zero on the DRS, those with scores of 1-2 and 3+ had 1.98 and 3.08 times greater odds of loneliness, respectively. In comparison, individuals with an official diagnosis of clinical depression had 1.40 times greater odds of loneliness in the comparison sample. The COVID sample showed comparable results. Individuals with a score of 1-2 and 3+ on the DRS scale had 2.08 and 3.36 times greater odds of loneliness than those who scored 0, and individuals with a depression diagnosis had 1.44 times greater odds of loneliness. The presence of anhedonia increased the odds of loneliness by 1.58 times in the comparison sample and 1.41 times in the COVID sample. Clinical variables

including dizziness, sleep disturbance, and poor self-rated health were associated with higher odds of loneliness by 1.20, 1.27, and 1.19 times, in the comparison sample, respectively and 1.25, 1.34, and 1.16 times, in the COVID sample, respectively. Individuals with a delirium CAP trigger had greater odds of loneliness by 1.18 times in the comparison sample and 1.24 times in the COVID sample. The CPS indicates that mild cognitive impairment had slightly higher odds of loneliness, with moderate cognitive impairment (level 3) having a protective effect in the comparison sample, decreasing the odds of loneliness by 0.80 times when compared to individuals who scored 0 and an had an insignificant effect in the COVID sample. ADL impairment reported through the ADL hierarchy also was associated with lower odds of loneliness comparably at both examined impairment levels for the comparison (1-2: AOR=0.75 95% CI: 0.69 – 0.82; 3+: AOR=0.74 95% CI: 0.68 – 0.81) and COVID sample (1-2: AOR=0.81 95% CI: 0.74 – 0.89; 3+: AOR=0.78 95% CI: 0.70 – 0.87). Moderate auditory and visual impairment signified by a level 2 score on the DBSI was related to higher odds of loneliness by 1.22 times in the comparison sample and 1.16 times in the COVID sample when compared to no impairment. The pain scale showed that a 3+ score had the strongest relationship with loneliness, increasing the odds of loneliness by 1.20 times when compared to no pain in the comparison sample and 1.39 times in the COVID sample. Opposite to the bivariate analyses, having a child as a primary informal helper was associated with higher odds of loneliness by 1.22 times in the comparison sample and 1.20 times in the COVID sample. Further regarding social relationships, in the comparison sample, individuals with family or close friends feeling overwhelmed by the individual's illness and reduced social interaction had 1.20 and 1.25 times greater odds of loneliness than their counterparts. In the COVID sample, the odds of loneliness were higher by

1.21 and 1.30 times for family or close friends feeling overwhelmed and reduced social interaction, respectively.

Variable	Level	PE (SE)	AOR (95% CI)	P-value
<i>Age group</i>	16 – 44	0.428 (0.128)	1.53 (1.19 – 1.97)	0.0009
	45 – 64	0.303 (0.066)	1.35 (1.19 – 1.54)	<.0001
	65 – 74	0.097 (0.055)	1.10 (0.99 – 1.23)	0.08
	75 – 84	0.040 (0.042)	1.04 (0.96 – 1.13)	0.34
	85+	-	<i>Reference</i>	-
<i>LHIN ID</i>	5	0.276 (0.111)	1.32 (1.06 – 1.64)	0.01
	6	0.335 (0.099)	1.40 (1.15 – 1.70)	0.0008
	7	-	<i>Reference</i>	-
	8	0.033 (0.079)	1.03 (0.89 – 1.21)	0.68
	9	0.269 (0.071)	1.31 (1.14 – 1.50)	0.0001
	10	0.151 (0.104)	1.16 (0.95 – 1.43)	0.14
	11	0.286 (0.077)	1.33 (1.14 – 1.55)	0.0002
	12	0.348 (0.109)	1.42 (1.14 – 1.75)	0.001
	13	0.427 (0.087)	1.53 (1.29 – 1.82)	<.0001
	14	0.357 (0.106)	1.43 (1.16 – 1.76)	0.0008
<i>Depression rating scale</i>	1-2	0.681 (0.042)	1.98 (1.82 – 2.15)	<.0001
	3+	1.125 (0.047)	3.08 (2.81 – 3.38)	<.0001
<i>Depression diagnosis</i>	Yes	0.333 (0.038)	1.40 (1.29 – 1.50)	<.0001
<i>Anhedonia</i>	Yes	0.460 (0.059)	1.58 (1.41 – 1.78)	<.0001
<i>Dizziness</i>	Yes	0.178 (0.035)	1.20 (1.12 – 1.28)	<.0001
<i>Sleep disturbance</i>	Yes	0.237 (0.035)	1.27 (1.18 – 1.36)	<.0001
<i>Poor self-rated health</i>	Yes	0.175 (0.042)	1.19 (1.10 – 1.29)	<.0001
<i>Delirium CAP trigger</i>	Yes	0.167 (0.064)	1.18 (1.04 – 1.34)	0.009
<i>Cognitive Performance Scale</i>	1	0.112 (0.063)	1.12 (0.99 – 1.27)	0.08
	2	0.130 (0.054)	1.14 (1.02 – 1.27)	0.02
	3	-0.225 (0.074)	0.80 (0.69 – 0.92)	0.002
<i>ADL Hierarchy</i>	1-2	-0.287 (0.042)	0.75 (0.69 – 0.82)	<.0001
	3+	-0.304 (0.045)	0.74 (0.68 – 0.81)	<.0001
<i>Deaf-blind severity index</i>	1-2	0.078 (0.041)	1.08 (0.99 – 1.17)	0.06
	3+	0.197 (0.047)	1.22 (1.11 – 1.33)	<.0001
<i>Pain Scale</i>	1-2	0.104 (0.043)	1.11 (1.02 – 1.21)	0.02
	3+	0.181 (0.054)	1.20 (1.08 – 1.33)	0.0009
<i>Child primary informal helper</i>	Yes	0.199 (0.043)	1.22 (1.12 – 1.33)	<.0001
<i>Family or close friends overwhelmed</i>	Yes	0.184 (0.037)	1.20 (1.12 – 1.29)	<.0001
<i>Reduced social interaction</i>	Yes	0.225 (0.041)	1.25 (1.16 – 1.36)	<.0001
<i>Sex</i>	Female	0.268 (0.071)	<i>See figures 3, 4 and 5 for interaction</i>	0.0002
<i>Rural dwelling</i>	Yes	-0.062 (0.087)	<i>See figure 3 for interaction</i>	0.48

<i>Widow</i>	Yes	0.490 (0.075)	<i>See figure 4 for interaction</i>	<.0001
<i>Social Isolation Scale</i>	-	0.565 (0.047)	<i>See figure 5 for interaction</i>	<.0001
Model c-statistic = 0.77				
<i>Note.</i> PE = parameter estimate; SE = standard error; AOR = adjusted odds ratio; CI = confidence interval				

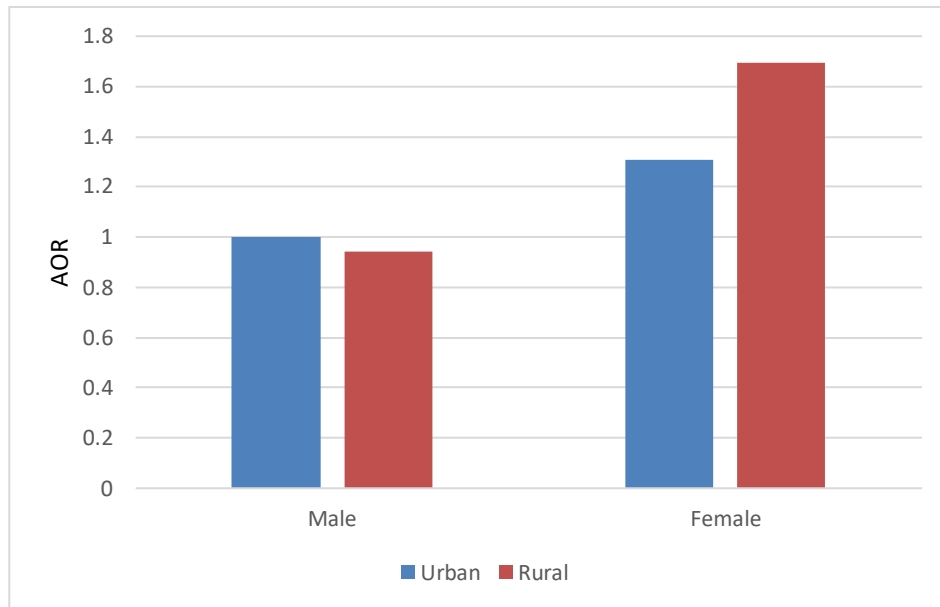


Figure 3. Adjusted odds ratios for loneliness by sex and rurality, Ontario home care clients (n=25,293), T1 comparison sample, 2019

Figure 3 displays the interaction of sex and rural vs. urban dwelling against loneliness at T1 in the comparison sample. There is a clear difference in the impact of rurality on loneliness among men and women. Regardless of the setting, women had greater odds of loneliness than men. However, living in a rural setting showed little difference in loneliness for men, but substantially magnified the odds of loneliness for women (AOR = 1.70; reference=urban males).

