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# Prospective Associations Between Older Adults' Social Connections and Trajectories of Change in Physical Activity and Psychological Well-Being During the COVID-19 Pandemic

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UNIVERSITY OF CALGARY

Prospective Associations Between Older Adults' Social Connections and Trajectories of Change  
in Physical Activity and Psychological Well-Being During the COVID-19 Pandemic

by

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A THESIS

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## Abstract

Social connections show promising evidence for increasing physical activity participation and improving psychological well-being among older adults. However, there is limited longitudinal examinations of associations between different social connection constructs and changes in physical activity and psychological well-being, particularly across periods of rapid change. The purpose of this thesis was to prospectively examine associations between baseline values of social connections and trajectories of change in physical activity and psychological well-being among adults 55 years of age and older. Data was collected over a 6-month period during the COVID-19 pandemic. A single dataset was used for both studies in this thesis. The first study examined associations between seven social connection constructs and trajectories of moderate-to-vigorous physical activity and light-intensity physical activity during a period in the COVID-19 pandemic when access to community-based programs was restricted and then restored to follow public health requirements. Six monthly surveys were administered between October 2021 and May 2022 ( $N = 890$ ). Hypotheses were tested using latent growth curve modelling. Injunctive and descriptive norms did not significantly change over time. Social network and relatedness had a negative linear change whereas social support amount and quality had a positive linear change. Social participation and light-intensity physical activity changed quadratically, and moderate-to-vigorous physical activity demonstrated linear and quadratic change over time. Social network negatively predicted the positive quadratic curve of moderate-to-vigorous physical activity, and descriptive norms positively predicted the quadratic curve of light-intensity physical activity. The second study investigated associations between seven social connection constructs and trajectories of change in stress, negative affect, and positive affect among an older adult sample. Latent growth curve modelling indicated stress and negative affect

declined linearly, while positive affect followed a positive quadratic change. Descriptive norms negatively predicted the change in stress, whereas social participation positively predicted the change in negative affect and negatively predicted the change in positive affect. Together findings from these studies provide insights into the nature of these relationships and suggests levels of social connections may make older adults resilient to factors that change their physical activity and psychological well-being.

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## List of Abbreviations

<b>Abbreviation</b>	<b>Definition</b>
COVID-19	Coronavirus 2019
PA	Physical activity
MVPA	Moderate-to-vigorous physical activity
LPA	Light-intensity physical activity
LTPAQ	Godin-Shepard Leisure-Time Physical Activity Questionnaire

## Chapter 1: Introduction

### 1.1 Research Statement

There is substantive evidence suggesting physical activity (PA) participation improves well-being, reduces the risk of noncommunicable chronic conditions, diminishes cognitive decline, and lessens the risk of mortality in older adults (Langhammer et al., 2018). Despite these benefits, few older adults meet current PA guidelines, including moderate-to-vigorous and light intensity PA recommendations (Rollo et al., 2022). With the global population aging (Jakovljevic et al., 2023), targeted efforts are needed to bolster PA participation, especially among sedentary older adults (Rai et al., 2020). One consideration that may be helpful for improving and maintaining moderate-to-vigorous PA (MVPA) and light-intensity PA (LPA) as well as older adults' psychological well-being are social connections (Kovalenko & Spivak, 2018; Lindsay Smith et al., 2017).

Social connections are multifaceted and can be broadly defined as a subjective sense of closeness, caring, support and the relationships one has with those in their network (Lowe et al., 2023; Santini et al., 2015). While not exhaustive, social connections include social norms (i.e., implicit rules and conventions that can influence conduct and perceptions; Legros & Cislighi, 2020), social network (i.e., a web of relationships perceived as meaningful to and maintained by the individual; Doubova et al., 2010), relatedness (i.e., feelings of closeness, belonging, and connectedness with others; O'Rourke & Sidani, 2017), social participation (i.e., involvement in activities that have interpersonal exchanges with others in a group or society; Levasseur et al., 2010, 2022) and social support (i.e., perceived quality and amount of helpfulness of an interpersonal interaction; Bianco & Eklund, 2001).

The absence of social connections has been identified as an indicator of premature morbidity and mortality (Holt-Lunstad et al., 2017; Naito et al., 2023; Wang et al., 2003). Evidence from a meta-analysis of 148 studies (308,849 participants) found older adults who were socially connected had approximately 50% higher chance of survival when controlling for sociodemographic factors (e.g., age, sex, initial health status; Holt-Lunstad et al., 2017). The influence of social connections on risk for mortality may be similar to other well-documented risk factors including smoking, obesity, and physical inactivity (Holt-Lunstad et al., 2010; Naito et al., 2023; Wang et al., 2003). Social connections also appear to impact a range of other physical and psychological health concerns (Holt-Lunstad et al., 2017). For example, data from a nationally representative study of adults aged 50 and older reported associations with loneliness and greater challenges managing everyday activities when controlling for depression, age, and health status (Shankar et al., 2017). A prospective study examining older adults' social networks (e.g., interaction frequency between social network members and perceived relationship quality) and perceived stress found older adults who had social networks with two or more individuals who also had a strong social tie with each other tended to have lower stress (Ellwardt et al., 2020). The authors suggested the closeness between social network members may contribute to reductions in stress by assisting with the transfer of resources and coordination of support among network members (Ellwardt et al., 2020). Similarly, a cross-sectional study of 50,428 older adults across 18 different countries found higher levels of social engagement and social connectedness were independently associated with higher cognitive scores, memory performance, and may serve as a protective factor against cognitive decline (Paiva et al., 2023). Mechanisms underpinning positive associations between social connections and well-being are complex and include the development and maintenance of social relationships, promoting

cognitive engagement, and the influence of social ties on health behaviour (Ellwardt et al., 2020; Paiva et al., 2023; Umberson & Karas Montez, 2010). Findings further signal a need for examining the impact social connections may have on subsequent changes in the physical health and psychological well-being of older adults (Kovalenko & Spivak, 2018; Lindsay Smith et al., 2017).

PA, including community-based programs, can offer older adults' opportunities for meaningful social connections, including expanding peer networks and cultivating a sense of closeness and rapport among others (Lindsay Smith et al., 2017). Many social connections have distinct correlations with PA (Lindsay Smith et al., 2017; Zimmer & McDonough, 2022). For example, a cross-sectional study with 21,491 older adults, aged 65 to 89 years, found social network size, social contact with network members, and participation in community-based activities were positively associated with total PA (Zimmer & McDonough, 2022). Building on the literature evaluating these associations (Scarapicchia et al., 2017), efforts are needed to examine how higher or lower reported levels of different social connections are associated with changes in PA and well-being. Investigating prospective associations between different social connections and PA, stress, and affect will provide insights into how older adults' behaviour and psychological well-being change over time depending on their social connections.

Older adults' social connections tend to remain stable but disruptions to social connections during the pandemic had broad implications on the psychological and physical functioning of older adults (Raina et al., 2021). In March of 2020, many older adults' social connections changed due to the preventative public health measures put into effect during the Coronavirus 2019 (COVID-19) pandemic (Choi et al., 2024). For example, physical distancing, masking, closures to recreation and other fitness facilities, and reducing social contacts were

preventative public health measures implemented to mitigate the risk of contracting and spreading the virus (Suzuki et al., 2020). To date, several studies have examined the impact of the COVID-19 pandemic on older adults' PA, psychological well-being, and social connections (Fuller et al., 2022; Oliveira et al., 2022; Seckman, 2023; Zhao et al., 2023). Concerns of social isolation (Lefferts et al., 2022), reductions in PA levels (Oliveira et al., 2022), and social contacts (Jarvis et al., 2020; Tomori et al., 2021) were reported in cross-sectional population-based studies during the early stages of the pandemic. The current thesis builds on this prior literature by collecting longitudinal data during a period of changing public health measures related to physical distancing and program closures, from October 2021 to May 2022. During this time, public health measures were less stringent and community-based programs had started to reopen until the COVID-19 subvariant Omicron became the dominant variant and the measures were reintroduced, and then gradually removed when the pandemic wave subsided. Capturing data throughout this period created a unique opportunity to examine how changes in older adults' social connections are prospectively associated with changes in the PA and psychological well-being (Rosen, 2021).

## **1.2 Research Purpose**

The purpose of the current thesis was to prospectively examine associations between baseline values of several social connection constructs (injunctive and descriptive norms, social network, relatedness, social participation, and social support) and trajectories of change in PA (MVPA and LPA) and psychological well-being outcomes (stress, negative affect, and positive affect). Evaluating the change of these variables during the pandemic when public health measures related to physical distancing and program closures were changing was also an aim for this thesis.

### **1.3 Research Hypotheses**

The following research hypotheses were proposed and addressed in two studies:

- (1) There will be a variety of experiences with some participants experiencing improvements, some experiencing declines, and some experiencing stable social connections, PA, and psychological well-being over time.
- (2) All social connections, PA, and psychological well-being variables will on average become worse during time periods where there were greater public health restrictions in place due to the COVID-19 pandemic and will improve during periods when restrictions were lifted or reduced.
- (3) Higher levels of descriptive norms, social networks, relatedness, social participation, and amount and quality of social support, as well as lower levels of injunctive norms will be associated with higher baseline values and greater increases in MVPA and LPA over time.
- (4) Higher levels of descriptive norms, social networks, relatedness, social participation, and amount and quality of social support, as well as lower levels of injunctive norms will be associated with higher baseline values and greater increases in positive affect and lower baseline values and greater decreases in stress and negative affect over time.

### **1.4 Summary of Thesis Format**

This MSc thesis prospectively examined older adults' social connections and the associations with PA and psychological well-being during the COVID-19 pandemic. A single dataset was used for both studies in this thesis and the data was collected from October 2021 to May 2022. This chapter introduced the concepts examined in this thesis and provided a rationale for why these relationships merit further investigation. The second chapter will describe the



conceptualization of social connections, older adults' PA behaviours, psychological well-being, and past literature on why social connections predicting PA and psychological well-being is important to examine. The third chapter will describe a quantitative study that examined social connection, MVPA, and LPA trajectories and associations between social connections and PA trajectories. The fourth chapter will describe a quantitative study that explored trajectories of psychological well-being during the pandemic and prospective associations between social connections and trajectories of psychological well-being in older adults. The fifth chapter will discuss the interpretations of the findings in relation to existing literature as well as the study limitations, and future directions for examining relationships between social connections, PA, and psychological well-being.

## Chapter 2: Literature Review

### 2.1 Theoretical Framework

#### 2.1.1 Conceptualizing Social Connections

Social connections encompass a broad range of variables that are associated with older adults' physical activity (PA) and psychological well-being (Kovalenko & Spivak, 2018; Lindsay Smith et al., 2017). Social connections can be defined several ways including feelings of togetherness, support, and the interpersonal interactions within one's web of relationships (Lowe et al., 2023; Santini et al., 2015). Several systematic reviews have highlighted social connection constructs that address the functional and structural aspects of older adults' interactions (Cornwell et al., 2008; O'Rourke et al., 2017; Wickramaratne et al., 2022). Social connections can be specified to the PA context and can occur when older adults are participating in PA (Lindsay Smith et al., 2017). Social connections include social norms, social networks, relatedness, social participation, and social support (McDonough et al., 2021). This list is not exhaustive but represents many of the social connections that have been shown to be closely associated with moderate-to-vigorous PA (MVPA) and light-intensity PA (LPA; Beselt et al., 2021; Lindsay Smith et al., 2017; McDonough et al., 2021).

Previous research has defined social norms as rules and expectations understood by those who are part of a group (Legros & Cislighi, 2020). Social norms often pertain to perceived pressure or implicit expectations by members of a group to participate or not participate in a specific behaviour (Ganguli et al., 2018). Social norms include injunctive norms (i.e., what most individuals in a group may endorse) and descriptive norms (i.e., what most individuals in a group may accept, perceive, or perform; Legros & Cislighi, 2020). Social norms can influence decisions to be physically active by helping older adults perceive PA as a normative, appropriate,

and feasible behaviour (Meredith et al., 2023; Pelssers et al., 2019). The perception of others successfully engaging in habitual PA (i.e., descriptive norms) may prompt individuals to perceive themselves as able to participate in PA successfully (Stehr et al., 2021). This subsequently may strengthen the desire and engagement in PA over time (Kim & Robertson-Wilson, 2021, 2024). For example, results from a serial mediation model using longitudinal data ( $N = 185$ ) found adults tend to feel more effective and successful engaging in PA when they perceive others successfully engaging in PA (Kim & Robertson-Wilson, 2021).

The current literature on injunctive norms for PA and PA engagement is limited compared to descriptive norms (Kim & Robertson-Wilson, 2024). Injunctive norms can be operationalized by asking older adults the extent to which others may exert pressure to engage in PA (Koeneman et al., 2017; Teixeira Vaz et al., 2019). Such statements may reflect a restrictive social pressure, which can be an ineffective approach to promoting PA initiation and maintenance (Newsom et al., 2022; Ryan & Deci, 2002; Teixeira et al., 2012; Teixeira Vaz et al., 2019). Cross-sectional studies have suggested injunctive norms can create social pressure that undermines older adults' desire for autonomy during PA participation (Kim & Robertson-Wilson, 2024; Newsom et al., 2022). However, lower levels of injunctive norms have also been associated with higher intentions to engage in PA when coupled with lower motivation to comply (Stehr et al., 2021). Given many older adults' desire to build social connections and adhere to social conventions (Legros & Cislighi, 2020; Meredith et al., 2023; Pelssers et al., 2019), further investigations needed to better understand the complexity of social norms and PA participation (Newsom et al., 2022). Findings would further inform how older adults' social norms can be used to leverage PA engagement and improve well-being over time (Koeneman et al., 2017; Newsom et al., 2022).