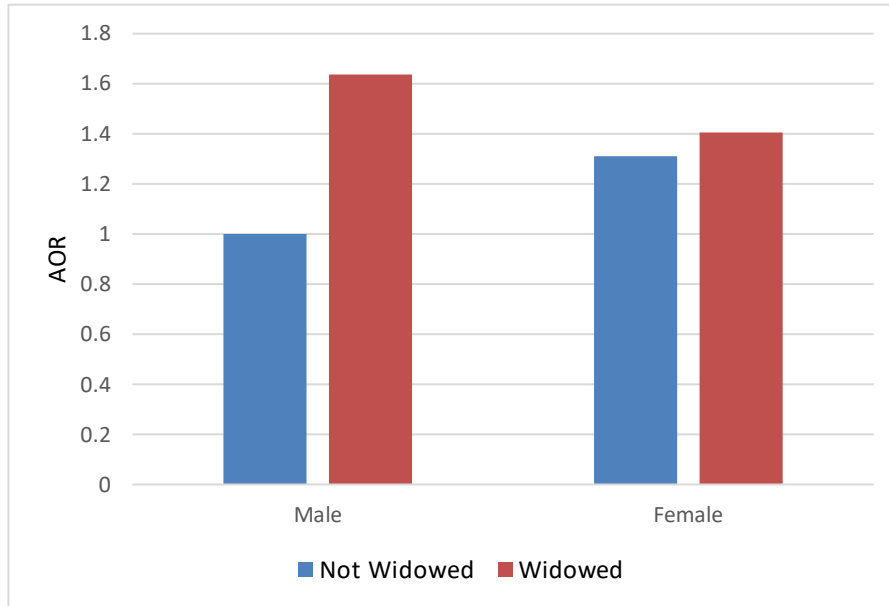


Figure 4. Adjusted odds ratios for loneliness by sex and widowhood, Ontario home care clients (n=25,293), T1 comparison sample, 2019

Figure 4 displays the interaction between sex and widowhood for loneliness at T1 in the comparison sample. Widowhood was associated with higher odds of loneliness for both males and females, though the greatest difference was seen among males (AOR = 1.63; reference=males not widowed)

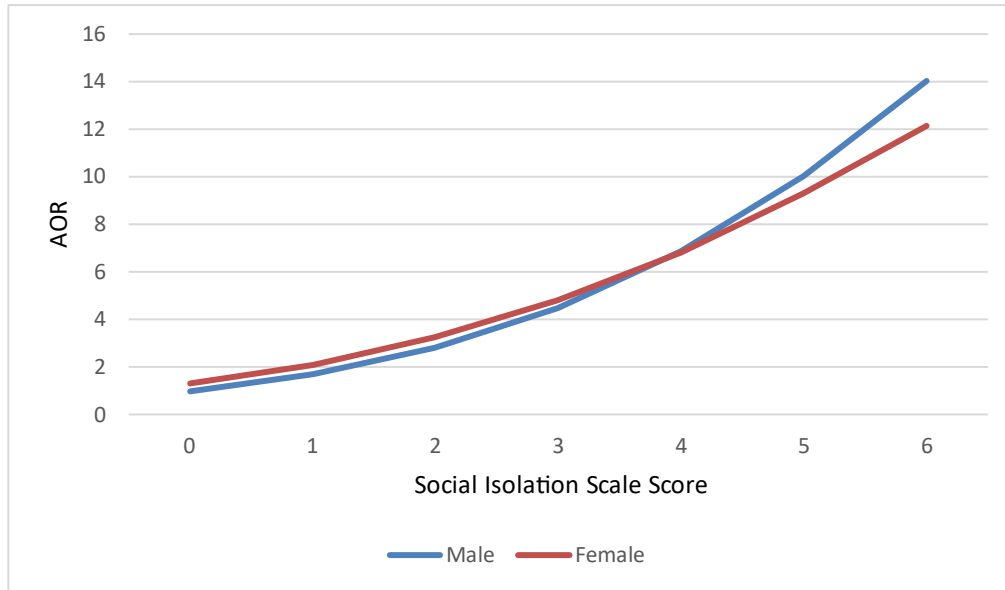


Figure 5. Adjusted odds ratios for loneliness by sex and social isolation scale, Ontario home care clients (n=25,293) T1 comparison sample, 2019

Figure 5 displays the interaction between sex and the social isolation scale for loneliness at T1 in the comparison sample. There are clearly higher odds of loneliness among males and females with a higher scale score. For scores above 4, the magnitude of the effect of social isolation became greater for males, with the greatest odds of loneliness seen for males with a score of 6 (AOR = 14.03; reference=males with SIS score=0).

Table 10. Cross-sectional predictors of loneliness (T1) in COVID sample (n=18,326), 2020				
Variable	Score	PE (SE)	AOR (95% CI)	P-value
<i>Age group</i>	16 – 44	0.226 (0.149)	1.25 (0.94 – 1.68)	0.13
	45 – 64	0.197 (0.076)	1.22 (1.05 – 1.41)	0.009
	65 – 74	0.017 (0.065)	1.02 (0.90 – 1.15)	0.80
	75 – 84	0.089 (0.049)	1.09 (0.99 – 1.20)	0.07
	85+	-	<i>Reference</i>	-
<i>LHIN ID</i>	5	0.440 (0.133)	1.55 (1.20 – 2.02)	0.0009
	6	0.265 (0.165)	1.30 (0.94 – 1.80)	0.11
	7	-	<i>Reference</i>	-
	8	0.067 (0.124)	1.07 (0.84 – 1.37)	0.59
	9	0.333 (0.094)	1.40 (1.16 – 1.68)	0.0004
	10	0.185 (0.128)	1.20 (0.94 – 1.55)	0.15
	11	0.173 (0.101)	1.19 (0.98 – 1.45)	0.09
	12	0.016 (0.135)	1.02 (0.78 – 1.32)	0.91
	13	0.398 (0.109)	1.49 (1.20 – 1.84)	0.0003
	14	0.361 (0.117)	1.44 (1.14 – 1.81)	0.002
<i>Depression rating scale</i>	1-2	0.732 (0.048)	2.08 (1.89 – 2.29)	<.0001
	3+	1.212 (0.055)	3.36 (3.02 – 3.74)	<.0001
<i>Depression diagnosis</i>	Yes	0.362 (0.044)	1.44 (1.32 – 1.57)	<.0001
<i>Anhedonia</i>	Yes	0.346 (0.071)	1.41 (1.23 – 1.63)	<.0001
<i>Dizziness</i>	Yes	0.226 (0.040)	1.25 (1.16 – 1.36)	<.0001
<i>Sleep disturbance</i>	Yes	0.291 (0.040)	1.34 (1.24 – 1.45)	<.0001
<i>Poor self-rated health</i>	Yes	0.150 (0.050)	1.16 (1.05 – 1.28)	0.003
<i>Delirium CAP trigger</i>	Yes	0.214 (0.074)	1.24 (1.07 – 1.43)	0.004
<i>Cognitive Performance Scale</i>	1	0.130 (0.078)	1.14 (0.98 – 1.33)	0.09
	2	0.156 (0.066)	1.17 (1.03 – 1.33)	0.02
	3	-0.105 (0.087)	0.90 (0.76 – 1.07)	0.23
<i>ADL Hierarchy</i>	1-2	-0.209 (0.048)	0.81 (0.74 – 0.89)	<.0001
	3+	-0.249 (0.053)	0.78 (0.70 – 0.87)	<.0001
<i>Deaf-blind Severity Index</i>	1-2	0.078 (0.048)	1.08 (0.98 – 1.19)	0.11
	3+	0.147 (0.054)	1.16 (1.04 – 1.29)	0.007
<i>Pain Scale</i>	1-2	0.169 (0.052)	1.18 (1.07 – 1.31)	0.001
	3+	0.330 (0.064)	1.39 (1.23 – 1.58)	<.0001
<i>Child primary informal helper</i>	Yes	0.182 (0.050)	1.20 (1.09 – 1.32)	0.0003
<i>Family or close friends overwhelmed</i>	Yes	0.194 (0.043)	1.21 (1.12 – 1.32)	<.0001
<i>Reduced social interaction</i>	Yes	0.262 (0.043)	1.30 (1.18 – 1.43)	<.0001
<i>Sex</i>	Female	0.287 (0.082)	<i>See figures 6-8 for interactions</i>	0.0004
<i>Rural dwelling</i>	Yes	-0.163 (0.098)	<i>See figure 6 for interaction</i>	0.10
<i>Widow</i>	Yes	0.452 (0.087)	<i>See figure 7 for interaction</i>	<.0001
<i>Social Isolation Scale</i>	-	0.564 (0.053)	<i>See figure 8 for interaction</i>	<.0001
Model c-statistic = 0.78				
<i>Note.</i> PE = parameter estimate; SE = standard error; AOR = adjusted odds ratio; CI = confidence interval				

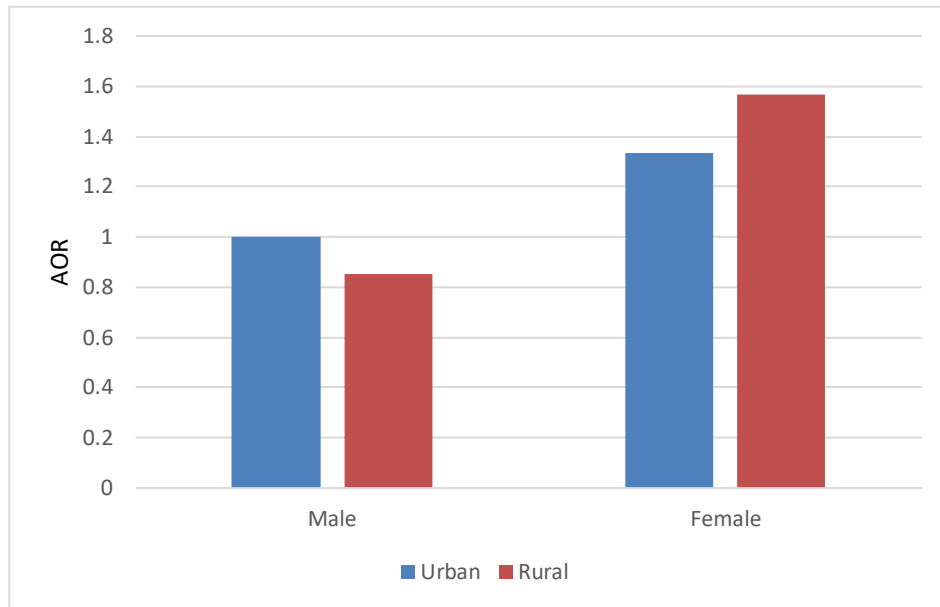


Figure 6. Adjusted odds ratios for loneliness by sex and rurality, Ontario home care clients (n=18,326) T1 COVID sample, 2020

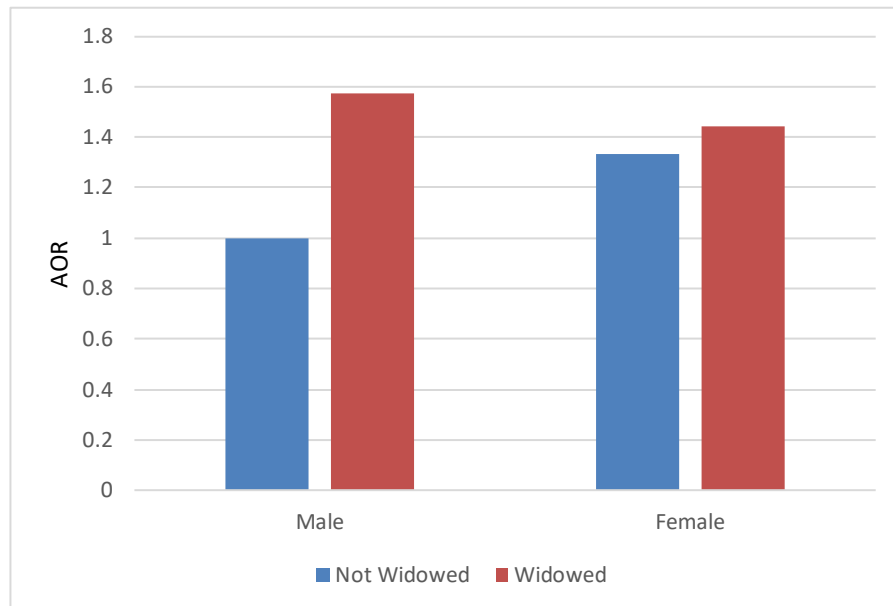


Figure 7. Adjusted odds ratios for loneliness by sex and widowhood, Ontario home care clients (n=18,326), T1 COVID sample, 2020

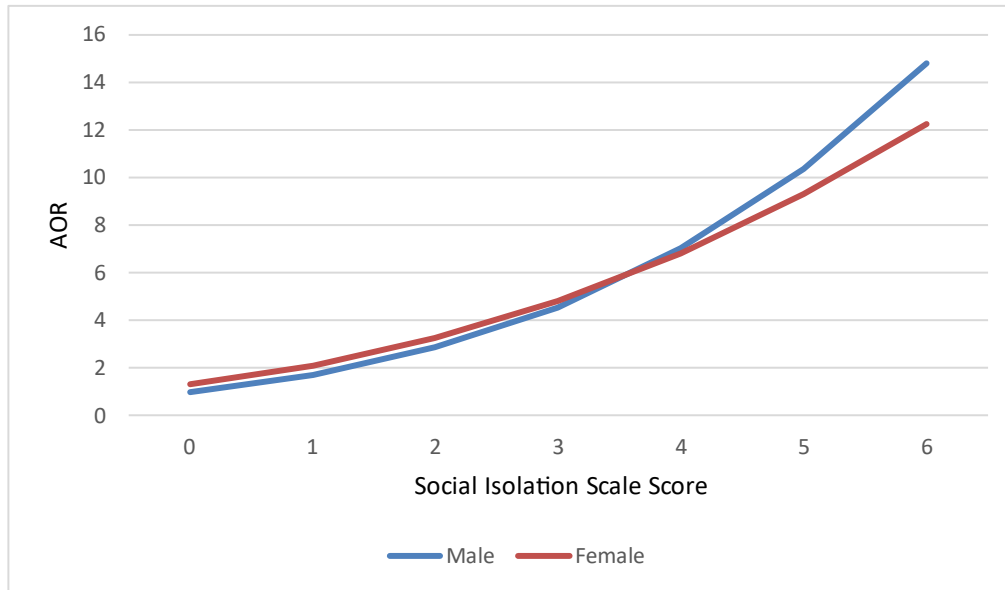


Figure 8. Adjusted odds ratios for loneliness by sex and social isolation scale, Ontario home care clients (n=18,326), T1 COVID sample, 2020

Figures 6, 7, and 8 display the interactions between sex and rural vs urban dwellings, widowhood, and the social isolation scale against loneliness at T1 in the COVID sample. The nature of each interaction is similar to those displayed in the interactions for model 1. Females living in rural settings (AOR = 1.57; reference=urban males) and males who were widowed (AOR = 1.57; reference=males not widowed) or had a score of 6 on the social isolation scale had the greatest odds of loneliness (AOR = 14.82; reference=males with SIS score=0). These results suggest the underlying associations of risk factors with loneliness were similar at the start of the COVID-19 pandemic to those in the pre-pandemic period.

Table 11. Longitudinal predictors of the onset of loneliness (T1 → T2) in comparison sample, (n=19,603), 2019				
Variable	Score	PE (SE)	AOR (95% CI)	P-value
<i>Age group</i>	16 – 44	-0.076 (0.255)	0.93 (0.56 – 1.53)	0.77
	45 – 64	0.247 (0.106)	1.28 (1.04 – 1.58)	0.02
	65 – 74	-0.058 (0.093)	0.94 (0.79 – 1.13)	0.54
	75 – 84	0.086 (0.070)	1.09 (0.95 – 1.25)	0.22
	85+	-	<i>Reference</i>	-
<i>LHIN ID</i>	5	-0.045 (0.185)	0.96 (0.67 – 1.37)	0.81
	6	-0.267 (0.168)	0.77 (0.55 – 1.06)	0.11
	7	-	<i>Reference</i>	-
	8	-0.408 (0.130)	0.67 (0.52 – 0.86)	0.002
	9	-0.159 (0.112)	0.85 (0.69 – 1.06)	0.15
	10	0.093 (0.165)	1.10 (0.79 – 1.52)	0.57
	11	-0.432 (0.128)	0.65 (0.51 – 0.84)	0.0008
	12	0.120 (0.173)	1.13 (0.80 – 1.58)	0.49
	13	0.176 (0.135)	1.19 (0.92 – 1.55)	0.19
	14	-0.299 (0.180)	0.74 (0.52 – 1.06)	0.10
<i>Depression Rating Scale</i>	1-2	0.178 (0.071)	1.19 (1.04 – 1.37)	0.01
	3+	0.491 (0.080)	1.63 (1.40 – 1.91)	<.0001
<i>Anhedonia</i>	Yes	0.250 (0.115)	1.28 (1.02 – 1.61)	0.03
<i>Sleep disturbance</i>	Yes	0.191 (0.061)	1.21 (1.07 – 1.36)	0.002
<i>Cognitive Performance Scale</i>	1	-0.074 (0.102)	0.93 (0.76 – 1.14)	0.47
	2	-0.112 (0.085)	0.89 (0.76 – 1.06)	0.19
	3	-0.509 (0.124)	0.60 (0.47 – 0.77)	<.0001
<i>ADL Hierarchy</i>	1-2	-0.162 (0.070)	0.85 (0.74 – 0.98)	0.02
	3+	-0.334 (0.077)	0.72 (0.62 – 0.83)	<.0001
<i>Pain Scale</i>	1-2	0.087 (0.072)	1.09 (0.95 – 1.26)	0.23
	3+	0.231 (0.093)	1.26 (1.05 – 1.51)	0.01
<i>Fall within last 90 days</i>	Yes	0.263 (0.059)	1.30 (1.16 – 1.46)	<.0001
<i>Diabetes</i>	Yes	0.257 (0.061)	1.29 (1.15 – 1.46)	<.0001
<i>Child primary informal helper</i>	Yes	0.213 (0.070)	1.24 (1.08 – 1.42)	0.002
<i>Neglected or abused within last 30 days</i>	Yes	0.365 (0.141)	1.44 (1.09 – 1.90)	0.01
<i>Lack of personal safety in home environment</i>	Yes	0.649 (0.238)	1.91 (1.20 – 3.05)	0.006
<i>Availability of grocery home delivery</i>	Yes	0.147 (0.063)	1.16 (1.02 – 1.31)	0.02
<i>Sex</i>	Female	0.312 (0.108)	<i>See figure 9 for interaction</i>	0.004
<i>Social Isolation Scale</i>	-	0.373 (0.076)	<i>See figure 9 for interaction</i>	<.0001
Model c-statistic = 0.66				
Note. PE = parameter estimate; SE = standard error; AOR = adjusted odds ratio; CI = confidence interval				

Model 3 is displayed in Table 11, which reports longitudinal predictors of the onset of loneliness in the comparison sample. In this and subsequent models, the denominator is based on only those who were not lonely at T1. Compared to individuals aged 85+, individuals aged

between 45 – 64 had 1.28 times greater odds of becoming lonely. Residing in Central (8), Champlain (11), and North East (13) LHIN regions had a protective effect, with lower odds of becoming lonely by 0.67, 0.65, and 0.74 times, respectively. A score of 1-2 and 3+ on the DRS yielded higher odds of becoming lonely by 1.19 and 1.63 times, respectively, while anhedonia was associated with 1.28 adjusted odds of becoming lonely. Individuals experiencing sleep disturbance, diabetes, or a fall within the last 90 days had 1.21, 1.29, and 1.30 greater odds of becoming lonely than their counterparts, respectively. Though levels 1-2 on the CPS were not significantly associated with loneliness, a score of 3 yielded lower odds of becoming lonely by 0.60 times. ADL impairment also had a protective effect on loneliness, with the greatest difference seen with a score of 3+ reducing the odds of becoming lonely by 0.72 times. Individuals scoring 3+ on the pain scale had 1.26 times greater odds of becoming lonely when compared to a score of 0. Having a child as a primary informal helper or experiencing neglect or abuse within the last 30 days of assessment yielded higher odds of becoming lonely over time by 1.24 and 1.44 times, respectively. Lack of personal safety in one's home environment and availability of grocery delivery services also had higher odds of an individual becoming lonely over time by 1.91 and 1.16 times, respectively.

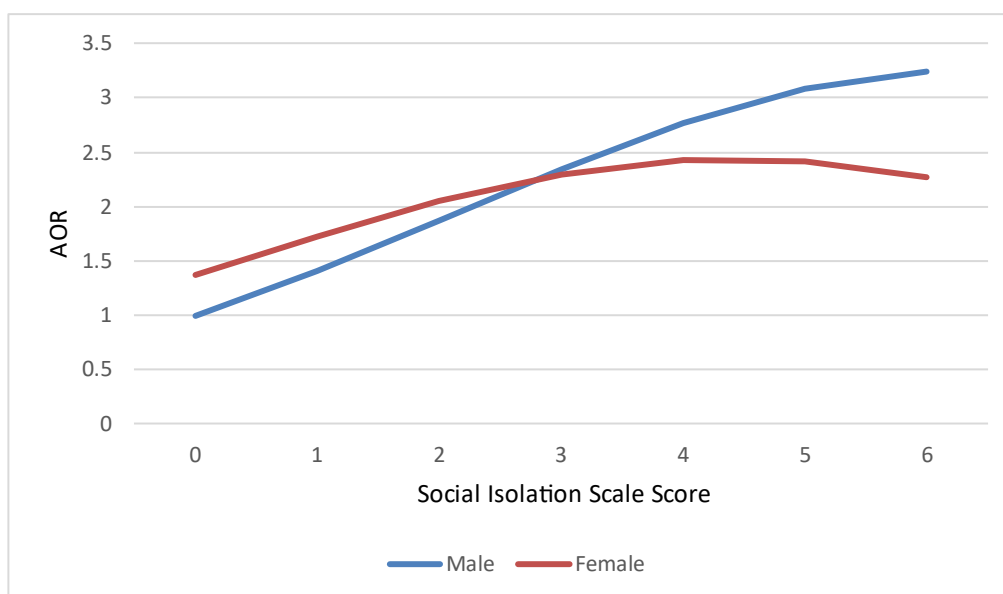


Figure 9. Adjusted odds ratios for the onset of loneliness by sex and social isolation, Ontario home care clients (n=19,603), T1 to T2 comparison sample, 2019

Figure 9 depicts the interaction between sex and the social isolation scale against individuals in the comparison sample becoming lonely at T2. With higher scale scores, there are consistently higher odds of becoming lonely for males. For females, the relationship is curvilinear with peak values at scores of 4 (AOR=2.42). For males, the greatest odds of loneliness were seen at a score of 6 (AOR = 3.25; reference=males with SIS score=0).