Social networks are defined as a collection of meaningful personal ties that are maintained by the individual (Litwin, 2010). Social networks can include relationships with members of one's family, friends, neighbours, or other individuals who may be significant to the person (Doubova et al., 2010; Fiori et al., 2006). Social networks encompass structural characteristics (e.g., network size, composition) and the interpersonal environment (frequency of contact, duration of the relationship; Litwin, 2010). A nationally representative population-based study measured social connectedness among American older adults aged 57 to 85 and found as individuals age, their social networks changes, including shifts in the composition, size, and function of the relationships (Cornwell et al., 2008). Reductions in the number and composition of social networks may be related to factors such as retirement, moving to a new location, and loss of family members or friends (Bakhshandeh Bavarsad & Stephens, 2024; Cornwell et al., 2008). However, there are mixed findings investigating older adults' social networks (Fiori et al., 2006; Litwin, 2010). The decreasing and stabilizing of social networks over time may also be due to the finding that older adults tend to be more satisfied with their social network size compared to younger adults (Lansford et al., 1998).

A longitudinal investigation of a national adult life span sample ( $N = 534$ ) found the number of close contacts tends to remain stable with increasing age and becomes primarily comprised of more emotionally fulfilling non-kin relationships (Fiori et al., 2006). Cross-sectional findings have suggested friend-focused networks may provide older adults with greater emotional support compared to family-centred networks (Bruine de Bruin et al., 2020). Older adults who have a greater number of friendships tend to report higher self-reported mental health (Thompson et al., 2024). Evidence from cross-sectional studies have suggested the presence of higher quality and close relationships can promote greater psychological well-being and PA

when they are a source of support for the individual (Bruine de Bruin et al., 2020; Carstensen, 2006; Roberts et al., 2009). For example, in a longitudinal study of middle-aged ( $n = 2,830$ ) and older adults ( $n = 2032$ ), friends were a significant source of support for older adults' PA engagement and well-being as they can offer social opportunities when family members are unavailable (Huxhold et al., 2014). Similar findings among older adults with friend-focused networks have been reported in other cross-sectional studies (e.g., Bruine de Bruin et al., 2020). Having several direct ties to others, including family and friends, may provide older adults with multiple avenues for social connection and increase the likelihood of receiving support when needed (Cornwell et al., 2008). Moreover, the total social network size and frequency of contact with social network members may be useful for capturing key facets of older adult social networks and have been positively associated with older adult PA and psychological well-being (Thompson et al., 2024; Zimmer & McDonough, 2022).

Social participation plays a critical role in the physical health and psychological well-being of older adults (Lindsay Smith et al., 2019). Despite the extensive research on social participation within the older adult literature (James & Buffel, 2023; Ong et al., 2024; Townsend et al., 2021), several definitions and operationalizations of social participation exist (Hashidate et al., 2021). Levasseur et al. (2010) applied a scoping study framework to examine definitions of social participation within the aging literature and suggested defining the concept to include an individual's involvement in activities (e.g., cultural, social, recreational) that provide opportunities for interactions and engagement with other individuals in the community. Opportunities to enhance social participation was also recognized by the World Health Organization (WHO) as an important consideration for addressing concerns related to aging populations (WHO, 2002).

Social participation can involve different kinds of activities, including but not limited to physical activities, and has been largely associated with several health outcomes (e.g., decreased risk of disability, depression, and dementia; Wanchai & Phrompayak, 2019). A systematic review of 76 studies conducted by Townsend et al., (2021) identified a significant relationship between social participation and improvements in physical functioning, cognitive performance, and psychological well-being. Findings also highlighted social factors, such as existing social networks, may be important considerations for increasing social participation (Townsend et al., 2021). However, barriers to initiating and maintaining social participation continue to exist (e.g., transportation, limited programs) and merit further investigation (Townsend et al., 2021). There is also limited evidence on whether higher levels of social participation are associated with rates of change of PA (Kikuchi et al., 2017). Further clarifying associations of social participation, PA, and psychological well-being would inform health strategies targeted for older adult populations and further elucidate the nature of these relationships.

Relatedness refers to feelings of belonging, connectedness, and having meaningful interactions with others (Ryan & Deci, 2002; Wilson et al., 2008). Relatedness is a facet of self-determination theory (SDT) and is considered a basic need (Duncan et al., 2017; Ryan & Deci, 2002, Wilson et al., 2008). Broadly, relatedness has been cross-sectionally associated with higher perceptions of social support and physical functioning and lower levels of psychological distress (Duncan et al., 2017; Vanderhorst & McLaren, 2005). For example, a cross-sectional study of older adults, aged 65 to 100 living in long term care homes, examined the impact of leisure PA on physical and psychological well-being (Duncan et al., 2017). The study found recreational environments can serve as spaces for older adults to foster a sense of relatedness (Duncan et al., 2017; Ryan & Deci, 2002). Additionally, older adults' leisure PA and well-being was partially

mediated by social support, suggesting those who reported greater social support also tend to have lower feelings of loneliness due to their relatedness (Duncan et al., 2017). Older adults may seek out environments that offer opportunities for relatedness (Deci & Ryan, 2014), including recreational facilities. These environments may increase the number of opportunities to connect with others, acquire social resources (e.g., friendship, empathy), establish social networks, and are considered an environmental factor that can directly influence older adults' psychological well-being (Mu et al., 2023).

A possible positive association was found between relatedness, autonomy, competence, and PA adherence ( $N = 209$ ,  $M_{\text{age}} = 68.69$ ) among a cross-sectional sample of active older adults (Kirkland et al., 2011). Similarly, a systematic review of qualitative studies on social factors and older adult PA participation reported increased enjoyment, comfort, and relatedness as well as reduced feelings of loneliness among older adults who exercised with individuals of a similar age and functional status (Meredith et al., 2023). Greater levels of relatedness in these instances may be due to older adults forming relationships with others who may routinely come together for a similar purpose (e.g., participating in a weekly fitness class at a local recreation facility; Kirkland et al., 2011; Meredith et al., 2023). Another systematic review of 66 empirical studies examined perceptions of individuals relatedness and PA and found null and positive associations (Meredith et al., 2023). The authors suggested certain PA contexts (e.g., independent exercise) may not require the same desire for relatedness (Meredith et al., 2023). However, there are limited longitudinal findings investigating relatedness and associations with different PA intensities (i.e., MVPA and LPA) among older adults.

Social support refers to interpersonal exchanges that are perceived as or are intended to be helpful, as well as a general satisfaction with the amount and quality of perceived available

assistance from those in one's network (Bianco & Eklund, 2001). The term social support has been used to broadly define the emotional and practical assistance that is part of meaningful interpersonal interactions (Lindsay Smith et al., 2017). A substantial body of research has examined the role of social support in older adults' physical and psychological outcomes (Donovan & Blazer, 2020; Mu et al., 2023; Lindsay Smith et al., 2017). A systematic review examining the effect of social connections on the cognitive function of older adults found significant positive associations between emotional and general perceptions of social support and global cognition (Kelly et al., 2017). Results also highlighted larger social networks and greater levels of social support were associated with improve global cognition (Kelly et al., 2017). Social support has also been positively associated with PA adherence and participation across several cross-sectional studies, particularly among older adult women (Lindsay Smith et al., 2017). Findings from a prospective study of 1967 older adults emphasized the importance of support from friends for increasing leisure and recreational PA, particularly when instrumental and emotional support was received (Sasidharan et al., 2007). Several kinds of social support have been identified (e.g., informational, emotional, tangible assistance) but general perceptions of social support amount and quality have demonstrated unique associations with PA and other well-being outcomes (Lindsay Smith et al., 2017). For example, a systematic review of prospective studies examining social support and PA participation found social support quality was positively associated with PA, self-reported health, and psychological well-being (Scarapicchia et al., 2017). Similarly, cross-sectional data of American adults aged 50 and older found social support related to PA also associated with total weekly leisure time PA and was a stronger predictor than general measures of social support (Orsega-Smith, 2007). However,



additional longitudinal investigations of general perceptions of social support amount and quality predicting PA and well-being are needed.

## **2.2. Review of Older Adults' Physical Activity Behaviours**

### **2.2.1 Older Adults and Moderate-To-Vigorous Physical Activity**

It is well accepted that PA plays an important role in maintaining a balanced and healthy lifestyle (Warburton et al., 2006). Systematic reviews have suggested benefits of MVPA include improved psychological well-being, functional ability, and reduction in the risk of heart disease (Langhammer et al., 2018). Current 24-hour movement guidelines for older adults suggest an accumulation of at least 150 minutes of aerobic MVPA a week, muscle strengthening activities using major muscle groups at least twice a week, several hours of LPA a week, and physical activities that challenge balance for health benefits (Ross et al., 2020).

Consistent engagement in MVPA offers a variety of advantages to older adults' health outcomes and longitudinal evidence suggests participation can improve psychological well-being and decrease the risk of specific types of cancer, cardiovascular disease, and early morbidity (Arem et al., 2015). For many older adults, aging and the period after or nearing retirement is a critical time to promote PA (Cornwell et al., 2008; Kohl et al., 2012). Engaging in MVPA serves several purposes including being an effective strategy for increasing functional independence in older adults (Kohl et al., 2021; Marques et al., 2014), as it can help retain muscle mass and density (Paterson & Warburton, 2010; Lai et al., 2020). A systematic review and meta-analysis conducted to determine if a lower dose of MVPA was effective in reducing mortality in adults over 60 reported that participating in MVPA below the recommended amounts can also have physical and psychological benefits (Hupin et al., 2015; Pearce et al., 2022).

Several cross-sectional investigations of older adults' social connections and MVPA exist (Flórez et al., 2018). For example, a population-based study of older adults' who had companions within their social network who were available and physically able to participate in MVPA were more likely to meet the PA recommendations compared to those who did not (Böhm et al., 2016). Another cross-sectional survey study examined data from 1146 community-dwelling older adults and found those who had higher social participation spent approximately 50% more time participating in MVPA (Kikuchi et al., 2017). Weekly walking minutes, social support for PA, and self-efficacy have also been associated with greater MVPA in a cross-sectional sample of 718 older adults who were living independently (Carlson et al., 2012). Social connections may encourage older adults who are less active or who are living with a chronic condition to gradually increase their daily activity (Kohl et al., 2012) and incremental increases in PA are still associated health benefits even when participation is below recommended levels (Hupin et al., 2015; Pearce et al., 2022).

### **2.2.2 Older Adults and Light-Intensity Physical Activity**

Many studies have examined associations between MVPA and the benefits of participation (Arem et al., 2015). There is also evidence of associations between LPA and older adults' well-being (Ekelund et al., 2016). For example, a cohort study of 5861 women found participants who were in the highest quartile of LPA had an approximately 40% decreased risk of heart attack and a 22% reduced risk of experiencing a cardiovascular disease event compared to those in the lowest quartile of LPA, after controlling for age and other health related factors (LaCroix et al., 2019). A prospective cohort of individuals aged 65 and older using accelerometers found every additional 500 steps was associated with a 15% lower rate of a major mobility disability (Mankowski et al., 2017). Similarly, middle aged and older adults who met or

exceeded LPA recommendations had a 42% lower risk of disability when compared to inactive older adults, independent of time spent in MVPA (Dunlop et al., 2014). This prospective cohort study included 1680 adults 49 years and older with knee osteoarthritis or risk factors for knee osteoarthritis and measured LPA using an accelerometer (Dunlop et al., 2014).

Many older adults spend much of their time participating in sedentary activities and their remaining time and energy expenditure in LPA (Espinel et al., 2015; Evenson et al., 2011). Understanding the benefits of LPA and factors associated with participation in lower intensities of PA are particularly important given MVPA may become increasingly difficult for some older adults as they age (Carlson et al., 2010). Social connections have also been associated with LPA but there are fewer studies compared to MVPA. For example, individuals who did not have someone who they could walk with were less likely to reach the current LPA recommendations among a cross-sectional sample of community dwelling older adults (Ory et al., 2016). Several prospective cohort studies have evaluated the benefits of LPA participation among older adults (e.g., Mankowski et al., 2017), but there is limited research examining the role of different social connections predicting LPA as an independent outcome while controlling for older adults MVPA. Much of the existing literature examining social connections and LPA is cross-sectional or tends to evaluate PA as total score, suggesting a need for additional longitudinal investigations of older adults' LPA and social connections (An et al., 2020; Espinel et al., 2015).

## **2.3 Review of Older Adults' Psychological Well-Being**

### **2.3.1 Affect and Stress of Older Adults**

Psychological well-being, specifically hedonic psychological well-being, includes affective components of well-being (i.e., positive and negative affect, stress) and has been largely associated with several positive health outcomes (Stone et al., 2010). Affect is comprised

of two valences (i.e., positive and negative affect) and can be defined as both a trait and state (Charles et al., 2016). Trait affect refers to stable patterns of an emotional experience over time across different situations (Watson et al., 1988). State affect refers to short-term perceptions of an event or situation and may fluctuate based on the individual's circumstances (Watson et al., 1988). Positive affect describes subjective perceptions of favourable experiences typically paired with emotional states such as joy, alertness, and attentiveness (Charles et al., 2016). On the other hand, negative affect includes perceptions of adverse experiences coupled with emotional states including feeling hostile, afraid, and ashamed (Charles et al., 2016). Global and hedonic well-being were assessed in a 2008 telephone survey of 340,847 individuals aged 18 to 85 and found older adults tend to report higher levels of positive affect and lower levels of negative affect when compared to younger adults (Stone et al., 2010). Perceived stress refers to the appraisal of the level of uncertainty of well as one's perception of their ability to handle the situation (Phillips, 2013). Stress has been frequently associated with several negative health outcomes among older adults (Nielsen et al., 2008). Cross-sectional cohort studies have suggested older adults may be exposed to several stressful events with age (Da Silva-Sauer et al., 2021), including declines in health, caring for unwell family members, loneliness, and bereavement which may contribute to increased levels of perceived stress over time (Cohen & Janicki-Deverts; Osmanovic-Thunström et al., 2015).