Table 12. Longitudinal predictors of the onset of loneliness (T1 → T2) in COVID sample, (n=13,947), 2020				
Variable	Score	PE (SE)	AOR (95% CI)	P-value
<i>LHIN ID</i>	5	0.550 (0.214)	1.73 (1.14 – 2.63)	0.01
	6	0.699 (0.229)	2.01 (1.29 – 3.15)	0.002
	7	-	<i>Reference</i>	-
	8	0.177 (0.202)	1.19 (0.81 – 1.77)	0.38
	9	-0.075 (0.156)	0.93 (0.68 – 1.26)	0.63
	10	0.149 (0.206)	1.16 (0.77 – 1.74)	0.47
	11	0.005 (0.166)	1.01 (0.73 – 1.39)	0.98
	12	0.190 (0.209)	1.21 (0.80 – 1.82)	0.36
	13	0.340 (0.172)	1.41 (1.00 – 1.97)	0.05
	14	0.121 (0.190)	1.13 (0.78 – 1.64)	0.52
<i>Depression Rating Scale</i>	1-2	0.400 (0.076)	1.49 (1.29 – 1.73)	<.0001
	3+	0.305 (0.095)	1.36 (1.13 – 1.63)	0.001
<i>Anxiety</i>	Yes	0.274 (0.084)	1.32 (1.12 – 1.55)	0.001
<i>Sleep disturbance</i>	Yes	0.138 (0.068)	1.15 (1.01 – 1.31)	0.04
<i>Delirium CAP trigger</i>	Yes	0.484 (0.121)	1.62 (1.28 – 2.06)	<.0001
<i>Medication adherence</i>	80% or less	0.201 (0.094)	1.22 (1.02 – 1.47)	0.03
<i>Fall within last 90 days</i>	Yes	0.189 (0.066)	1.21 (1.06 – 1.37)	0.004
<i>ADL Hierarchy</i>	1-2	-0.234 (0.078)	0.79 (0.68 – 0.92)	0.003
	3+	-0.398 (0.088)	0.67 (0.57 – 0.80)	<.0001
<i>Communication Scale</i>	1-2	0.031 (0.071)	1.03 (0.90 – 1.19)	0.67
	3+	-0.252 (0.108)	0.78 (0.63 – 0.96)	0.02
<i>Social Isolation Scale</i>	1	-0.023 (0.108)	0.98 (0.79 – 1.21)	0.83
	2	0.298 (0.120)	1.35 (1.07 – 1.71)	0.01
	3	0.435 (0.124)	1.54 (1.21 – 1.97)	0.0005
	4	0.530 (0.136)	1.70 (1.30 – 2.22)	<.0001
	5-6	0.538 (0.185)	1.71 (1.19 – 2.46)	0.004
<i>Major life stressor within last 90 days</i>	Yes	0.383 (0.077)	1.47 (1.26 – 1.71)	<.0001
<i>Made financial trade-off within last 30 days</i>	Yes	0.399 (0.174)	1.49 (1.06 – 2.10)	0.02
<i>Sex</i>	Female	0.289 (0.089)	<i>See figure 10 for interaction</i>	0.001
<i>Widow</i>	Yes	0.422 (0.138)	<i>See figure 10 for interaction</i>	0.002
Model c-statistic = 0.66				
<i>Note.</i> PE = parameter estimate; SE = standard error; AOR = adjusted odds ratio; CI = confidence interval				

Model 4 depicted in Table 12 displays longitudinal predictors of loneliness in the COVID sample. Individuals residing in Central West (5), Mississauga Halton (6), and North East (13) LHIN regions had 1.73, 2.01, and 1.41 times greater odds of becoming lonely, respectively, when compared to residents of Toronto Central (7). Both levels of the DRS showed an increase in the odds of becoming lonely over time; a score of 1-2 had a stronger association, increasing

the odds of loneliness by 1.49 times compared to a score of 3+ increasing the odds by 1.36 times. Individuals with anxiety and sleep disturbance had 1.32 and 1.15 times greater odds of becoming lonely. A delirium CAP trigger, adhering to medication less than 80% of the time or experiencing a fall within the last 90 days led to greater odds of being lonely by 1.62, 1.22, and 1.21 times, respectively. Both levels of ADL impairment were protective against becoming lonely (1-2: AOR=0.79 95% CI: 0.68 – 0.92; 3+: AOR=0.67 95% CI: 0.57 – 0.80), as seen with scoring a 3+ on the communication scale (AOR=0.78 95% CI: 0.63 – 0.96). Excluding a score of 1, the social isolation scale showed incrementally higher odds of becoming lonely among a person with more factors contributing to social isolation. Individuals scoring 5 or 6 on the scale had the greatest likelihood of experiencing loneliness, with a 1.71 times increase in odds. Individuals who experienced a major life stressor within the last 90 days or had to make a financial trade-off within the last 30 days also had 1.47 and 1.49 times greater odds of becoming lonely over time.

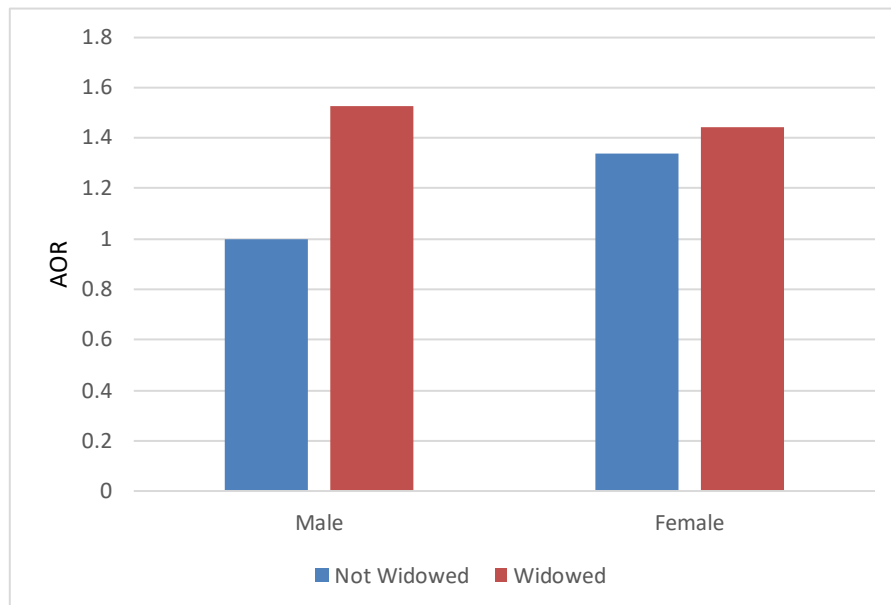


Figure 10. Adjusted odds ratios for the onset of loneliness by sex and widowhood, Ontario home care clients (n=13,947), T1 to T2 COVID sample, 2020

Figure 10 displays the interaction between sex and widowhood among individuals in the COVID sample for becoming lonely at T2. When compared to individuals that are not widowed, widowhood increased the odds of becoming lonely for both males and females; however, male widows saw the greatest increase in odds (AOR = 1.53; reference=male not widowed).

Table 13. COVID main effects model for the onset of loneliness (T1→ T2), comparison and COVID sample (n=33,550), 2019-2020

Variable	Score	PE (SE)	AOR (95% CI)	P-value
<i>COVID</i>	Yes	0.109 (0.044)	1.12 (1.02 – 1.22)	0.01
<i>LHIN ID</i>	5	0.150 (0.137)	1.16 (0.89 – 1.52)	0.27
	6	0.011 (0.134)	1.01 (0.78 – 1.32)	0.94
	7	-	<i>Reference</i>	-
	8	-0.269 (0.109)	0.77 (0.62 – 0.95)	0.01
	9	-0.166 (0.090)	0.85 (0.71 – 1.01)	0.07
	10	0.059 (0.127)	1.06 (0.83 – 1.36)	0.64
	11	-0.274 (0.099)	0.76 (0.63 – 0.92)	0.006
	12	0.085 (0.131)	1.09 (0.84 – 1.41)	0.52
	13	0.190 (0.104)	1.21 (0.99 – 1.48)	0.07
	14	-0.106 (0.125)	0.90 (0.70 – 1.15)	0.40
<i>Depression Rating Scale</i>	1-2	0.297 (0.052)	1.35 (1.22 – 1.49)	<.0001
	3+	0.452 (0.060)	1.57 (1.40 – 1.77)	<.0001
<i>Anxiety</i>	Yes	0.157 (0.058)	1.17 (1.05 – 1.31)	0.007
<i>Sleep disturbance</i>	Yes	0.178 (0.045)	1.20 (1.09 – 1.31)	<.0001
<i>Delirium CAP trigger</i>	Yes	0.238 (0.086)	1.27 (1.07 – 1.50)	0.006
<i>Cognitive Performance Scale</i>	1	0.026 (0.078)	1.03 (0.88 – 1.20)	0.73
	2	-0.061 (0.065)	0.94 (0.83 – 1.07)	0.35
	3	-0.454 (0.092)	0.64 (0.53 – 0.76)	<.0001
<i>ADL Hierarchy</i>	1-2	-0.196 (0.052)	0.82 (0.74 – 0.91)	0.0002
	3+	-0.346 (0.058)	0.71 (0.63 – 0.79)	<.0001
<i>Fall within last 90 days</i>	Yes	0.236 (0.044)	1.27 (1.16 – 1.38)	<.0001
<i>Child primary informal helper</i>	Yes	0.158 (0.055)	1.17 (1.05 – 1.30)	0.004
<i>Social Isolation Scale</i>	1	0.101 (0.073)	1.11 (0.96 – 1.28)	0.17
	2	0.403 (0.081)	1.50 (1.28 – 1.76)	<.0001
	3	0.496 (0.085)	1.64 (1.39 – 1.94)	<.0001
	4	0.670 (0.091)	1.95 (1.63 – 2.34)	<.0001
	5	0.599 (0.135)	1.82 (1.40 – 2.37)	<.0001
	6	0.638 (0.261)	1.89 (1.13 – 3.16)	0.01
<i>Lack of personal safety in home environment</i>	Yes	0.473 (0.186)	1.60 (1.12 – 2.31)	0.01
<i>Major life stressor within last 90 days</i>	Yes	0.236 (0.053)	1.27 (1.14 – 1.40)	<.0001
<i>Made financial trade-off within last 30 days</i>	Yes	0.300 (0.118)	1.35 (1.07 – 1.70)	0.01
<i>Sex</i>	Yes	0.213 (0.059)	<i>See figure 11 for interaction</i>	0.0003
<i>Widow</i>	Yes	0.249 (0.097)	<i>See figure 11 for interaction</i>	0.01
Model c-statistic = 0.65				
<i>Note.</i> PE = parameter estimate; SE = standard error; AOR = adjusted odds ratio; CI = confidence interval				

Model 5 (Table 13) depicts the main effects model of the COVID-19 pandemic and longitudinal predictors of loneliness across the time periods of both the comparison and COVID samples. The direction and magnitude of associations for most independent variables were comparable between models 4 and 5 with some becoming stronger and others somewhat weaker. Individuals who lived through the COVID time period had 1.12 times greater odds of becoming lonely than those in the pre-COVID period. Those residing in Central (8), Central East (9), and Champlain (11) LHIN regions had lower odds of becoming lonely by 0.77, 0.85, and 0.76 times respectively, while residing in North East (13) had higher odds of becoming lonely by 1.21 times when compared to Toronto Central (7). A score of 1-2 and 3+ on the DRS was associated with higher odds of becoming lonely by 1.35 and 1.57 times while experiencing anxiety yielded an AOR of 1.17. Individuals experiencing sleep disturbance or with a delirium CAP triggered or fall within the last 90 days had 1.20, 1.27, and 1.27 times greater odds of becoming lonely than their counterparts. Having a child as a primary informal helper increased the odds of becoming lonely by 1.17 times. A CPS score of 3 and both levels of the ADLH were all protective against becoming lonely over time (CPS 3: AOR=0.64 95% CI: 0.53 – 0.76; ADLH 1-2: AOR=0.82 95% CI: 0.74 – 0.91; ADLH 3+: AOR=0.71 95% CI: 0.63 – 0.79). The social isolation scale showed that the odds of becoming lonely were higher with a greater number of isolation indicators. The strongest associations were seen with a score of 4 and 6, at which the odds of becoming lonely were 1.95 and 1.89 times greater, respectively, compared to a score of 0. Individuals who reported a lack of personal safety in their home environment, experienced a major life stressor within the last 90 days or made a financial trade-off within the last 30 days had 1.60, 1.27, and 1.35 times greater odds of becoming lonely across both samples, respectively.

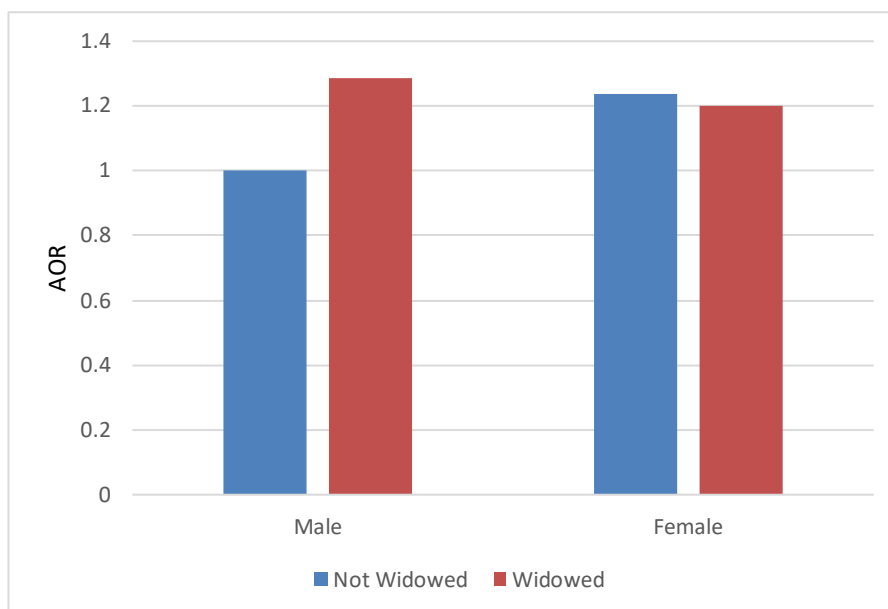


Figure 11. Adjusted odds ratios for the onset of loneliness by sex and widowhood for COVID main effects model, Ontario home care clients (n=33,550), T1 to T2 comparison and COVID samples, 2019-2020

Figure 11 displays the interaction between sex and widowhood against becoming lonely longitudinally across both samples in model 5. Among the non-widowed group, females were at a greater risk of becoming lonely over time when compared to males. Widowed men had the greatest odds of becoming lonely over time (AOR=1.28; reference=male not widowed), while widowed females' odds of becoming lonely were marginally lower compared to non-widowed females.

Table 14. COVID interaction effects model for the onset of loneliness (T1 → T2), comparison and COVID sample (n=33,550), 2019-2020						
Variable	Score	PE (SE)	AOR (95% CI)	P-value		
<i>Sleep disturbance</i>	Yes	0.183 (0.045)	1.20 (1.10 – 1.31)	<.0001		
<i>Cognitive Performance Scale</i>	1	0.027 (0.078)	1.03 (0.88 – 1.20)	0.73		
	2	-0.062 (0.065)	0.94 (0.83 – 1.07)	0.34		
	3	-0.455 (0.093)	0.63 (0.53 – 0.76)	<.0001		
<i>ADL Hierarchy</i>	1-2	-0.192 (0.052)	0.83 (0.75 – 0.91)	0.0002		
	3+	-0.346 (0.058)	0.71 (0.63 – 0.79)	<.0001		
<i>Fall within last 90 days</i>	Yes	0.239 (0.044)	1.27 (1.17 – 1.38)	<.0001		
<i>Child primary informal helper</i>	Yes	0.159 (0.055)	1.17 (1.05 – 1.31)	0.004		
<i>Social Isolation Scale</i>	1	0.105 (0.073)	1.11 (0.96 – 1.28)	0.15		
	2	0.407 (0.082)	1.50 (1.28 – 1.76)	<.0001		
	3	0.494 (0.085)	1.64 (1.39 – 1.94)	<.0001		
	4	0.669 (0.091)	1.95 (1.63 – 2.34)	<.0001		
	5	0.614 (0.135)	1.85 (1.42 – 2.41)	<.0001		
	6	0.639 (0.261)	1.90 (1.14 – 3.16)	0.01		
<i>Lack of personal safety in home environment</i>	Yes	0.460 (0.186)	1.58 (1.10 – 2.28)	0.01		
<i>Made financial trade-off within last 30 days</i>	Yes	0.300 (0.118)	1.35 (1.07 – 1.70)	0.01		
<i>Sex</i>	Female	0.212 (0.060)	<i>See figure 12 for interaction</i>	0.0004		
<i>Widow</i>	Yes	0.246 (0.097)	<i>See figure 12 for interaction</i>	0.01		
<i>COVID</i>	Yes	-0.275 (0.183)	<i>See figures 13-17 for interactions</i>	0.13		
<i>LHIN ID</i>	5	-0.078 (0.183)	<i>See figure 13 for interaction</i>	0.67		
	6	-0.292 (0.167)		0.08		
	7	-	<i>Reference</i>	-		
	8	-0.443 (0.129)	<i>See figure 13 for interaction</i>	0.0006		
	9	-0.163 (0.111)		0.14		
	10	0.011 (0.163)		0.94		
	11	-0.454 (0.127)		0.0004		
	12	0.076 (0.172)		0.66		
	13	0.124 (0.133)		0.35		
	14	-0.286 (0.179)		0.11		
	<i>Depression Rating Scale</i>	1-2		0.207 (0.070)	<i>See figure 14 for interaction</i>	0.003
		3+		0.570 (0.077)		<.0001
	<i>Anxiety</i>	Yes		0.046 (0.079)	<i>See figure 15 for interaction</i>	0.56
	<i>Major life stressor within last 90 days</i>	Yes	0.144 (0.073)	<i>See figure 16 for interaction</i>	0.05	
<i>Delirium CAP trigger</i>	Yes	-0.009 (0.123)	<i>See figure 17 for interaction</i>	0.94		
Model c-statistic = 0.66						
<i>Note. PE = parameter estimate; SE = standard error; AOR = adjusted odds ratio; CI = confidence interval</i>						

Table 14 depicts the COVID interaction effects model for predicting a transition in loneliness across the entire study sample (Model 6). Individuals who reported sleep disturbance or had at least one fall within the last 90 days had 1.20 and 1.27 times greater odds of becoming

lonely, respectively, than individuals that did not. Having a child as a primary informal helper increased the odds of becoming lonely by 1.17 times. A score of 3 on the CPS was protective against becoming lonely, lowering the odds by 0.63 times. Both levels of the ADLH also reduced the odds of becoming lonely by 0.83 times and 0.71 times, for levels 1-2 and 3+, respectively. All scores except for 1 on the social isolation scale yielded significantly higher odds of becoming lonely, with a general upward trend corresponding to more indicators met. Comparable to model 5, individuals with scores of 4 and 6 had 1.95 and 1.90 times greater odds of becoming lonely, respectively, compared to those with a score of 0. Lack of safety in one’s home environment and having made a financial trade-off within the last 30 days increased the odds of becoming lonely by 1.58 and 1.35 times, respectively. The COVID interaction terms tested in model 6 can be seen in the figures below.

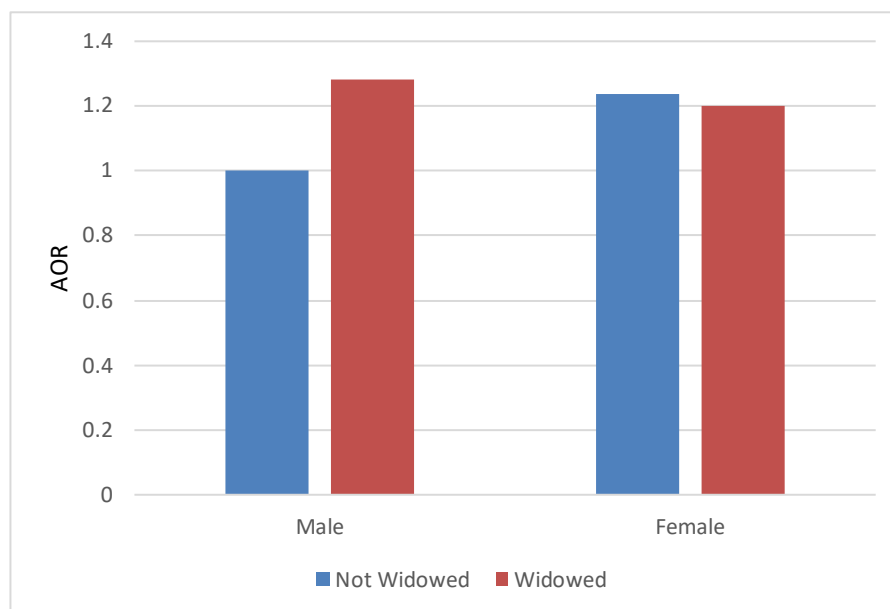


Figure 12. Adjusted odds ratios for the onset of loneliness by sex and widowhood for COVID interaction effects model, Ontario home care clients (n=33,550), T1 to T2 comparison and COVID samples, 2019-2020

Figure 12 displays the interaction between sex and widowhood for becoming lonely longitudinally across both samples in model 6. This interaction followed the same trend as seen in model 5, with non-widowed females having greater odds of becoming lonely when compared to non-widowed males. Widowed females had lower odds of becoming lonely than non-widowed females, and widowed males had the greatest odds of becoming lonely (AOR=1.28; reference=male not widowed).