### **2.3.2 Social Connections and Psychological Well-Being of Older Adults**

Previous research suggests older adults' social connections are positively associated with psychological well-being (Wickramaratne et al., 2022). For example, the size and how often older adults contact those within their social networks was associated with positive affect in a cross-sectional sample of older adults aged 50 and older ( $N = 58, 489$ ; Tomini et al., 2016). A

cross-sectional study of older adults between the ages of 65 to 93 ( $N = 1089$ ) who were more socially active and engaged in diverse activities within their community tended to have less psychological stress (Mackenzie & Abdulrazaq, 2021). However, cross-sectional evidence suggests when older adults engage in social participation activities that were perceived as obligatory, social participation was associated with greater psychological distress and poorer mental health outcomes (Sasaki et al., 2021; Tomioka et al., 2017). Similarly, authors Kawachi & Berkman (2001) argued older adults who reported lower perceived relatedness were more likely to experience greater negative affect, particularly among individuals who felt their opportunities to connect was dependent on their ability to offer support to others in their network. Greater quality of social support, compared to amount of social support, has also been associated with lower stress responses in an exploratory study that examined social support as predictors of older adults' cardiovascular reactivity (Howard et al., 2017). There are limited studies investigating injunctive norms predicting psychological well-being outcomes among older adult populations, suggesting a need for further research in this area. Additional longitudinal evidence would contribute to understandings of which social connections may be most relevant to predicting greater psychological well-being among older adult populations.

## **2.4 Summary**

Research suggests declines in functional capacity, quality of life, and increased risk of morbidity may be counteracted by engaging in a more active lifestyle (Cunningham et al., 2020). However, inactive living has become common for many older adults (Kohl et al., 2012), highlighting the continued need for investigating avenues for increasing PA participation and psychological well-being among this age group. Further research is necessary to better understand the associations between social connections and changes in PA participation, stress,

and affect among older adults. The pandemic provided an opportunity to examine these variables during a period of changing public health measures related to physical distancing and program closures. Capturing data during this time allowed for changes in older adults' social connections, PA, and psychological well-being to be examined as well as how social connections may predict changes in these outcomes. Given the concerns about physical inactivity and psychological well-being among older adults, it is important to further examine the nature of these relationships.

**Chapter 3: Associations Between Older Adults' Social Connections and Physical Activity  
During the COVID-19 Pandemic: A Latent Growth Curve Approach**

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### 3.1 Abstract

Social connections appear to be important for increasing physical activity (PA) participation among older adults. However, few studies have examined associations between different social connections and changes in PA, particularly during periods when change is occurring. This study employed latent growth curve modelling to examine associations between seven social connection variables and trajectories of moderate-to-vigorous PA (MVPA) and light-intensity (LPA). Data was collected during a period in the Coronavirus 2019 (COVID-19) pandemic when public health requirements were changing. Six monthly surveys were conducted between October 2021 and May 2022 ( $N = 890$ ). All models demonstrated good fit. Injunctive and descriptive norms did not significantly change over time. Social network and relatedness had a negative linear change whereas social support quality and amount had a positive linear change. Social participation and LPA changed quadratically, and MVPA demonstrated linear and quadratic change over time. Social network negatively predicted the positive quadratic curve of MVPA, and descriptive norms positively predicted the quadratic curve of LPA. Findings suggest PA participation among older adults changed in relation to preventative measures during the pandemic and social network and descriptive norm variables were associated with greater LPA and greater decreases in MVPA over time. Levels of social connections may make older adults more or less resilient to factors that change their PA and highlight how program availability may affect and be affected by social factors and PA.

*Keywords:* exercise, latent growth curve modelling, social support, aging, omicron



## 3.2 Introduction

The proportion of older adults in the Canadian population is rising (Choi & Lee, 2024). Health behaviours, such as engaging in physical activity (PA), can delay or reduce the risk of several chronic conditions later in life and offers physical, psychological, and social benefits (Langhammer et al., 2018). Despite these benefits, less than 15% of older adults meet movement guidelines (Rollo et al., 2022). Engaging in less than the recommended level of PA still provides advantages (Garcia et al., 2023). For example, low doses of moderate-to-vigorous PA (MVPA) has been showed to reduce mortality risk by 22% and these benefits increase linearly as PA increases (Hupin et al., 2015). However, low participation rates suggest a need for better understanding ways to encourage daily movement and promote PA among this population.

Concerns about physical inactivity were heightened during the Coronavirus 2019 (COVID-19) pandemic (Weaver et al., 2021). Longitudinal data collected from adults across the lifespan ( $N = 362$ ) prior to the pandemic and between April and June 2020 found the preventative measures caused notable shifts in participants' perceived health-related behaviours, including reductions in self-reported PA and increases in sedentary behaviour and social isolation (Weaver et al., 2021). Older adults were at a disproportionately higher risk of developing more severe complications associated with the COVID-19 virus and many older adults were physically and socially isolated as a result (Raina et al., 2021). Results from an older adult sample recruited from the Canadian Longitudinal Study on Aging (CLSA) during the initial closures (i.e.,  $n = 28,559$ , March to December 2020) found approximately 40% of participants felt lonely at least some of the time (Savage et al., 2021). Women in this study were more likely to report feeling lonely than men but participants who were older, regardless of gender, had a lower likelihood of loneliness when adjusting for self-reported health status (Savage et al., 2021).

Additionally, a rapid review reported PA levels dropped significantly worldwide during the initial stages of the pandemic and physical distancing protocols and recreation facility closures likely impacted older adults' social opportunities (Park et al., 2022). PA is an important source of social connections for many older adults, offering opportunities to build relationships with others who share common interests, provide a sense of purpose, and can increase confidence (Cornwell et al., 2008; Levasseur et al., 2010; Lindsay Smith et al., 2019; Seppala et al., 2013). The disruptions during the pandemic created an opportunity to examine associations between older adults' social connections and PA patterns during a time when social connections and recreational programming were disrupted (Park et al., 2022; Rosen, 2021). These circumstances also allowed for the investigation of how social connections may predict patterns of change in PA.

### **3.2.1 Social Connections and Older Adults**

Social connections refer to social interactions that provide relationships, support, and feelings of closeness and caring (Lowe et al., 2023; Santini et al., 2015). There are many types of social connection constructs that address functional and structural aspects of how individuals interact with one and other (Beselt et al., 2021; McDonough et al., 2021). While not exhaustive, some major social connection concepts include social norms, social networks, relatedness, social participation, and social support. Social norms are implicit rules or interpersonal conventions including perceptions of what behaviours are endorsed or perceived to be appropriate in a particular context, and what other people are expected to do (Legros & Cislighi, 2020). Social networks are webs of people who we have contact with each other and can be conceptualized in various ways including network size and the frequency of contact between network members (Logan & Spitze, 1994). Social participation refers to involvement in activities that offer

opportunities to interact with others in our communities or society (Levasseur et al., 2010, 2022). Relatedness refers to feeling connected, belonging, and having meaningful interactions with others (O'Rourke & Sidani, 2017). Social support includes interpersonal exchanges that are or are intended to be helpful as well as one's perception of the amount and quality of assistance available from network members (Bianco & Eklund, 2001). These social connection constructs have been shown to have unique associations with PA among older adults (Zimmer & McDonough, 2022) and have been identified as meaningful social connections related to PA among older adult populations (Zimmer et al., 2023).

### **3.2.2 Social Connections and Physical Activity**

Several associations exist between social connections and PA, but associations can vary depending on PA intensity. MVPA and light-intensity physical activity (LPA) may have different associations with health outcomes (An et al., 2020). Moreover, examining associations between social connections and MVPA and LPA may be useful. For instance, older adults who had individuals in their social network who were available and able to participate in MVPA were more likely to meet the PA recommendations (Böhm et al., 2016). Similarly, older adults' who were more satisfied with their social participation were more likely to participate in MVPA when compared to those who were less satisfied (Kikuchi et al., 2017). General social support perceptions were also significantly associated with total weekly MVPA among older adults (Carlson et al., 2012). Several studies have evaluated the benefits of LPA participation among older adults (Mankowski et al., 2017), but few studies have examined the role of social connections predicting LPA as an independent outcome. Part of the current challenge is that many of the existing studies are cross-sectional and often examine PA as a total score, making it difficult to interpret differences across intensities or evaluate changes in these variables over

time (An et al., 2020; Espinel et al., 2015). For example, Boen et al., (2020) evaluated PA mediating the relationship between physical well-being and indicators of social capital (e.g., connectedness with same age peers) and found PA played a minor role in these outcomes. However, PA was calculated by adding together the mean expenditure value for each intensity level rather than evaluating the intensities independently (Boen et al., 2020). Prospective longitudinal studies are needed to further understand the relationships between social connections related to the context of PA and PA among older adults (Lindsay Smith et al., 2017). The mixed findings from a review of prospective associations between social support and PA also emphasized the need for PA specific measurement of social connections, and extending investigations beyond young and middle-aged adults (Scarapicchia et al., 2017).

### **3.3 Purpose**

The current study prospectively examined associations between baseline values of several social connection constructs related to PA (injunctive and descriptive norms for PA, social network size, relatedness with others in the PA context, social participation, and social support for PA) and trajectories of change in MVPA and LPA among adults 55 years of age and older over a 6-month period during the COVID-19 pandemic. The independent trajectories of each social connection and PA variable were also explored. This period captured a time when preventative health measures were changing in response to the Omicron variant. We first examined how older adults' social connections and PA changed over time. We hypothesized that (1) there would be a variety of experiences with some participants experiencing improvements, some experiencing declines, and some experiencing stable social connections and PA over time; and (2) that social connections and PA would on average become worse during time periods

where there were greater public health restrictions in place due to the COVID-19 pandemic and would improve during time periods where those restrictions were relaxed.

Seven social connection constructs (i.e., injunctive norms, descriptive norms, social network, relatedness, social participation, social support quality, and social support amount) were also examined to evaluate prospective associations between PA (i.e., MVPA and LPA) trajectories. We hypothesized (3) higher levels of descriptive norms, social networks, satisfaction with social participation, relatedness, and quality and amount of social support, as well as lower levels of injunctive norms would be associated with higher baseline values and greater increases in MVPA and LPA activity over time.

### **3.4 Method**

#### **3.4.1 Participants**

The study was approved by the University of Calgary Conjoint Health Research Ethics Board (Ethics ID: REB21-1167). Participants were recruited from the Calgary, Alberta area via multiple recruitment channels, including local recreation facilities circulating the recruitment message with a link to the survey to individuals on their email databases, contacting individuals who had participated in previous research and consented to being contacted for future studies, and through social media platforms. Eligible participants were 55 years of age or older at time of study enrollment and were able to complete a questionnaire in English. We aimed to recruit a minimum of 100 participants with complete data across all six waves. Samples of this size can detect small to moderate effect sizes for person-level effects using latent growth curve modelling (Cohen's  $d$ , .20 to .40), and there are diminishing improvements in detectable mean differences with sample sizes greater than 150 participants (Little, 2013). Sample size considerations were also based on the robustness and complexity of the models, potential heterogeneity of the

sample, reliability and scaling of the measures, as well as the discriminant and convergent validity of the measure indicators and constructs (Little, 2013).

In total, 1068 individuals responded to the recruitment message and 899 completed the consent procedure and initiated the baseline survey. Nine participants were excluded because they did not meet the age criteria (i.e., five participants were under 55 years of age and four participants did not provide their age). The final analytical sample size was  $N = 890$  and included eligible participants who completed the consent procedure and at least one survey question relevant to the research question. Analytical sample sizes for the second through sixth survey were  $n = 629$ ,  $n = 620$ ,  $n = 533$ ,  $n = 463$ , and  $n = 425$ . Of the 890 participants, the mean age was 65.05 years ( $SD = 6.91$ ) and approximately 74.83% identified as women, 24.72% identified as men, and less than 1% of participants identified as gender queer, gender non-conforming, or agender. Participants' ethnic and/or racial background included approximately 1.57% Indigenous, 2.91% Asian, 1.35% South Asian, 90.1% White, and less than 1% of participants indicated their ethnic and/or racial background as Arab, Black, Latin American, Southeast Asian, and/or West Asian/Middle Eastern. Additionally, approximately 78.31% of participants were born in Canada, 47.53% completed university or college, and 60.22% were retired. See Table 3-1 for complete sociodemographic characteristics of the study participants.

### **3.4.2 Procedure**

Participants who volunteered to participate in the study clicked a link taking them to a consent form and indicated electronically that they consented to participating in the study by proceeding to the survey questions. Those who were 55 years of age or older and were able to complete an online survey in English first answered a set of demographic questions (first survey only), followed by established measures or modified versions of established measures of social

connections and PA. Participants had the option to skip any question(s) they did not wish to answer.

The first survey took participants approximately 20-45 minutes to complete, and the subsequent surveys took approximately 15-20 minutes to complete. Approximately every 30 days after completing the first survey, participants received an email with the monthly survey link. The second through sixth surveys asked about monthly PA and social connection experiences. Surveys were administered between October 2021 and May 2022.

### **3.4.3 Measures**

**Sociodemographic Characteristics.** Participants' age, gender identity, ethnic and/or racial background, whether they were born in Canada, highest level of education, annual household income, employment status, marital status, number of people in their household, self-identification as a person living with a disability, and whether they were the primary caregiver to a person with a disability or chronic health condition was collected at baseline.

**Social Norms.** Six items adapted from Karvinen et al., (2009) were used to capture social norms. The three items that measured injunctive norms asked participants about whether most people who are important to them (a) think they should exercise regularly, (b) would encourage them to exercise regularly, (c) would support them exercising regularly. The three items that measured descriptive norms asked participants about whether most people who are important to them (a) "exercise regularly themselves", (b) "are extremely active", (c) "have an extremely high exercise level". Participants were asked how much they agree or disagree with the following statements over the past 30 days. Responses were recorded on a Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Scale scores were calculated by taking the average of the items and greater scores indicated high injunctive and descriptive norms, respectively. There

is evidence supporting the valid use (Cronbach's  $\alpha = .93$  and  $.84$ ) of this measure with an older adult sample (i.e.,  $M_{age} = 70.2$  years,  $SD = 11.2$ ; Karvinen et al., 2009).

**Social Network.** Social network was measured using two items from the sociability subscale of the Berkman-Syme Social Network Index (Berkman & Syme, 1979). Social network size was measured by indicating the frequency of contact (e.g., “How many close friends do you have, people that you feel at ease with, can talk to you about private matters”) and perceived closeness (e.g., “How many of those close friends do you see at least once a month”). Participants scored the items on with a 5-point Likert scale (*none, 1-2, 3-5, 6-9, 10 or more*) or indicated “*unknown*”. Social network was calculated by taking the average of the two items and “*unknown*” responses were not included in the calculation; higher scores indicated a larger social network. The sociability subscale of the Berkman-Syme Social Network Index is a reliable measure of social interaction and has demonstrated strong psychometric properties, including construct validity, test-retest reliability (i.e.,  $M_{age} = 20-65$  years; stability estimate  $.92, p < .01$ ), and high internal consistency (Cronbach's  $\alpha = .85$ ; Berkman & Syme, 1979). Factor analyses suggest the subscale items significantly contributed to the broader social network measure, with factor loadings approximately above  $.40$  (Berkman & Syme, 1979).

**Relatedness.** Relatedness was measured using the relatedness satisfaction subscale of the Basic Psychological Need Satisfaction and Frustration Scale (Chen et al., 2015). The Basic Psychological Need Satisfaction and Frustration Scale consists of six factors and each factor is assessed by four items, with a 5-point Likert scale ( $1 = \textit{not at all true}$  to  $5 = \textit{completely true}$ ; Chen et al., 2015). Participants were asked to consider how they typically felt while they were exercising when answering the questions: (a) “I feel that the people who I care about also care about me”, (b) “I feel connected with people who care for me, and for whom I care”, (c) “I feel



close and connected with other people who are important to me”, (d) “I experience a warm feeling with the people I spend time with” (Chen et al., 2015). Responses were rated on a 5-point Likert scale and the mean score of the four items were calculated (Chen et al., 2015). The relatedness satisfaction subscale has demonstrated high internal consistency (Cronbach’s  $\alpha = .90$ ) as well as cross-cultural, convergent, and predictive validity among adult populations (Chen et al., 2015).

**Social Participation.** Social participation was assessed using the World Health Organization Quality of Life Instrument-Older Adults Module (Power et al., 2005). Participants responded to four items from the social participation subscale, including how completely they experienced or were able to do certain things in the last 30 days: “To what extent do you feel that you have enough to do each day?” They also indicated how satisfied, happy, or good they felt about various aspects of their life over the last 30 days: “How satisfied are you with the way you use your time?” (Power et al., 2005). The items were scored on a 5-point Likert scale (1 = *very dissatisfied* to 5 = *very satisfied*) and higher average scores indicated greater satisfaction with social participation (Power et al., 2005). The World Health Organization Quality of Life Instrument-Older Adults Module demonstrated adequate internal consistencies (Cronbach’s  $\alpha$ ) ranging from .72 to .88 and a robust factor structure (e.g., CFI = .94) among an older adult sample ( $N = 5566$ ; Power et al., 2005).

**Social Support.** Social support quality and amount was measured using two items adapted from the Social Support Survey (Richman et al., 1993). The two single item measures captured general perceptions of social support amount and quality received for participating in PA or exercise, including “Currently, how satisfied are you with the amount of support you receive for participating in PA or exercise” and “Currently, how satisfied are you with the quality

of support you receive for participating in PA or exercise”. Items were assessed with 5-point Likert scales (1 = *very dissatisfied* to 5 = *very satisfied*; Rees et al., 2007; Richman et al., 1993). Higher scores indicated more amount and quality of social support. Items were adapted to ask participants about the general amount and quality of social support received for participating in PA. Fong et al., (2017) provided evidence on the reliability (Cronbach’s  $\alpha = .79$  and  $.89$ ) of the quality and amount composite scores derived from the Social Support Survey (Richman et al., 1993). Evidence supporting the use of the adapted version of the measure was based on a sample of adult women who were breast cancer survivors ( $N = 157$ ,  $M_{\text{age}} = 55$ ; Fong et al., 2017).

**Physical Activity.** PA was measured using an adapted version of the Godin-Shepard Leisure-Time Physical Activity Questionnaire (LTPAQ; Godin & Shepard, 1985, 2011). Participants indicated the number of times per week and the average duration of each session (in minutes) they participated in strenuous, moderate, mild, resistance, and flexibility activities (Godin & Shephard, 1985). The MVPA and LPA scores were subsequently converted to hours per week to be on a similar metric to the other study variables. The questionnaire is a simple instrument that is an appropriate measure to estimate PA for older adult populations and does not require high self-reporting skills (Godin, 2011). There is validity evidence to support the use of the questionnaire to classify adults into active and insufficiently active categories (Amireault et al., 2015).

#### **3.4.4 Data Analysis**

Latent growth curve modelling was used to examine prospective relationships between the different social connections and the mean rates of change of different PA intensities (i.e., MVPA and LPA). These modelling techniques were also used to investigate the average trajectories the different social connections and PA intensities followed during the pandemic.

This analysis technique used repeated measures of MVPA and LPA, as latent factors, to evaluate the hypotheses related to older adults' trajectories and examine whether any of the social connections would predict the baseline values and rates of change among these outcomes (Curran et al., 2004). Latent growth curve modelling is a robust technique that can handle missing or nonnormal data patterns as well as evaluate linear and curvilinear growth patterns (Curran et al., 2004). Given the nature of the pandemic and the ongoing changes to the public health measures, latent growth curve modelling was a well-suited analysis technique to capture these complex patterns of change (Curran et al., 2004).

### **3.5 Results**

#### **3.5.1 Preliminary Analysis**

Preliminary analyses were performed using SPSS version 28 (IBM Corp, 2022). Across all six time points, missing data was random and ranged 1.08% to 10.34% for all variables. Variables were reported as missing if participants did not respond to at least one of the construct indicators. Participants were included in analyses if they had complete data or responded to items from any of the social and PA measures from at least one timepoint. If participants had missing data from all the predictor or outcome variables, they were excluded from the analyses.

The skew, kurtosis, and outliers were examined for each variable of interest. MVPA is known to have extreme outliers due to the nature of participants tending to overreport their PA estimations. Upon removing extreme and unplausible estimations (e.g., the number of minutes of LPA extended the plausible number of minutes per week), the distributions of MVPA and LPA were approximately normally distributed. Outliers in the data that were greater than 3.3 *SD* above or below the mean were modified with the value of the mean plus or minus 3.3 times the *SD* (Tabachnick & Fidell, 2007). The social connection variables were all approximately

normally distributed. Subsequently, the averages of each multi-item social connection variable were calculated. If a participant responded to at least one indicator per variable, the average value was calculated based on the responses answered. If a participant responded to at least one of the LTPAQ subscales but left others blank, the blank responses were replaced with a zero. If a participant did not respond to any items on the LTPAQ, they were reported as missing and were not included in the univariate or conditional model analyses. See Table 3-2 for the correlations between the main variables of interest.

### **3.5.2 Confirmatory Factor Analyses**

Confirmatory factor analyses (CFAs) were run to examine if the data fit the presumed measurement models and were conducted for each of the social connection variables that had four or more items in the scales. The full information maximum likelihood estimator with robust standard errors (MLR) was used in the analyses to account for missing data and the possibility of non-normality within the data set. Mplus, version 8.9 (Muthén & Muthén, 2017) was used to run all analyses. Evaluating model fit included examining the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the standard root mean squared residual (SRMR). Models were considered well-fitting if they had an RMSEA of  $\leq .06$ , CFI of  $\geq .95$ , and SRMR of  $\leq .08$  but were considered acceptable if they had an RMSEA of  $\leq .10$ , CFI of  $\geq .90$ , and SRMR of  $\leq .10$ . Relatedness and social participation did not meet the RMSEA criteria and did not improve despite attempting theoretically meaningful modifications. Composite reliability (.77 to .94) coefficient  $H$  (.78 to .95) demonstrated acceptable reliability. Therefore, subsequent models were analyzed using composite scores (i.e., manifest variables; calculated as the average of all items).

### 3.5.3 Unconditional Univariate Models

All univariate models across all social connections and PA demonstrated good fit. Injunctive norms and descriptive norms did not, on average, change significantly over time but rates at which participants social norms were changing did vary significantly across the sample. Social network and relatedness decreased linearly, on average. Participants social network rates of change differed significantly across the sample. Social support amount and quality increased linearly, and participants rates of change did vary. Additionally, the intercepts and linear slope parameters of social networks were positively correlated.

Social participation and LPA changed quadratically, and the rates of change of social participation did vary across participants. The average quadratic slope of social participation did not significantly correlate with the baseline values ( $p = .15$ ) but did correlate with the linear rate of change ( $p < .001$ ). The quadratic slope of LPA was significantly correlated with the baseline values ( $p = .003$ ) and linear rate of change ( $p < .001$ ). MVPA ran as a piecewise model—whereby MVPA decreased linearly, increased linearly, and then changed quadratically. The linear slope one of MVPA was negatively correlated with the baseline values ( $p < .001$ ) and the quadratic slope was negatively correlated with linear slope two ( $p < .001$ ). See Table 3-3 for all univariate unconditional models.

### 3.5.4 Conditional Multivariate Models

The conditional piecewise model of MVPA ( $\chi^2_{(21)} = 23.26, p = .33, \text{RMSEA} = .01, 90\% \text{ CI } [ < .001, .03], \text{CFI} = 1.0, \text{SRMR} = .02$ ) and LPA ( $\chi^2_{(57)} = 35.18, p = .37, \text{RMSEA} = .01, \text{CI } [ < .001, .03], \text{CFI} = 1.0, \text{SRMR} = .03$ ) fit the data well. Social network negatively predicted the quadratic slope of MVPA ( $\lambda = .16, p = .026$ ; see Figure 3-1). Linear slope one of MVPA was negatively correlated with the intercept ( $p < .001$ ) and the quadratic slope was negatively

correlated with slope two ( $p = .008$ ). All observed (i.e., MVPA at time 1-6) and unobserved (i.e., MVPA intercept, linear slope one, linear slope two, quadratic slope) residual variances were significant ( $p < .001$ ), and parameter values ranged from .37 to 5.2. Descriptive norms positively predicted the quadratic rate of change of LPA ( $\lambda = .02, p = .039$ ; see Figure 3-2). The linear slope and intercept of LPA were negatively correlated ( $p = .043$ ) but none of the social connection variables significantly predicted the intercept or linear slopes of MVPA and LPA. All observed LPA variables (i.e., LPA time 1-6) and the LPA intercept had significant ( $p < .001$ ) residual variances that ranged from 1.42 to 5.25. Descriptive norms positively predicted the intercept of MVPA ( $\lambda = .16, p = .053$ ) and negatively predicted the linear slope of LPA ( $\lambda = -.094, p = .051$ ), and social network negatively predicted linear slope two of MVPA ( $\lambda = .41, p = .053$ ); these findings were close to significance but should be interpreted in light of the large sample size. The effect sizes of the significant pathways for the conditional models ranged from small to medium.

### 3.6 Discussion

The purpose of the current study was to use the pandemic as a natural experiment (Rosen, 2021) to examine the relationship between older adults' social connections and their PA as well as evaluate the average trajectories of these variables during the pandemic. The results of the present study partially supported the hypotheses. Firstly, participants social connection trajectories did differ significantly within the sample, except for relatedness and PA. Secondly, social participation, LPA, and MVPA did on average become worse during periods where there were greater public health restrictions in place and improved when pandemic related restrictions relaxed. Lastly, of the seven social connections evaluated as predictors of PA, lower levels of social networks predicted greater increases of MVPA, and higher levels of descriptive norms

predicted greater increases of LPA over time. These results are one of very few longitudinal examinations of social connections related to PA predicting different patterns of MVPA and LPA. The results of this research also provide supporting evidence that older adults' social connections are relevant to predicting PA and that the pandemic did disrupt the physical and social well-being of older adults.

Identifying univariate trajectories of older adults' social connections and PA allowed patterns of change to be evaluated across the sample and between the different variables. Results indicate older adults' social connections and PA trajectories responded differently to the public health measures. Variables, such as social support, had positive linear patterns whereby participants satisfaction with the amount and quality of their social support were increasing, on average, over time. Other variables, such as social networks and relatedness, had negative linear patterns and injunctive and descriptive norms remained stable despite changes to public health measures (Park et al., 2022). Interestingly, social participation and PA followed similar curvilinear patterns, which closely followed the closures and openings of the public health measures put in place during the pandemic.

The average baseline reports of social networks, LPA, and MPVA were positively associated with their corresponding rates of change. This suggests that those who had greater social networks, LPA, and MVPA at the beginning of the study were more likely to experience greater increases or slowed decreases in their PA over time. These results are consistent with the findings that older adults social and PA experiences were disrupted during the earlier stages of the pandemic (Derrer-Merk et al., 2023; Oliveira et al., 2022). Taken together, findings demonstrate differences among older adults' social and PA responses during the pandemic and

support claims that social connection variables are distinct, and some closely follow PA patterns over time.