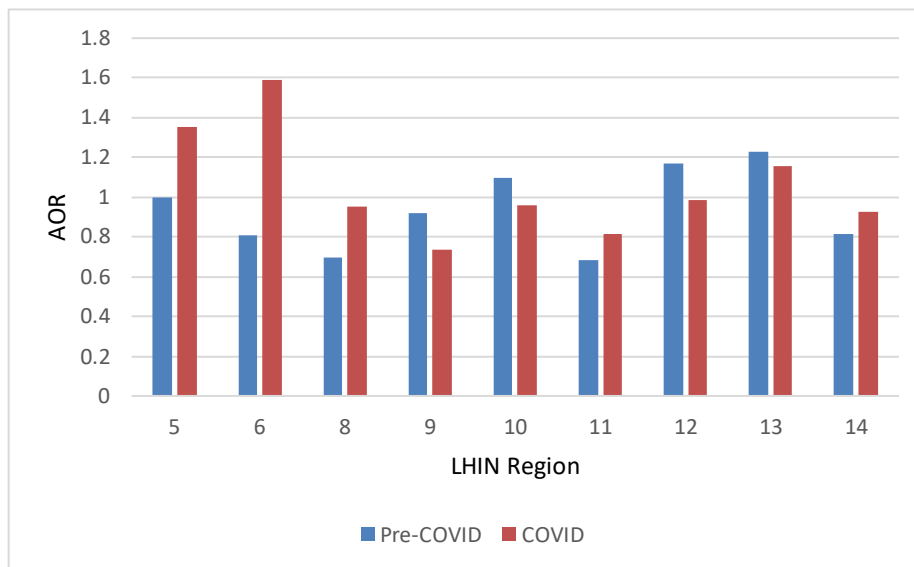


Figure 13. Adjusted odds ratios for the onset of loneliness by COVID and LHIN region for COVID interaction effects model, Ontario home care clients (n=33,550), T1 to T2 comparison and COVID samples, 2019-2020

Figure 13 depicts the interaction between LHIN region and COVID for becoming lonely over time across both samples. LHIN regions 5, 6, 8, 11, and 14 had significant interactions with COVID, in which an increase in the odds of loneliness was present during the pandemic when compared to prior to the pandemic. The odds of loneliness for individuals residing in the Central West (5), Mississauga Halton (6), Central (8), Champlain (11), and North West (14) LHIN

regions were compared to Toronto Central (7) as a reference group. For other LHIN regions the differences were minor or with somewhat lower odds.

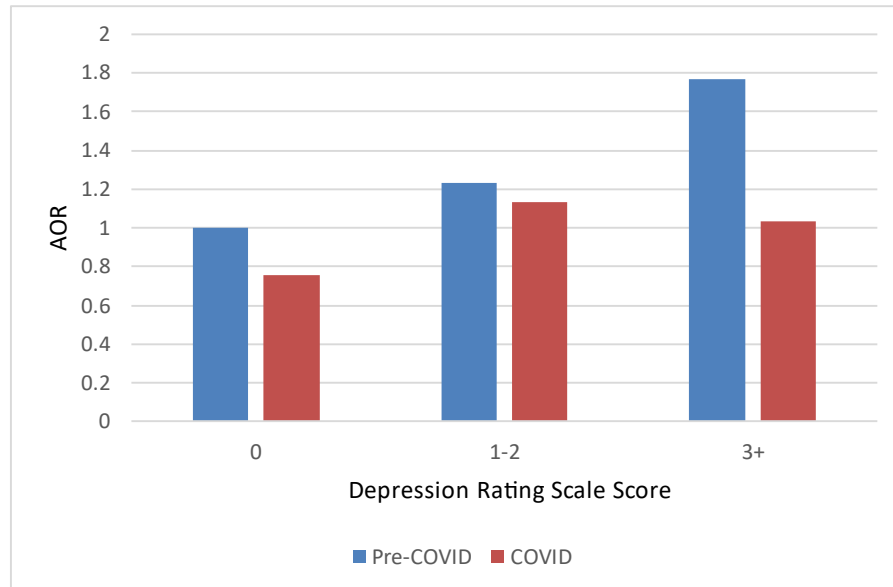


Figure 14. Adjusted odds ratios for the onset of loneliness by COVID and DRS for COVID interaction effects model, Ontario home care clients (n=33,550), T1 to T2 comparison and COVID samples, 2019-2020

Figure 14 displays the interaction between the DRS and COVID for becoming lonely longitudinally across both samples. Prior to the pandemic, there was a proportional increase in the odds of becoming lonely with an increase in DRS score. However, during the pandemic this relationship was curvilinear with the greatest odds of loneliness associated with a DRS score of 1-2.

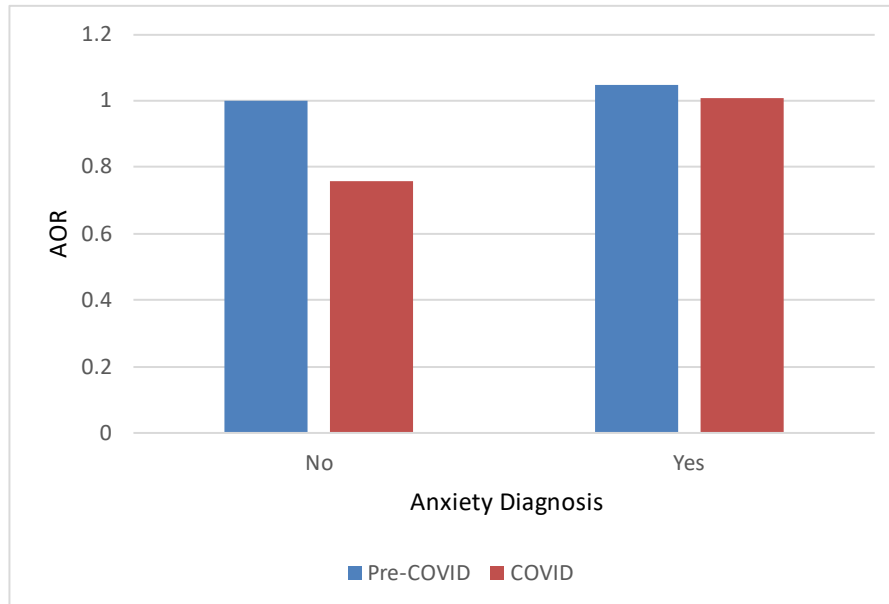


Figure 15. Adjusted odds ratios for the onset of loneliness by COVID and Anxiety for COVID interaction effects model, Ontario home care clients (n=33,550), T1 to T2 comparison and COVID samples, 2019-2020

Figure 15 depicts the interaction between an anxiety diagnosis and COVID with becoming lonely longitudinally across both samples. Individuals with anxiety had only slightly greater odds of becoming lonely prior to the pandemic compared to individuals who did not have anxiety. However, individuals without anxiety had lower odds of becoming lonely during the pandemic than before. This apparent protective effect was not evident in the group with anxiety during the COVID period.

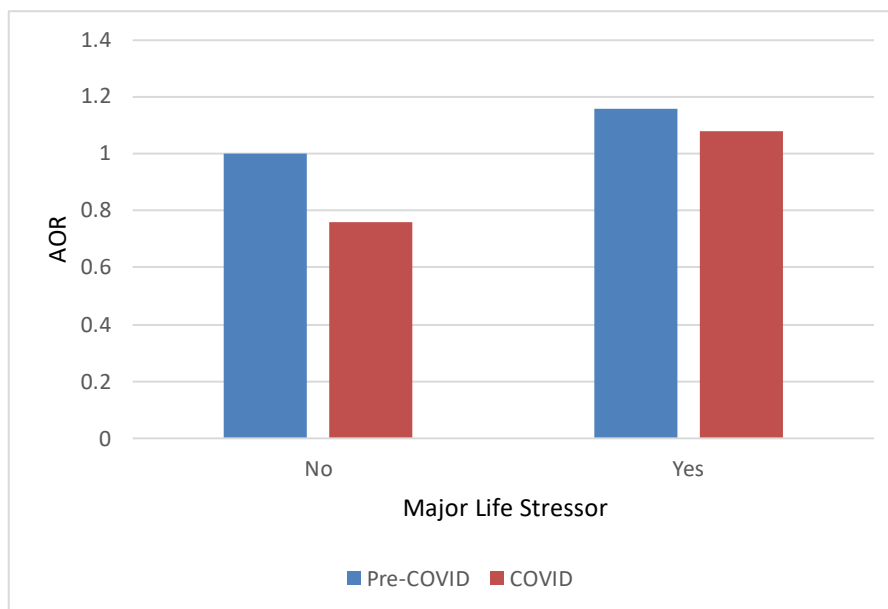


Figure 16. Adjusted odds ratios for the onset of loneliness by COVID and major life stressor for COVID interaction effects model, Ontario home care clients (n=33,550), T1 to T2 comparison and COVID samples, 2019-2020

Figure 16 displays the interaction between having a major life stressor within the last 90 days and COVID against becoming lonely longitudinally across both samples. In both periods, individuals who experienced a major life stressor had greater odds of becoming lonely when compared to their counterparts. However, for those with no prior stressors, the odds of becoming lonely were lower in the COVID time period when compared to the pre-COVID time. Individuals who experienced a major life stressor had the greatest odds of becoming lonely prior to the pandemic (AOR=1.16; reference=not stressed, pre-COVID). However, those with prior stressors during the COVID period had notably greater odds of transitioning to loneliness compared with the non-stressed group in that period.