The examination of how baseline social connection constructs predicted trajectories of change in MVPA and LPA provide further insight into the associations between social connections and PA (Meredith et al., 2023; Rai et al., 2020). Understanding factors that support PA is relevant given the relatively high rates of physical inactivity among older adults (Rollo et al., 2022) and the 24-hour movement guideline recommendations of at least 150 minutes of MVPA and several hours of light physical activities per week (Ross et al., 2020). Findings demonstrate those who saw more examples of people in their social circle being physically active and saw PA as more typical or normal for someone like themselves at the start of the study typically experienced greater increases in their LPA over time. These results were consistent with previous reports that greater endorsement of descriptive norms is associated with greater PA over time (Priebe & Spink, 2011). However, it is relevant to note the effect sizes in this model; descriptive norms likely have modest effects on LPA, and utility in interventions requires further research.

Those who had larger social networks at the beginning of the study typically experienced greater decreases in their MVPA over the six months. A possible interpretation of these findings is a ceiling effect—older adults who had larger social networks may otherwise benefit from social opportunities that facilitate physical activities, but there may be a threshold of those benefits (Lansford et al., 1998). Concerted efforts are often needed to maintain a large social network and that may impact opportunities to engage in more vigorous forms of PA (Roberts et al., 2009). Additionally, during the earlier stages of the pandemic, many older adults' social networks and relatedness decreased but their satisfactions with their level of general social support increased,



suggesting a shift towards more centralized social ties within one's network during this time (Steijvers et al., 2022).

### **3.6.1 Limitations**

Despite the study strengths, there were several limitations that should be acknowledged. Limitations of the study include the latent variables for relatedness and social participation constructs not meeting the criteria for good fit. Using the scale scores is a common solution to addressing concerns with fit, but it means that measurement error was not accounted for in the models. The study sample was relatively homogenous (e.g., White, highly educated, high annual household income). This limits the generalizability of the findings. Future research should aim to recruit a more diverse and representative sample of older adults to better understand the nature of these relationships. Lastly, although outliers and implausible responses were removed for the PA outcomes, it is possible that the measures used to capture PA produced over estimations. Future research would benefit from incorporating other methods (e.g., accelerometer) to examine older adults' PA behaviours.

### **3.6.2 Conclusion**

The present research contributes to the growing body of evidence suggesting the usefulness of social connections predicting PA behaviours among older adults. Specifically, this longitudinal examination adds to current understandings of how older adults' social connections and PA were disrupted during the pandemic. Evaluating several social connections in one model predicting PA further informed the nature of these relationships and may help contribute to the development of future PA interventions for older adults. Future research should consider examining growth factors of the different social connections and PA simultaneously, as it will provide additional insights into how social connections can be used to increase and sustain PA

engagement of older adults. Furthermore, findings suggest older adults' social connections and PA responded to the cyclic waves of the pandemic and preventative measures differently and certain social connections were more closely associated with PA than others. Additional research exploring how social connections are related to and may co-develop with different PA intensities over time is warranted to better understand the underlying processes of these relationships.

**Table 3-1***Sociodemographic Characteristics of Study Participants*

Sample characteristics				
	<i>N</i>	%	<i>M</i>	<i>SD</i>
Age	890		65.05	6.907
Gender identity				
Woman	666	74.83		
Man	221	24.83		
Gender queer	2	.22		
Gender non-conforming	1	.11		
Agender	1	.11		
Other options not listed	2	.22		
Prefer not to answer	1	.11		
Ethnic and/or racial background				
White	809	90.1		
Asian	26	2.91		
Indigenous	14	1.57		
South Asian	12	1.35		
Black	5	.56		
Latin American	5	.56		
Southeast Asian	4	.45		
Arab	1	.11		
West Asian / Middle Eastern	1	.11		
Other options not listed	22	2.47		
Prefer not to answer	4	.45		
Born in Canada				
Yes	697	78.31		
No	188	21.12		
Years lived in Canada			47.43	17.58
Highest level of education				
At least some high school	239	26.85		
Completed university or college	423	47.53		
At least some graduate school	181	20.33		
Other options not listed	42	4.72		
Prefer not to answer	3	.34		
Annual household income				
\$39,000 or less	130	14.61		
\$40,000 to \$79,999	236	26.52		
\$80,000 or over	346	38.88		
Prefer not to answer	174	19.55		
Current employment status				
Retired	536	60.22		
Employed full time or part time	263	29.55		

Temporarily unemployed	28	3.15		
On disability or sick leave	19	2.13		
Homemaker	17	1.91		
Other options not listed	51	5.73		
Prefer not to answer	4	.45		
<hr/>				
Current marital status				
Married or common-law	542	61.45		
Separated or divorced	169	18.98		
Single	103	11.57		
Widowed	67	7.53		
Other options not listed	3	.34		
Prefer not to answer	5	.56		
<hr/>				
Number of people who live in the household				
Live alone	280	31.46		
With one other person	486	54.61		
With two or more people	116	13.03		
Prefer not to answer	5	.56		
<hr/>				
Self-identify as a person living with a disability				
No	807	90.67		
Yes	72	8.09		
Prefer not to answer	8	.90		
<hr/>				
Primary caregiver to a person with a disability or chronic health condition				
No	832	93.48		
Yes	50	5.62		
Number of years caregiving			9.21	9.42
Prefer not to answer	2			
<hr/>				

**Table 3-2***Descriptive Statistics and Correlations of Variables at Baseline*

Variable	1	2	3	4	5	6	7	8	9
1. Injunctive norms	-								
2. Descriptive norms	.49*	-							
3. Social network	.55	.10*	-						
4. Social participation	.16*	.15*	.30*	-					
5. Relatedness	.24*	.21*	.30*	.35*	-				
6. Social support amount	.30*	.30*	.20*	.41*	.34*	-			
7. Social support quality	.28*	.28*	.20*	.44*	.36*	.90*	-		
8. MVPA	.12*	.15*	.10*	.17*	.11*	.22*	.22*	-	-
9. LPA	.01	.03	.01	.02	.02	-.01	-.001	-.05	-
<i>n</i>	818	816	820	817	817	801	798	817	817
<i>M</i>	5.60	4.48	2.55	3.34	4.26	3.73	3.70	3.87	2.39
<i>SD</i>	1.54	1.71	.82	.82	.82	.97	.98	3.68	3.00

*Note.* Pearson correlations are reported on the diagonal for Time 1 study variables; \*  $p \leq .05$ ; MVPA = moderate-to-vigorous physical activity; LPA = light-intensity physical activity

**Table 3-3***Unstandardized Mean Estimates and Standard Errors of Unconditional Univariate Models*

Univariate models	Intercept			Linear Slope			Quadratic Slope		
	$\lambda$	<i>SE</i>	<i>p</i>	$\lambda$	<i>SE</i>	<i>p</i>	$\lambda$	<i>SE</i>	<i>p</i>
Descriptive norms	4.45	.05	< .01	.004	.01	.77			
Injunctive norms	5.59	.05	< .01	.002	.01	.88			
Social network	2.56	.03	< .01	-.06	.015	< .01			
Relatedness	4.27	.03	< .01	-.06	.02	< .01			
Social participation	3.35	.03	< .01	-.04	.02	.04	.02	.003	< .01
Social support quality	3.71	.03	< .01	.02	.01	.01			
Social support amount	3.75	.03	< .01	.02	.01	.02			
LPA	2.30	.10	< .01	-.45	.07	< .01	.08	.01	< .01

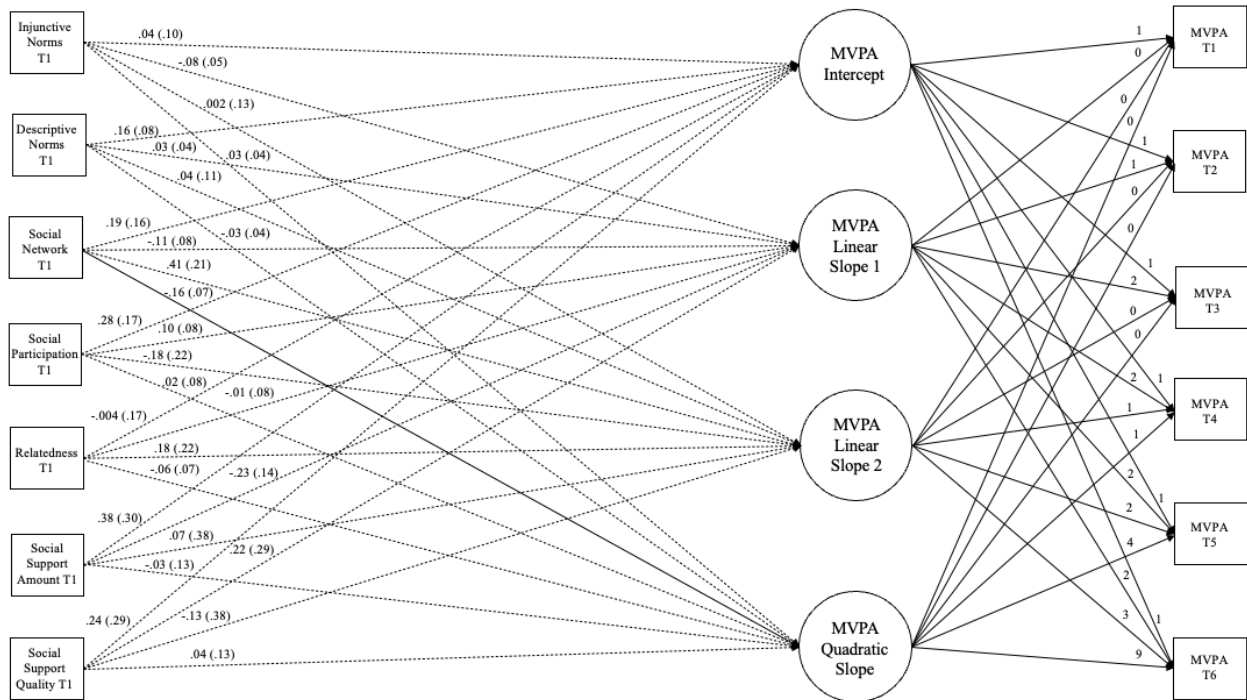
  

Univariate piecewise model	Intercept			Linear Slope 1			Linear Slope 2			Quadratic Slope		
	$\lambda$	<i>SE</i>	<i>p</i>	$\lambda$	<i>SE</i>	<i>p</i>	$\lambda$	<i>SE</i>	<i>p</i>	$\lambda$	<i>SE</i>	<i>p</i>
MVPA	3.87	.13	< .01	-.22	.06	< .01	.64	.16	< .01	-.17	.05	< .01

*Note.* MVPA = moderate-to-vigorous physical activity; LPA = light-intensity physical activity

**Figure 3-1**

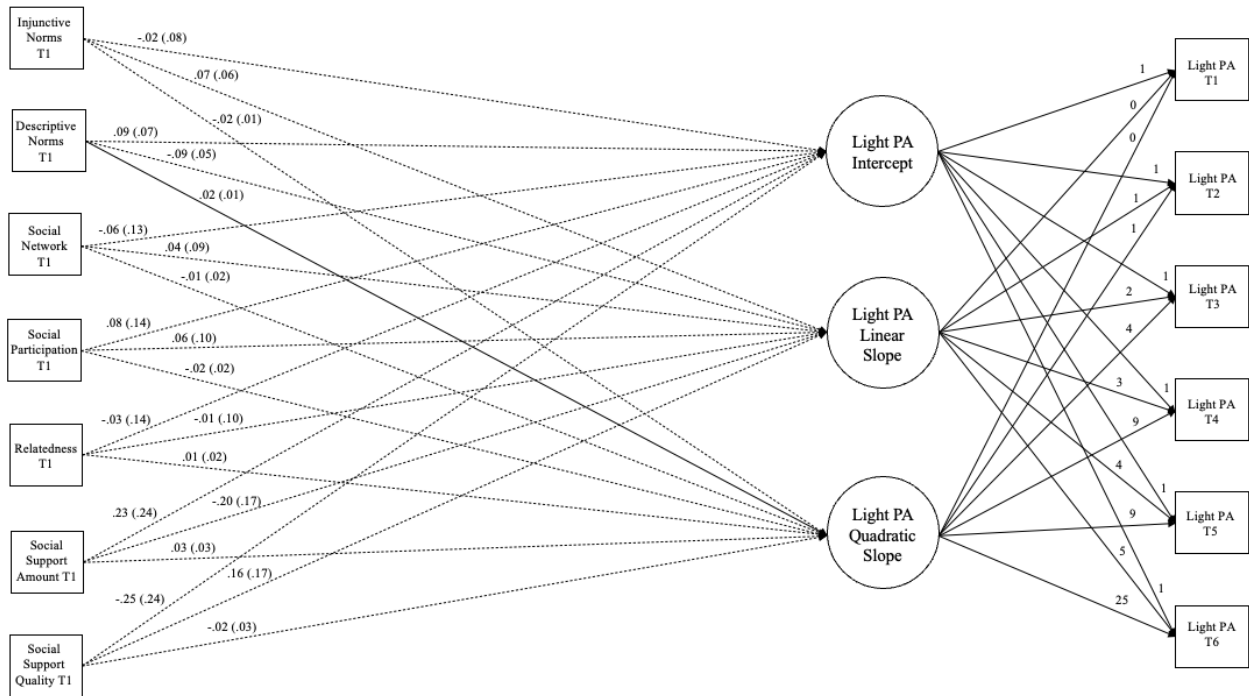
*Conditional Latent Curve Model Predicting Trajectory of Change in MVPA*



*Note.* Statistical significance of  $p \leq .05$ ; standardized parameter estimates for all pathways were reported.