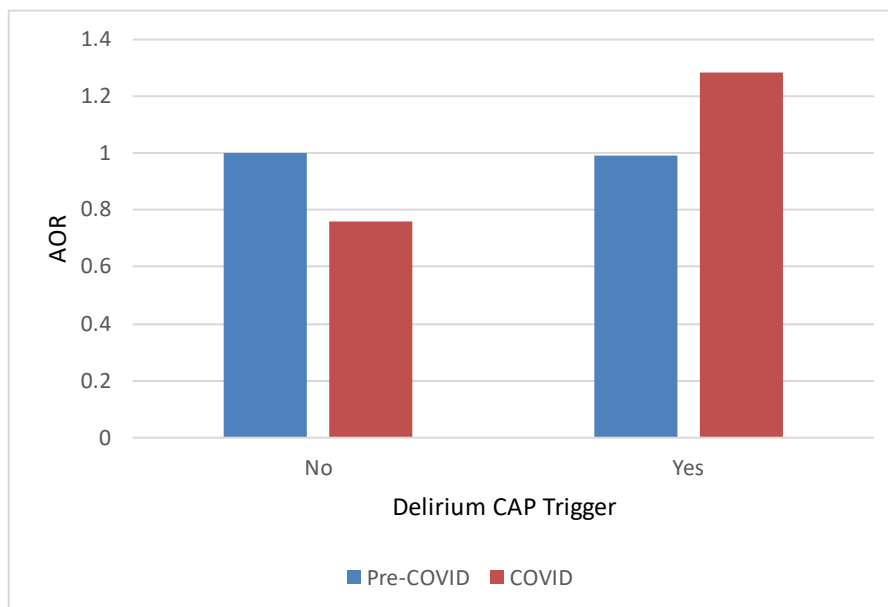


Figure 17. Adjusted odds ratios for the onset of loneliness by COVID and Delirium CAP trigger for COVID interaction effects model, Ontario home care clients (n=33,550), T1 to T2 comparison and COVID samples, 2019-2020

Figure 17 depicts the interaction between the delirium CAP trigger and COVID for becoming lonely longitudinally across both samples. Prior to the pandemic, delirium showed no relationship with the odds of becoming lonely over time. During the pandemic, those without delirium at T1 had lower odds of transition to loneliness but having delirium was associated with substantially higher odds of becoming lonely (AOR=1.28; reference=no delirium, pre-COVID) when compared to individuals who did not have delirium in either period.

Discussion

This thesis sought to determine predictors of loneliness and a transition in loneliness in older adults receiving home care and how these relationships were modified by the first wave of the COVID-19 pandemic in Ontario. Bivariate analyses and six multivariate logistic regression models were developed, exploring what predicted loneliness prior to and during the first wave of

the pandemic. Consistent with our first hypothesis, loneliness risk was associated with several demographic, physical, clinical, psychological, social, and environmental factors at a cross-sectional and longitudinal level. Some risk factors were found to have a stronger association than others, with depressive symptoms, anhedonia, geographic variations, and social isolation having the strongest associations. Our findings were somewhat supportive of the second hypothesis, with the pandemic exacerbating the effect of several risk factors on loneliness, though loneliness rates did not drastically increase in the COVID sample when compared to the comparison sample. When comparing the comparison and COVID cross-sectional models, there was little variation in effect size. However, when comparing the respective longitudinal models, several variables had larger effect sizes in the COVID sample and in the COVID main and interaction effects models, several interactions were found with the COVID variable. *Appendix A* displays the variations among variables that were significant across all 6 models to narrow down which factors may contribute to loneliness within a designated context.

Demographic Predictors

When looking at both samples, about one-quarter of the population reported feeling lonely at both time periods, with a slight increase seen at T2. The transition rate of individuals who were not lonely at T1 but became lonely at T2 was 6.7% in the comparison sample, slightly increasing to 7.6% in the COVID sample. Though these results reflect meaningful changes, with increased social isolation during the pandemic, greater contrast in loneliness rates between the pre-COVID and COVID time periods was expected. These findings could likely be attributed to the sense of community cultivated during the first wave of the pandemic, creating a paradoxical effect where social isolation was coupled with greater emotional concern among loved ones leading to a protective effect against loneliness (Bowe et al., 2021; Jenkins et al., 2021). We

found that loneliness risk did not necessarily increase with age, when compared to the 85+ age group, the highest risk of loneliness was seen in the 45-64 age category at the bivariate level and in the 16-44 age category, followed by the 45-64 age category at the multivariate level when looking at loneliness cross-sectionally in the comparison sample. In the COVID sample, only the 45-64 age category was associated with increased odds of loneliness cross-sectionally. Longitudinally, only falling within the 45-64 age category was found to have a significant association with becoming lonely prior to the pandemic. Though there is evidence suggesting that loneliness risk increases with age, our findings are consistent with alternative schools of thought and socioemotional selectivity theory that suggest the risk of loneliness may be more prevalent among younger age groups as the value placed on broad social relationships diminishes with age (Carstensen, 1995; Carstensen et al., 1999; De Koning et al., 2017; Heidinger & Richter, 2020). These results signify that loneliness risk was pertinent regardless of age during the first wave of the pandemic. The unexpected lack of association in older adults may be further described by older adults being more likely to have established and stable lives and social connections wherein isolation measures were less disruptive than for other age groups, leading to easier adaptability to isolation (Bruine de Bruin, 2020; Knepple Carney et al., 2020; Krendl & Perry, 2020; Nicolaisen & Thorsen, 2016). Throughout the entire study period, females had greater rates of loneliness than men and widowhood increased the odds of loneliness both cross-sectionally and longitudinally, with significant interaction with sex demonstrating that the odds were slightly greater for males. This is consistent with the literature, with widowhood leading to the uptake of new responsibilities, and lack of proximal social support that influences greater degrees of loneliness and psychological distress, with some evidence suggesting adaptability is

more difficult for males (Cohen-Mansfield et al., 2016; De Koning et al., 2017; Lee et al., 2001; Panagiotopoulos et al., 2013; Paúl & Ribeiro, 2009; Streeter, 2020).

Psychosocial Predictors

At the multivariate level, moderate cognitive impairment (level 3) was notably associated with loneliness, lowering the odds of loneliness in almost all models. In the cross-sectional models, mild cognitive impairment (2) was associated with higher odds of loneliness. This difference may be attributed to moderate impairment reducing the capacity to recognize or manage stressors or perceive feelings of loneliness, while mild impairment may be a source of stress and loneliness (Yin et al., 2019). Our results also found that a delirium CAP trigger greatly increased the odds of becoming lonely in the COVID sample to a greater degree than seen cross-sectionally or before the pandemic. A depression diagnosis was only significant in increasing the odds of loneliness at the cross-sectional level in both samples. Depressive symptoms demonstrated by the DRS had a strong relationship with loneliness, showing a significant increase in the odds of loneliness cross-sectionally and longitudinally. Anhedonia, or expressed lack of pleasure, also had a strong effect size, increasing the odds of loneliness cross-sectionally, but only showing significance longitudinally in the comparison sample. Our findings are consistent with the broad literature supporting an association between loneliness and depression (Cacioppo et al., 2006; Domènech-Abella et al., 2017; Fiske et al., 2009; Leigh-Hunt et al., 2017; Kuiper et al., 2020). Moreover, while anxiety, having a major life stressor within the last 90 days or having made a financial trade-off within the last 30 days became significant during the pandemic, an interaction between COVID and anxiety and major life stressors also uncovered that the increase in odds of loneliness was greater prior to the pandemic, suggesting a protective effect of the pandemic for both variables. These findings again speak to the perception of a

greater sense of community that resulted from the pandemic, which may have led individuals to feel more supported than usual (Bowe et al., 2021; Jenkins et al., 2021). The effect that experiencing depression, anxiety, or major life stressors would have prior to the pandemic may have also been dulled by the shift in priorities during the first wave of the pandemic.

The strongest association was seen with loneliness and the social isolation scale at both the bivariate and multivariate levels. These results verify the effectiveness of the social isolation scale that was developed and anticipated with the strong interconnectedness of loneliness and social isolation highlighted in the literature (Beller & Wagner, 2018; Cornwell & Waite, 2009; Freedman & Nicolle, 2020; Leigh-Hunt et al., 2017; Paúl, & Ribeiro, 2009; Pinguart, & Sörensen, 2001). Across all models, a general trend of increased odds of loneliness with an increase in social isolation score was demonstrated. Cross-sectionally, the odds of being lonely with an increased score was higher for males than females. These findings are supported by reduced social interaction also increasing the odds of loneliness cross-sectionally. The value of social connection was further demonstrated by some psychosocial variables being predictive of loneliness at the bivariate level, such as experiencing conflict, neglect or abuse and being fearful of a family member or close acquaintance, though only neglect remained significant in the longitudinal model for the comparison sample. Having family or close friends feel overwhelmed by the person's illness increased the odds of loneliness at the cross-sectional level, which may be attributed to worse outcomes in the individual due to a weakened capacity to provide both physical and emotional support from their caregiver. Caregiver distress concerning adverse health outcomes has been widely studied in the literature and is a risk factor for increased health service utilization (Ankuda et al., 2017; Maxwell et al., 2018; Stall et al., 2018; Williams et al., 2018). In addition, having a child as a primary caregiver was protective against loneliness in the

bivariate analysis. However, when adjusted for other covariates, the direction of the association changed, suggesting an undetected interaction with one or more of the covariates. These results highlight the importance of diverse networks that could offset the risk associated with caregiver distress and relationships.

Clinical and Physical Predictors

ADL impairment had a protective effect against loneliness both cross-sectionally and longitudinally. It is assumed that individuals with ADL impairment are more likely to receive formal or informal care, leading to greater social interaction and support, which has been found to have the potential to fulfil social needs (Tomstad et al., 2021). It is also possible that the effort required to meet physical needs reduces the opportunity for boredom and concern over psychosocial needs, reducing feelings of loneliness (Cohen-Mansfield et al., 2016). Experiencing pain was predictive of loneliness cross-sectionally and longitudinally in the comparison sample, with experiencing a fall within the last 90 days being predictive of loneliness longitudinally. Experiencing ADL impairment, pain, or a fall all capture a similar dimension of physical distress and may increase loneliness and social isolation by a limited capacity or a weakened desire to be socially engaged or participate within the community when feeling unwell (Cohen-Mansfield et al., 2016; De Koning et al., 2017). Bivariate analyses including the DBSI showed an increase in the odds of loneliness at both levels, though, at the multivariate level, only individuals with moderate auditory and visual impairment had greater odds of loneliness cross-sectionally. As both auditory and visual impairment have been found to complicate social engagement, a larger effect size was expected; regardless, these findings remain consistent (Brunes et al., 2019; Cheung et al., 2019; Littlejohn et al., 2021; Ramage-Morin, 2016). Sleep disturbance was also cross-sectionally and longitudinally predictive of loneliness at the multivariate level across all

models. Similarly to depression, loneliness is suggested to have a bidirectional relationship with sleep disturbance (Griffin et al., 2019; Shankar, 2019; Simon & Walker, 2018). With sleep affecting several aspects of wellbeing, including cognition, stress vulnerability, and energy levels, the effect on loneliness is unsurprising (Griffin et al., 2019; McCoy & Strecker, 2011; Meerlo et al., 2008; Steptoe et al., 2008).