**Figure 3-2**

*Conditional Latent Curve Model Predicting Trajectory of Change in LPA*



*Note.* statistical significance of  $p \leq .05$ ; standardized parameter estimates for all pathways were reported.



**Chapter 4: Prospective Associations Between Social Connections and Trajectories of Psychological Well-being Among Older Adults During the COVID-19 Pandemic**

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## 4.1 Abstract

Social connections are critical to well-being, and physical activity contexts can be an important source of connections for older adults. However, public health restrictions and shutdowns due to the Coronavirus 2019 (COVID-19) pandemic disrupted these social opportunities and negatively impacted older adults' psychological well-being. This study investigated whether social connections predicted trajectories of change in older adults' psychological well-being between October 2021 and May 2022. Data collection occurred during a period when preventative public health measures were changing in response to the pandemic. Six monthly surveys were administered to 890 adults aged 55 and older. Trajectories of change in the psychological well-being variables (perceived stress, negative affect, and positive affect) were first examined using latent growth curve modelling. We then explored which social connection variables (injunctive norms, descriptive norms, social networks, relatedness, social participation, and social support quality and amount) predicted the psychological well-being trajectories. Stress and negative affect declined linearly, while positive affect followed a positive quadratic change. Descriptive norms negatively predicted the change in stress, whereas social participation positively predicted the change in negative affect and negatively predicted the change in positive affect. Findings indicate that while certain social connections were associated with adaptive outcomes, others were associated with less favorable results as some participants may have had more to lose when shutdowns occurred. Further research is needed to understand how these connections may promote and maintain psychological well-being among older adults, particularly during circumstances when social connections are disrupted.

*Keywords:* mental health, exercise, mood, rates of change, latent growth curve modelling

## 4.2 Introduction

Social connections are critical to several facets of well-being (Zanjari et al., 2022) and physical activity (PA) contexts can be an important source of these connections for older adults (Franco et al., 2015). Social connections can be defined as perceived sense of closeness, caring, support and the relationships one has with those around them (Lowe et al., 2023). To date, there are limited longitudinal studies that have examined older adults' social connections; much of the existing research has yielded cross-sectional findings and tends to focus on one or a small number of social connection variables (Lindsay Smith et al., 2017). Few studies have examined older adults' social connections related to PA (McDonough et al., 2021) and how these variables may predict changes in psychological well-being outcomes. Establishing cause and effect among these variables has also been limited as social connections tend to be difficult to manipulate and remain relatively stable over time (Rook & Charles, 2017). However, social disruptions were common during the COVID-19 pandemic and may have been important contributors to negative well-being outcomes among older adults (Raina et al., 2021), signaling a need for further investigation.

Physical distancing protocols, recreation facility closures, and challenges with communication technology used to move programs online during the pandemic contributed to changes in older adults' social environments and relationships, sense of connectedness, and ability to participate socially (Raina et al., 2021). Changes to older adults' social connections during this time, however, created a unique opportunity for researchers to investigate the pandemic as a natural experiment (Rosen, 2021). Collecting longitudinal data over a period of changing public health measures related to physical distancing and program closures could enable us to determine how older adults' social connections predict trajectories of change in their

psychological well-being. Since less is known about how older adults' well-being may have changed during the later stages of the pandemic (Ooi et al., 2023), there is also a need to understand the unintended social consequences of the pandemic and how it may have impacted the psychological well-being trajectories of older adults (Webb & Chen, 2022).

#### **4.2.1 Social Connections and Physical Activity of Older Adults**

Social connections play a critical role in older adults' adaption to aging-related challenges (Sharifian et al., 2022) and may have implications for psychological well-being (Fasihi et al., 2017). Social connections are complex and conceptualizing how older adults evaluate the availability of or access to social connections can be examined in several ways, such as social norms (i.e., unwritten social and interpersonal conventions that can impact behaviours and cognitions; participating in actions that an individual believes others may do [i.e., descriptive norms] and social pressures to engage in those actions [i.e., injunctive norms] are types of social norms; Legros & Cislighi, 2020), social networks (i.e., the total connections perceived as significant to the individual and can include the number and frequency of contacts; Logan & Spitze, 1994), relatedness (i.e., feelings of connectedness, belonging, and experiences of meaningful interactions with others in a group; O'Rourke & Sidani, 2017), social participation (i.e., engagement in activities that facilitate interpersonal exchanges with others in the community or society; Levasseur et al., 2010), and social support (i.e., perceptions of interactions aimed at being helpful to the recipient; Bianco & Eklund, 2001).

While these social concepts are part of several theoretical perspectives and overlap, they are conceptually distinct and have been shown to have unique associations with PA among older adults (Zimmer & McDonough, 2022). Several studies have examined different social connections, but few studies have investigated and compared multiple social connections related

to PA in one study (McDonough et al., 2021). Additionally, there is limited research that has examined how different social connections predict psychological well-being outcomes among older adult populations. Such findings would further inform the relationship between social connections and psychological well-being as well as contribute to future interventions that may target PA participation and well-being among this population.

#### **4.2.2 Social Connections and Psychological Well-being**

Psychological well-being is a multidimensional construct and has been conceptualized to include measurements of affect and stress (Kovalenko & Spivak, 2018; Stone et al., 2018; Tang et al., 2019). Affect has two valences (i.e., positive and negative affect) and is considered a trait and state (Watson et al., 1988). Namely, positive affect is characterized by experiences of joy, increased levels of energy, enthusiasm, alertness, and concentration (Watson et al., 1988). Whereas negative affect tends to be marked by experiences such as distress, anger, contempt, and nervousness (Watson et al., 1988). Trait affect refers to a consistent reaction towards an experience with either positive or negative emotions while state affect depicts an individual's affect at a specific instance (Watson et al., 1988). Perceived stress is characterized by an individual's evaluation of the amount of uncertainty and instability in their life and the perception of their ability to handle those challenges (Phillips, 2013).

Older adults' social connections are generally positively associated with their psychological well-being. While there is limited research on social norms, researchers have found positive associations between older adults' social network size and frequency of contact with network members and positive affect (Tomini et al., 2016). Higher levels of social participation has also been positively associated with well-being outcomes, as it can afford older adults greater opportunities to engage in social activities and feel connected to others (Mackenzie

& Abdulrazaq, 2021). Lower perceived availability of relatedness is associated with higher levels of negative affect, with these associations most prominent when older adults feel their social connection experiences involve a sense of responsibility to offer support to others (Kawachi & Berkman, 2001). Additionally, quality of social support rather than amount may predict lower physiological reactivity to perceptions of stress (Howard et al., 2017). Given these findings, the current study will build on existing literature by longitudinally examining multiple social connection variables, related to a PA, predicting psychological well-being outcomes during a time when change was naturally occurring as a result of the COVID-19 pandemic (Rosen, 2021).

### **4.3 Purpose**

The current study investigated which social connections are associated with trajectories of change in older adults' psychological well-being. The primary study aim was to examine how seven baseline social connections (e.g., injunctive norms, descriptive norms, social network, relatedness, social participation, social support amount, and social support quality) predicted trajectories of change in stress, negative affect, and positive affect among adults 55 years of age and older. It was hypothesized that (H1) higher levels of descriptive norms, social networks, relatedness, satisfaction with social participation, and amount and quality of social support, as well as lower levels of injunctive norms would be associated with (1) higher baseline values and greater increases in positive affect, and (2) lower baseline values and greater decreases in negative affect and perceived stress over time.

The secondary study aim was to examine how older adults' positive affect, negative affect, and perceived stress changed over time during the pandemic. It was hypothesized that (H2) there would be a variety of experiences with some participants experiencing improvements, some experiencing declines, and some experiencing stable psychological well-being over time.

Furthermore, it was expected that (H3) participants' well-being would on average become worse during time periods where there were greater public health restrictions in place due to the COVID-19 pandemic and would improve during time periods where those restrictions were relaxed.

## **4.4 Method**

### **4.4.1 Participants**

Participants aged 55 and older were asked to complete six monthly online surveys administered approximately four weeks apart between October 2021 and May 2022. This period reflected the fifth wave of the COVID-19 pandemic when public health measures were changing in response to the Omicron virus. Participants were recruited through multiple avenues. Local recreation facilities and groups serving older adults circulated the recruitment message with a link to the first survey to individuals in their email databases. The recruitment message with a link to the survey was also emailed to participants who participated in previous research and indicated they wished to be contacted for future studies. Recruitment messages were also posted on different social media and news outlets.

Participants were eligible for the study at the time of recruitment if they (a) were 55 years of age or older, and (b) were able to complete the online questionnaire in English. To detect person-level effects using latent growth curve modelling, we aimed to recruit a minimum of 100 participants at each time point to produce robust models that could detect small to moderate effect sizes (Cohen's  $d$  of approximately .20 to .40; Little, 2013). In total, 1068 individuals responded to the initial recruitment message and 899 completed the consent procedure and initiated the baseline survey. Nine participants were excluded due to not meeting the age criteria (i.e., five participants were under 55 years of age and four participants did not provide their age).

The final analytical sample size was  $N = 890$  and the analytical sample sizes for the second through sixth survey were  $n = 629$ ,  $n = 620$ ,  $n = 533$ ,  $n = 463$ , and  $n = 425$  respectively. The mean age of participants was 65.05 ( $SD = 6.91$ ) and approximately 74.83% identified as women, 24.72% identified men, and less than 1% identified as gender queer, gender non-conforming, or agender. Participants ethnic and/or racial background included 1.57% Indigenous, 2.91% Asian, 1.35% South Asian, and 90.1% White. Less than 1% of participants identified as Arab, Black, Latin American, Southeast Asian, and/or West Asian/Middle Eastern. Approximately 78.31% of participants indicated they were born in Canada, 47.53% completed university or college, 38.88% of participants had an annual household income of \$80,000 or more, 60.22% were retired, and 61.45% were married or common law.

#### **4.4.2 Procedure**

The current study was approved by the University of Calgary Conjoint Health Research Ethics Board (Ethics ID: REB21-1167). Individuals who were interested in participating were instructed to click the link in the recruitment message, which took them to an electronic consent form. If participants consented, they were directed to demographic questions, which were only asked on the first survey, followed by social connection and psychological well-being questionnaires (all time points). Participants received an email every 30 days, after completing the first survey, with a link for the second through sixth surveys. The first survey took participants approximately 20-45 minutes to complete and subsequent surveys took approximately 15-20 minutes. For each survey they participated in, participants were entered into a draw for 1 of 10 \$50 prepaid electronic gift cards.



#### 4.4.3 Measures

**Sociodemographic Characteristics.** Participants were asked their age, gender identity, ethnicity and/or race, immigration status, highest level of education, household income, employment status, marital status, number of people that live in their household, if they self-identified as a person living with a disability, and if they were a primary caregiver.

**Social Norms.** A subjective norm scale developed by Karvinen and colleagues (2009) was used to measure injunctive and descriptive norms. Participants responded to three injunctive norm items (e.g., “Most people who are important to me think I should exercise regularly;” 1 = *strongly disagree* to 7 = *strongly agree*), and three descriptive norm items (e.g., “Most people who are important to me exercise regularly themselves; 1 = *strongly disagree* to 7 = *strongly agree*; Karvinen et al., 2009). The average of the two items were calculated and higher scores indicated higher injunctive and descriptive norms. Evidence to support the valid use of this brief social norms measure was based on a sample of older adults who survivor bladder cancer (Cronbach’s  $\alpha = .93$  and  $.84$ ; Karvinen et al., 2009).

**Social Network.** Two items from sociability subscale of the Berkman-Syme Social Network Index were used to measure social network (Berkman & Syme, 1979). Participants were asked: (1) “How many *close friends* do you have, people that you feel at ease with, can talk to you about private matters” and (2) “How many of those *close friends* do you see at least once a month” (Berkman & Syme, 1979). Response options included *none*, *1-2*, *3-5*, *6-9*, *10 or more*, and *unknown* and the averages of the two items were calculated. Higher social network scores indicated a larger social network (Berkman & Syme, 1979). The sociability subscale is a brief and reliable measure of social network, has a well-fitting factor structure, demonstrated test-

retest reliability (i.e., stability estimate .92,  $p < .01$ ), and high internal consistency (Cronbach's  $\alpha = .85$ ; Berkman & Syme, 1979).

**Relatedness.** The relatedness subscale of the Basic Psychological Need Satisfaction and Frustration Scale was used to measure relatedness (Chen et al., 2015). Participants responded to four items using a 5-point Likert scale (1 = *not at all true* to 5 = *completely true*) and were instructed to consider how they typically felt while they were exercising when responding to the following: (a) "I feel that the people who I care about also care about me", (b) "I feel connected with people who care for me, and for whom I care", (c) "I feel close and connected with other people who are important to me", (d) "I experience a warm feeling with the people I spend time with" (Chen et al., 2015). There is evidence to support the use of the relatedness subscale in older adult populations; the measure has demonstrated high internal consistency (Cronbach's  $\alpha = .90$ ) and convergent and predictive validity (Chen et al., 2015).

**Social Participation.** The social participation subscale of the World Health Organization Quality of Life Instrument-Older Adults Module was used to assess social participation (Power et al., 2005). Participants responded to four items. One item asked how completely the participant experienced or was able to do certain things in the last 30 days (i.e., "To what extent do you feel that you have enough to do each day?") and three items asked how satisfied, happy, or good the participant felt about various aspects of their life over the last 30 days (e.g., "How satisfied are you with the way you use your time?"; Power et al., 2005). All items were scored on a 5-point Likert scale (1 = *very dissatisfied* to 5 = *very satisfied*) and higher scores indicated greater social participation satisfaction. The scale has been validated with an older adult sample 65 years of age and older and demonstrated good fit indices based on confirmatory factor

analyses (e.g., CFI = .94) and had acceptable internal consistencies ranging from .72 to .88 (Power et al., 2005).