Environmental Predictors

In the final models, several geographic and environmental variables were significantly associated with loneliness. Living in a rural setting increased the odds of loneliness in both samples at the multivariate, cross-sectional level, though it was not significant at the bivariate level or in any of the longitudinal models at the multivariate level. With rurality being viewed as a risk factor for loneliness and social isolation within the literature, the lack of longitudinal association was unexpected. However, LHIN region¹ variations were significant in all models, predicting loneliness both at the cross-sectional and longitudinal levels, which represent aspects of rurality (Domènech-Abella et al., 2017). At the cross-sectional level, northern regions and those far from major cities had the greatest odds of loneliness compared to those living in Toronto Central (7). Some surrounding regions in the Greater Toronto Area also had increased odds of loneliness, though to a lesser degree. Longitudinally, some remote and urban regions (i.e., Champlain (11), North Simcoe Muskoka (12), and Central (8)) were protective against becoming lonely. While living in one of the most northern regions, North East (13), greatly increased the odds of becoming lonely. Interactions between COVID and the following regions were also reported, Central West (5), Mississauga Halton (6), Central (8), and Champlain (11),

¹ Note. LHIN regions were officially replaced by Ontario Health teams in 2019 but can still be used to represent different geographic regions within Ontario.

suggesting that the odds of becoming lonely for individuals residing in these regions were worsened by the pandemic.

The variation seen in the effect of LHIN regions on loneliness is unsurprising as geographic regions hold great differences in population, environment, community, and resources, also having a difference in COVID risk and restrictions throughout the pandemic (Lawson et al., 2022). Communities with greater investment in safety, walkability, and resources that facilitate social connection, such as community centres and volunteering opportunities, have been associated with lower loneliness among older adults (Abbott & Sapsford, 2005; Bu et al., 2020; Cohen-Mansfield et al., 2016; De Koning et al., 2017). The unexpected protective effects of living in some rural regions against loneliness, particularly during the pandemic, suggest that smaller communities may have protective characteristics in which the risk of loneliness and social isolation is not uniform amongst regions of the same sort. For example, it is possible that more populated rural regions such as Champlain (11) and North Simcoe Muskoka (12) have tight-knit communities where social support is prominent, while more remote regions such as North East (13) could be less populated, with smaller communities, with the risk of social isolation being much larger with limited infrastructure and community, and travel being discouraged during the pandemic (Roussi et al., 2006). Alternatively, the Central (8) region being protective against loneliness compared to Toronto Central (7) in the COVID main effects model highlights that highly urbanized areas are not necessarily protective against loneliness. During the pandemic, greater value was placed on living in less populated areas with greater outdoor space, which may explain why regions outside of Toronto were found protective. These findings are consistent with other environmental factors that were examined in our research and may explain why lack of personal safety in one's home environment, and unavailability of

grocery home delivery services, increased the risk of loneliness longitudinally in both samples and the comparison sample, respectively, further highlighting that environmental factors play a role in the risk of loneliness and social isolation, and opportunities for social support (Abbott & Sapsford, 2005; Cohen-Mansfield et al. 2016; De Koning et al., 2017).

Strengths and Limitations

This study has many strengths. Given the size of the dataset and scope of the interRAI HC instrument, risk factors spanning several conceptual domains related to loneliness were examined for a study population that is larger than what is seen in most home care literature. Also, the study was based on all eligible home care clients rather than a sample, so non-response bias is not a source of concern. As such, one may be confident that the results generated were robust and largely representative of the older adult home care population in Ontario, importantly filling a research gap in an understudied population (Biau et al., 2008). This is further supported by the strong c-statistics representing good model fit for the multivariate models. Perhaps the greatest strength of this study was the ability to perform a longitudinal analysis to study transitions in loneliness and provide more robust data than achievable through cross-sectional analyses. Longitudinal capabilities are often a limitation for several smaller-scale studies and are limited in number within the existing loneliness literature. Given the differences in results between the cross-sectional and longitudinal models, a cross-sectional design would overlook several factors contributing to loneliness over time. Another strength was the ability to provide insights into what predicted loneliness during the pandemic and a direct comparison of how the context of loneliness changed as a result of the first wave of the COVID-19 pandemic. A final major strength is the development of a social isolation scale with a strong c-statistic that is interoperable between interRAI instruments and can be used beyond this study to measure social

isolation, a concept related to several clinical and public health concepts and previously unmeasurable across interRAI instruments.

Despite efforts to maintain scientific rigour, this study has some limitations. The interRAI HC is a quantitative assessment with pre-defined concepts and questions, which is notable particularly within the context of the pandemic as there may be certain confounding variables (i.e., frequency of visitors, technological usage) whose impact cannot be studied (Lei et al., 2020). Moreover, the loneliness measure is a single self-report item which may be limited in capturing the dynamism of the concept in a way that a multi-item scale can. The study is also limited by the interRAI HC instrument only collecting data in LHIN regions 5-14. Thus, few LHIN regions, as well as several pre-defined risk factors of loneliness that are not measured by the instrument, including ethnicity, immigration status, sexual orientation, and nature of social relationships, could not be assessed in relation to loneliness (National Seniors Council, 2016). Another limitation is that the COVID-19 data only included the period up to August 31, 2020. Though meaningful information regarding loneliness risk prior to and during the first wave of the pandemic has been provided, the rapidly ever-changing landscape of the pandemic may limit the representativeness of the experience of older adults in the present time. In addition, with the data provided, the results can only be generalized to the Ontario home care population. Future research should explore how the relationships between cross-sectional and longitudinal risk factors and loneliness changed in subsequent waves of the pandemic. Qualitative studies examining the subjective experience of loneliness during the first wave and subsequent waves of the pandemic would be an interesting way to explore concepts that this study could not have captured. In addition, in-depth, geographic and environmental studies are encouraged to explore

the characteristics of certain regions that may contribute to certain aspects of loneliness and social isolation.

Implications

With loneliness risk being explored as a multi-dimensional concept within this study, the findings demonstrate implications for several public health sectors, primarily aiding in risk identification, loneliness prevention, and treatment optimization. While there are non-modifiable risk factors of loneliness, such as visual impairments and widowhood, several factors are modifiable directly, or the impact on loneliness can be lessened by focusing on cultivating protective factors. Clinicians and home care practitioners are encouraged to explore components of loneliness that are not just of medical nature as a way to improve risk identification and care planning to embody holistic treatment protocols that achieve lasting outcomes and reduce the risk of patients becoming lonely over time. With home care workers often being clients' main point of contact, allocating resources to incorporate visits targeted for social engagement could be an easy and effective way to integrate social connectedness into care plans. interRAI should utilize these findings as a needs assessment to guide future projects that incorporate social programming among older adults receiving home care to reduce loneliness and improve wellbeing, as well as facilitate research that will expand upon the limitations and gaps of this study. With the value added to this study by the development of the social isolation scale, embedment of the scale within interRAI instruments is also encouraged to allow researchers to consider the effect of social isolation in future studies, an important social dimension that plays a significant role in clinical and psychological health outcomes. Moreover, the findings of this research can aid in the development of a CAP trigger for loneliness or social isolation within

interRAI instruments to systematically identify at-risk patients in clinical practice (Morris et al., 2009).

Importantly, the public perception of loneliness greatly increasing during the pandemic was inconsistent with the findings of this study. Though the first wave of the pandemic did not drastically increase the rates of loneliness in our study sample, meaningful findings were still identified, for example, with delirium, depression, and geographic factors putting individuals at a greater risk of implications during the pandemic. With loneliness risk lying beyond psychosocial and clinical factors and being strongly associated with environmental factors, investing in community safety, affordable housing, transportation infrastructure, and recreational opportunities for older adults are vital to creating accessible communities that facilitate social engagement and reduce isolation, having long-term pay off for older adult wellbeing (Abbott & Sapsford, 2005; Bu et al., 2020; Cohen-Mansfield et al., 2016; De Koning et al., 2017). In efforts to reduce the implications of future public health emergencies and reduce loneliness and the risk of becoming lonely for older adults today, policymakers and urban planners must work together to limit disparities seen through inequitable resource allocation across Ontario. Further, researchers and clinicians should build upon these findings to develop standardized indicators of loneliness and evidence-based practice protocols for loneliness to be approached systematically across populations.

Conclusion

Loneliness risk was associated with several demographic, physical, clinical, psychological, social, and environmental factors at a cross-sectional and longitudinal level. Variations exist in risk factors when examining loneliness cross-sectionally and longitudinally, with several risk factors of loneliness being exacerbated by the COVID-19 pandemic. Public

health professionals, organizations, and policymakers must consider loneliness as a multi-dimensional and holistic concern, taking an integrated approach to treat loneliness at the clinical, social, and policy levels to reduce and prevent loneliness in older adults receiving home care, ultimately improving wellbeing and health outcomes.

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Appendices

Appendix A: Summary of Loneliness Predictors by Model

Appendix - Table 1. Summary of Significant Independent Variables on Loneliness by Multivariate Model					
Variable	Model				
	Model 1	Model 2	Model 3	Model 4	Model 5+6
<i>Age</i>	X	X	X		
<i>Sex</i>	X	X	X	X	X
<i>Widow</i>	X	X		X	X
<i>Rural</i>	X	X			
<i>LHIN region</i>	X	X	X	X	X
<i>DRS</i>	X	X	X	X	X
<i>Depression diagnosis</i>	X	X			
<i>Anhedonia</i>	X	X	X		
<i>Anxiety</i>				X	X
<i>Diabetes</i>			X		
<i>Dizziness</i>	X	X			
<i>Sleep disturbance</i>	X	X	X	X	X
<i>Poor self-rated health</i>	X	X			
<i>Medication adherence</i>				X	
<i>Delirium CAP trigger</i>	X	X		X	X
<i>CPS</i>	X	X	X		X
<i>Fall within last 90 days</i>			X	X	X
<i>ADLH</i>	X	X	X	X	X
<i>Pain scale</i>	X	X	X		
<i>DBSI</i>	X	X			
<i>Communication scale</i>				X	
<i>Child as primary caregiver</i>	X	X		X	X
<i>Family or close friends overwhelmed</i>	X	X			
<i>Neglected or abused within last 30 days</i>			X		
<i>Reduced social interaction</i>	X	X			
<i>Social isolation scale</i>	X	X	X	X	X
<i>Major life stressor with last 90 days</i>				X	X
<i>Made financial trade-off within last 30 days</i>				X	X

<i>Lack of personal safety within home environment</i>			X		X
<i>Availability of home grocery delivery</i>			X		