**Social Support.** Two items from the Social Support Survey were used to measure social support amount and quality (Richman et al., 1993). The items were adapted to briefly assess participants' general perceptions of social support received when participating in PA or exercise (i.e., "Currently, how satisfied are you with the amount of support you receive for participating in PA or exercise?" and "Currently, how satisfied are you with the quality of support you receive for participating in PA or exercise?") and were rated on a 5-point Likert scale (1 = *very dissatisfied* to 5 = *very satisfied*; Rees et al., 2007; Richman et al., 1993). The original Social Support Survey was a multifaceted assessment of social support and was initially developed as a clinical assessment instrument (Richman et al., 1993). There is evidence to support the reliable use of the composite scores of social support amount and quality from this measure (Cronbach's  $\alpha = .79$  and  $.89$ ) as a brief assessment of social support in older adult populations (Fong et al., 2017).

**Affect.** The International Positive and Negative Affect Schedule Short-Form assessed positive and negative affect (Thompson, 2007). Participants indicated the extent to which they typically agreed with two 5-item mood scales during the past month for positive affect (i.e., active, determined, attentive, inspired, and alert) and negative affect (i.e., afraid, nervous, upset, hostile, and ashamed; Thompson, 2007). Participants rated each item using a 5-point Likert scale (1 = *not at all* to 5 = *extremely*; Thompson, 2007). Scores for positive and negative affect were calculated by summing each affect subscale and dividing by the number of items; higher scores indicated high positive and negative affect. The measure has demonstrated convergent, internal,

and factorial validity in a community sample of adults and is well-suited as a measure of affect among aging populations (Mackinnon et al., 1999)

**Perceived Stress.** The Perceived Stress Scale - Short Form (PSS-4) was used to measure perceived stress (Cohen et al., 1983). Participants responded to four items on a 5-point Likert scale (1 = *never* to 5 = *very often*) about levels of stress in the past month and how often they have (a) “been upset because something happened unexpectedly”, (b) “felt that you were unable to control important things in your life”, (c) “felt nervous and stressed”, and (d) “found you could not cope with all the things that you had to do” (Cohen et al., 1983). The mean of the items was calculated, and higher scores indicate greater perceived stress (Cohen et al., 1983). The scale is a reliable (Cronbach’s  $\alpha = .77$ ) and brief measure of stress and demonstrated acceptable psychometric properties across several cultures and languages (Cohen et al., 1983; Warttig et al., 2013).

#### **4.4.4 Analysis**

Latent growth curve modelling was used to explore predictive relationships between social connections and the mean rates of change of psychological well-being. It was also used to examine trajectories of psychological well-being during the pandemic. This method modelled repeated measures of psychological well-being (as latent factors) to test our hypotheses about older adults’ trajectories and determine whether time invariant social connection variables predicted the psychological well-being trajectories of participants (Curran et al., 2004). Latent growth curve modelling is robust approach used against missing data and can test linear and nonlinear growth, which is important given the nature of the COVID-19 pandemic and the changes in public health measures during the time of data collection (Curran et al., 2004).

## 4.5 Results

### 4.5.1 Preliminary Analyses

Data was missing at random and ranged from 1.08 % to 10.34% across the six surveys. All available data was used for analyses involving latent variables. Prior to examining the models, the distributions were evaluated by calculating the skewness and kurtosis of each variable and examining outliers. All items were approximately normally distributed. Person means imputation was used to calculate scale scores. Scale scores were created for each social connection and psychological well-being variable by calculating the mean score of one or more of the items answered (i.e., manifest variables). Outliers that were greater than 3.3 SD above or below the mean were replaced with the value of the mean plus or minus 3.3 times the SD, as applicable (Tabachnick & Fidell, 2007). See Table 4-1 for the descriptive statistics and correlations at time one for each variable.

### 4.5.2 Confirmatory Factor Analyses

Confirmatory factor analyses (CFAs) and reliability estimates were conducted to examine the scales. The CFAs were performed with Mplus version 8.9 (Muthén & Muthén, 2017) using full information maximum likelihood estimation with robust standard errors (MLR) to account for the possibility of non-normality. CFAs were conducted for measures that had four or more items. Model fit was evaluated based on multiple indicators, with root mean square error of approximation (RMSEA)  $\leq .06$ , comparative fit index (CFI)  $\geq .95$ , and standardized root mean squared residual (SRMR)  $\leq .08$  considered indicative of a very good fit (Hu & Bentler, 1999). Theoretically meaningful modifications were explored for models not reaching the outlined goodness-of-model fit criteria. However, model fit was considered acceptable if models reached less stringent fit criteria of RMSEA  $\leq .10$ , CFI  $\geq .90$ , and SRMR  $\leq .10$  (Little, 2013). CFAs

revealed that none of the measurement models met fit criteria. RMSEA ranged from .00 to .28; CFI ranged from .90 to 1.0; SRMR ranged from .002 to .06 (see Table 4-2 for example of CFA Time one fit indices). Despite attempts to improve fit through theoretically meaningful modifications, the RMSEA values did not meet the fit criteria across all time points. Composite reliability was used to measure the internal consistency of the scale items based on the factor loadings and errors of the measure items. The composite reliability scores were acceptable and ranged from .77 to .94 and  $H$  coefficient ranged from .78 to .95.

#### **4.5.3 Unconditional Univariate Psychological Well-being Models**

Trajectories of each psychological well-being variable were modelled as unconditional univariate models (see Table 4-3). Models included a latent intercept factor with fixed factor loading of zero to model the starting point and a slope factor to model the rate of change over time. The unconditional linear model of perceived stress fit the data well,  $\chi^2_{(16)} = 32.81, p = .01$ , RMSEA = .04, 90% CI [.02, .05], CFI = .99, SRMR = .06. The average baseline score for perceived stress was 3.90 ( $p < .001$ ) and varied significantly across participants ( $p < .001$ ). On average, scores of perceived stress declined by .62 and the decreases were significant ( $p < .001$ ). Slopes varied significantly ( $p < .001$ ), and the baseline score and linear slope were negatively correlated ( $p < .001$ ). The unconditional linear model of negative affect also fit the data well,  $\chi^2_{(16)} = 45.43, p = .0001$ , RMSEA = .05, 90% CI [.03, .06], CFI = .99, SRMR = .06. The average baseline score for negative affect was 3.44 ( $p < .001$ ) and there was significant variability in the negative affect scores across participants at baseline ( $p < .001$ ). On average, negative affect declined by .41, and the decreases were significant ( $p < .001$ ). Similar to perceived stress, negative affect slopes did vary significantly ( $p < .001$ ) and were negatively correlated with the baseline score ( $p = .001$ ). Lastly, the unconditional quadratic model of positive affect met the

less stringent fit criteria,  $\chi^2_{(12)} = 54.90, p < .001$ , RMSEA = .07, 90% CI [.05, .08], CFI = .98, SRMR = .10. The average baseline score for positive affect was 3.51 ( $p < .001$ ) and varied across individuals at baseline ( $p < .001$ ). On average, scores for positive affect increased by .36 and the increases were significant ( $p = .001$ ). Slopes did vary significantly ( $p = .007$ ) and were positively correlated to baseline values ( $p = .024$ ).

#### 4.5.4 Conditional Multivariate Models

The conditional multivariate model of stress yielded a good fit to the data,  $\chi^2_{(44)} = 83.37, p < .001$ , RMSEA = .03, 90% CI [.02, .05], CFI = .98, SRMR = .04. Social participation, relatedness, and social support amount negatively predicted the intercept factor of stress (see Figure 4-1). Descriptive norms negatively predicted the linear slope of stress. The conditional multivariate model of negative affect ( $\chi^2_{(44)} = 83.33, p < .001$ , RMSEA = .04, 90% CI [.03, .05], CFI = .98, SRMR = .04) and positive affect ( $\chi^2_{(33)} = 70.866, p < .001$ , RMSEA = .04, 90% CI [.03, .05], CFI = .98, SRMR = .07) fit the data well. Social participation, relatedness, and social support amount negatively predicted the intercept factor of negative affect and stress and positively predicted the intercept factor of positive affect. Social participation positively predicted the linear slope of negative affect and negatively predicted the linear slope of positive affect (see Figure 4-2 and 4-3). The effect sizes for the conditional models were small to medium.

## 4.6 Discussion

A longitudinal exploration was conducted of older adults' social connections and psychological well-being trajectories. Unconditional univariate growth trajectories were also examined to understand how older adults' perceived stress, positive affect, and negative affect changed over time during the pandemic. Conditional multivariate growth trajectories were

evaluated to determine which of seven different social connection variables predicted trajectories of change of psychological well-being in older adults. Hypotheses were partially supported for our primary study aim. Descriptive norms negatively predicted the linear trajectory of perceived stress—individuals who reported having more physically active people in their lives tended to experience greater declines in stress. Social participation positively predicted the linear slope of negative affect and negatively predicted the linear slope of positive affect. Participants who reported greater social participation tended to experience greater increases in negative affect and greater decreases in positive affect over time. On average, stress and negative affect declined significantly whereas social participation had a significant positive quadratic change.

The linear trajectory of negative affect that was predicted by social participation captures a period when there were increases in restrictions that would likely have impacted older adults' social participation opportunities (e.g., closures of recreation facilities, limitations on indoor and outdoor gatherings). It is possible that hedonic adaptation may have played a role in the decreasing affect trajectories despite changes in public health measures and increased social participation opportunities (Reitsema et al., 2023). Some participants may have adapted to disruptions in their social participation during the pandemic, and so decreases in social participation may not have negatively impacted their affect as expected. Participants who had greater social participation prior to the pandemic, or even prior to data collection, may have had more to lose when restrictions were in place during that time.

Hypotheses were also partially supported for the secondary study aim. There was significant variability across psychological well-being scores at baseline and slopes varied significantly among participants. This suggests that not all participants' stress, positive affect, and negative affect changed over time at the same rate, which is consistent with other research



that has found variability in adults' affect experiences during the COVID-19 pandemic (Reitsema et al., 2023). On average, stress and negative affect declined significantly. While we expected a curvilinear change where greater increases in stress and negative affect would occur during periods when there were more public health measures in place since the study timeline captured a time when restrictions were introduced and then removed, a linear model capturing the overall decline in stress and negative affect fit the data better. Individuals may have become used to the ups and downs of the case counts by this period in the pandemic and so declines in stress and negative affect were more prominent. It is also possible that some participants may have experienced more volatility in their stress and negative affect responses but that those changes may not have been strong enough to be evident in average changes. Additionally detecting any change beyond the overall linear trend of six months may not be possible with the data. Conversely, the results related to positive affect supported our hypothesis. A significant positive quadratic change occurred where there was a decrease on average between Time two and three when restrictions were put back in place, followed by an increase from Time four to six when restrictions were lifted again.

There was a significant negative correlation between the baseline scores and rates of change for stress and negative affect. This indicates that participants with higher perceived stress and negative affect at baseline were more likely to experience declines in stress and negative affect over time, representing a possible ceiling effect or suggesting that those who were most distressed by the pandemic had the most room for improvement in those feelings. The correlation between baseline reports of positive affect and rate of change was significant, indicating that on average participants with higher positive affect at baseline were also more likely to experience increases in positive affect over time. This potentially suggests having a more positive outlook at

baseline may enhance participants' receptiveness to experiences that can further boost their positive affect strategies (Finlay et al., 2021; McElroy-Heltzel et al., 2022; Pearman et al., 2021).

#### **4.6.1 Conclusion and Future Directions**

The findings of this study provide meaningful insights into associations between older adults' social connections and psychological well-being trajectories. Few studies have examined multiple social connections, related to PA, predicting well-being trajectories. Hypotheses were partially supported with associations observed between descriptive norms and perceived stress as well as social participation and positive and negative affect among older adults. Limitations include some measures having poor fit, as demonstrated by CFAs. The sample was also relatively homogenous which may limit the generalizability of the results. Despite these limitations, this study showed that the trajectories of social connections and psychological well-being among older adults were dynamic. There was considerable individual variation across the variables during this period of the pandemic and some trajectories appeared to be more affected by public health restrictions that impacted social opportunities. Additionally, some social connection variables were related to well-being baseline values and their rates of change. Further research is needed to understand how these variables may better promote and maintain psychological well-being among older adults, particularly when social connections are disrupted. Exploring the role of descriptive norms in the association between PA and stress may especially be important when considering opportunities to increase and maintain PA engagement among older adults.

**Table 4-1***Descriptive Statistics and Correlations at Time One*

Variable	1	2	3	4	5	6	7	8	9	10
1. Injunctive norms	-									
2. Descriptive norms	.49*	-								
3. Social network	.55	.10*	-							
4. Social participation	.16*	.15*	.30*	-						
5. Relatedness	.24*	.21*	.30*	.35*	-					
6. Social support amount	.30*	.30*	.20*	.41*	.34*	-				
7. Social support quality	.28*	.28*	.20*	.44*	.36*	.90*	-			
8. Stress	-.04	-.05	-.16*	-.37*	-.23*	-.28*	-.28*	-		
9. Negative affect	-.30	-.05	-.18*	-.36*	-.25*	-.23*	-.23*	.72*	-	
10. Positive affect	.13*	.15*	.24*	.53*	.35*	.41*	.41*	-.36*	-.30*	-
<i>n</i>	818	816	820	817	817	801	798	801	799	799
<i>M</i>	5.60	4.48	2.55	3.34	4.26	3.73	3.70	2.68	1.90	3.50
<i>SD</i>	1.54	1.71	.82	.82	.82	.97	.98	.83	.66	.68

*Note.*  $N = 890$ . Pearson correlations are reported on the diagonal for Time 1 study variables.

\*  $p \leq .05$

**Table 4-2***Confirmatory Factor Analyses of Time One for Measures with Four or More Items*

CFA Model	Fit Index Indicators			
	$\chi^2$ (df)	RMSEA	CFI	SRMR
Social participation	51.53* (2)	.17	.95	.04
Relatedness	29.35* (2)	.13	.99	.02
Stress	16.44* (2)	.10	.99	.02
Negative affect	37.09* (2)	.09	.97	.03
Positive affect	69.34* (2)	.13	.95	.04

*Note.* RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; SRMR = Standardized Root Mean Squared Residual.

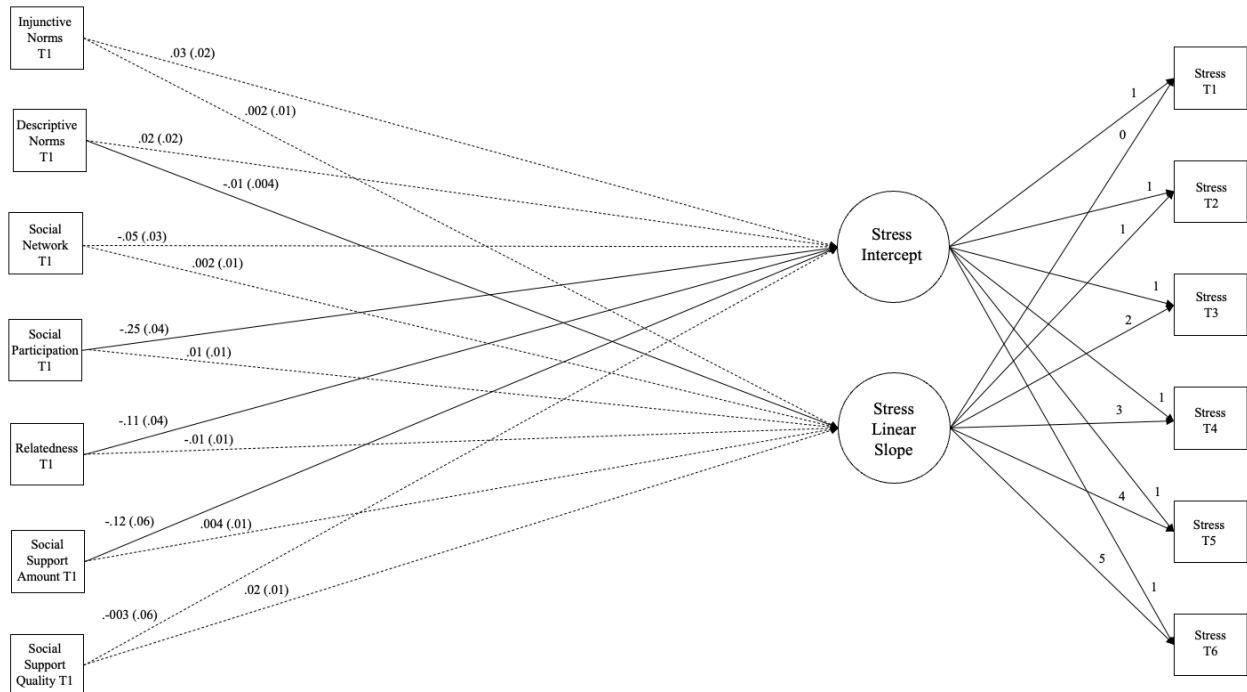
\*  $p \leq .05$ .

**Table 4-3***Unstandardized Mean Estimates and Standard Errors of Unconditional Univariate Models*

Model	Intercept			Linear Slope			Quadratic Slope		
	$\lambda$	<i>SE</i>	<i>p</i>	$\lambda$	<i>SE</i>	<i>p</i>	$\lambda$	<i>SE</i>	<i>p</i>
Stress	3.90	.14	< .001	-.62	.11	< .001	.27	.14	.06
Negative affect	3.44	.12	< .001	-.41	.08	< .001	-.02	.10	.84
Positive affect	3.51	.02	< .001	-.051	.02	< .001	.01	.003	< .001

**Figure 4-1**

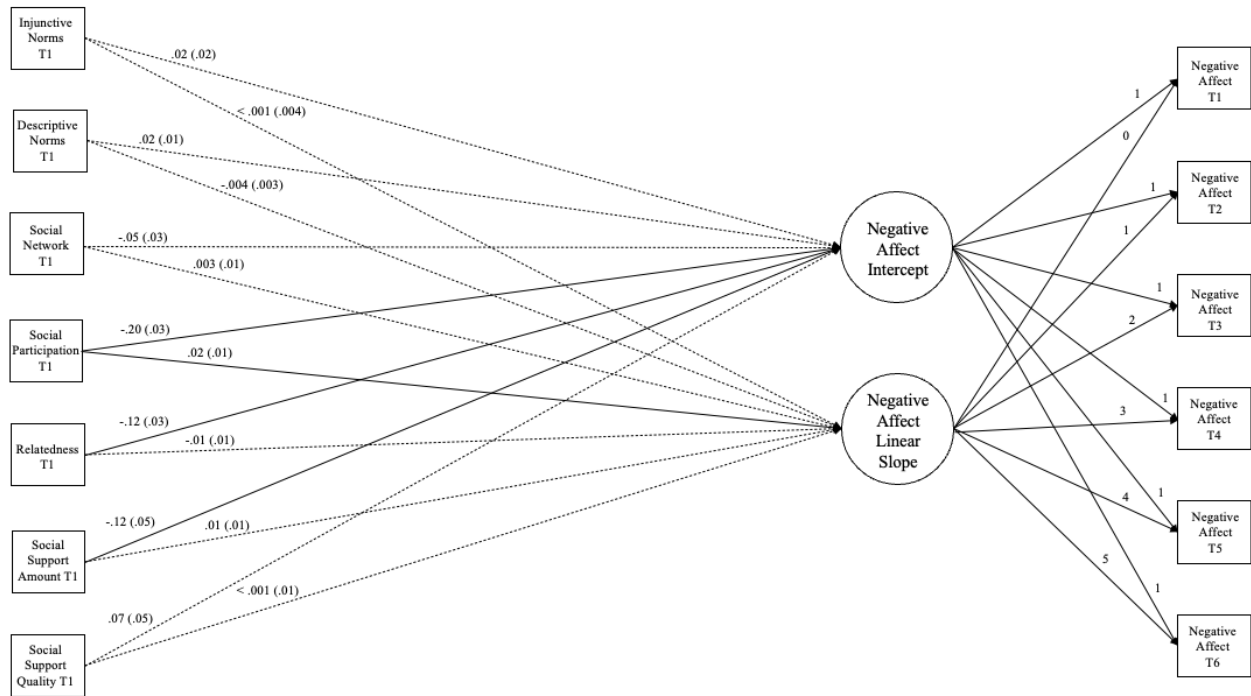
*Conditional Latent Curve Model Predicting Trajectory of Change in Stress*



*Note.* Solid lines denote statistical significance of  $p \leq .05$ ; standardized parameter estimates are reported.

**Figure 4-2**

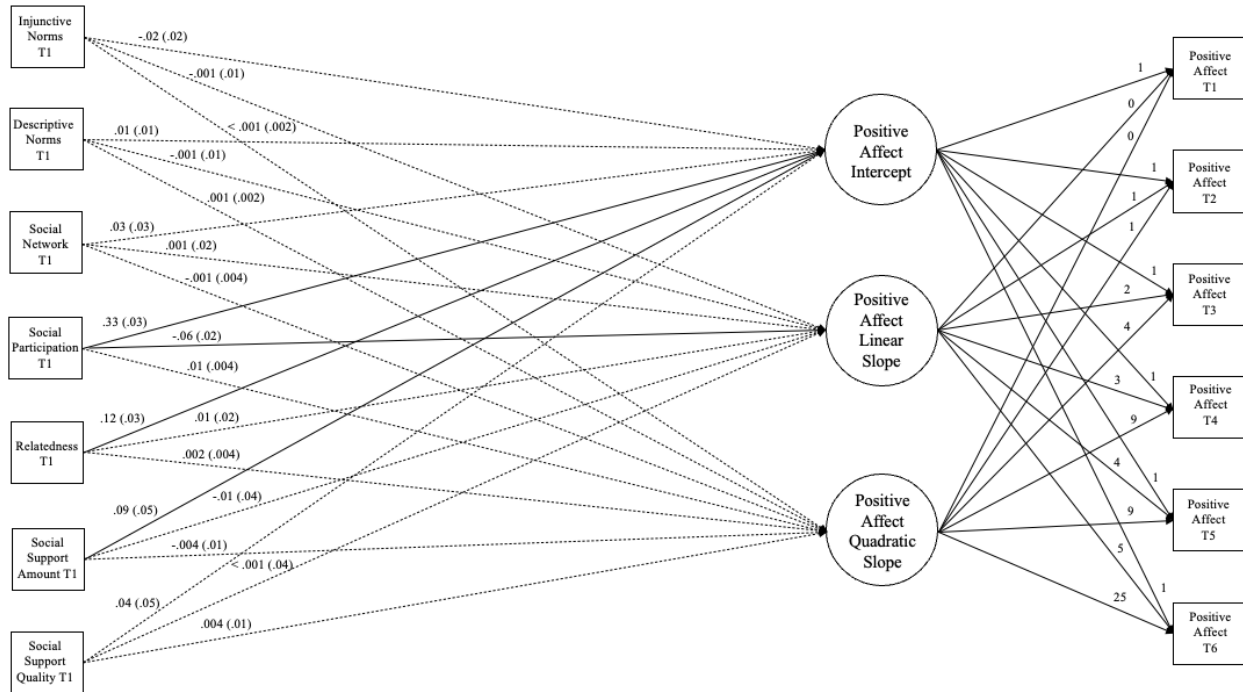
*Conditional Latent Curve Model Predicting Trajectory of Change in Negative Affect*



*Note.* Solid lines denote statistical significance of  $p \leq .05$ ; standardized parameter estimates are reported.

**Figure 4-3**

*Conditional Latent Curve Model Predicting Trajectory of Change in Positive Affect*



*Note.* Solid lines denote statistical significance of  $p \leq .05$ ; standardized parameter estimates are reported.



## **Chapter 5: Discussion**

### **5.1 Primary Findings**

#### **5.1.1 Unconditional Univariate Models of Social Connections, Physical Activity, and Psychological Well-being**

Findings from this prospective investigation furthered understandings of the relationships between older adults' social connections and health behaviours and affect. By examining the trajectories of older adults' social connections, physical activity (PA), and psychological well-being it was possible to understand how these variables changed as the COVID-19 preventative measures changed. As highlighted in both studies, the trajectories among variables differed.

Injunctive and descriptive norms remained stable over time. At the beginning of the pandemic, the restrictions on travel, directives against participating in outdoor activities, and closures to many public spaces (e.g., recreation facilities, public gyms) disrupted the physical activities of many older adults (Chen et al., 2020). While these efforts helped contain the spread of the virus, there were limited public health guidelines for what older adults could or should do in terms of engaging in or continuing their existing PA routine (Chen et al., 2020). A possible explanation was that social norms remained stable during this period; older adults' sense of other people's PA and others' perceptions and expectation of their PA were altered by the pandemic and preventative measures. Older adults' social norms may not have been as sensitive to the pandemic and related closures as some of the other social connection constructs. Another explanation for these findings could be that during early stages of the pandemic (i.e., March 2020) recommendations were developed that encouraged older adults to reimagine and prioritize their PA in the wake of the ongoing public health measures. This may have influenced older adults' perceptions of normative and expected PA behaviour and those influences may have

remained stable or levelled off during the pandemic (Moore et al., 2022) when data was collected.

Older adults' general perceptions of social support quality and amount increased on average during the pandemic. Social support appeared to be less sensitive to the changes in precautionary measures. Similar findings were reported during the early stages of the pandemic among middle aged adults who had moderate or strong social support and increases in their social support between pre-pandemic and the peak of the pandemic (Laham et al., 2021; Xu et al., 2020). Other studies that reported similar findings to this thesis highlighted that older adults may have made a concerted effort to seek out and maintain social support avenues and were satisfied with the level of social support despite declines in relatedness and social networks over time (Laham et al., 2021; Xu et al., 2020). Other longitudinal studies observed similar increases in general social support but decreases in the average number of social network members and the number of emotional and practical support providers for independently living middle aged and older adults during the pandemic (Steijvers et al., 2022).

Declines in relatedness and social networks reported in this thesis were in line with other studies that reported a decrease in the number of daily contacts with social network members during the initial waves of the pandemic (Feehan & Mahmud, 2021; Jarvis et al., 2020; Tomori et al., 2021). Increases in general perceptions of social support and decreases in social networks and relatedness may also be attributed to older adults' social ties becoming more focused on those within their existing networks because their interactions with other people may have been limited due to pandemic related restrictions (Steijvers et al., 2022). Some older adults may have been fearful of contracting the virus from larger groups or participating in PA activities near others outside their network when restrictions were relaxed. Although the shared experiences of

living through the pandemic may have brought some older adults closer together, physical distancing restrictions may have made it more difficult for some older adults to act on their desire to connect with and relate to other older adults (Folk et al., 2020).

Older adults' stress and negative affect also declined over time. The majority of the previous research on psychological well-being trajectories are based on the earlier waves of the pandemic (March 2020 to March 2021) but findings from this thesis do reflect similar trends in stress and negative affect, which tended to decline as the pandemic went on. While the pandemic likely threatened many older adults' psychological well-being, many appeared to show resilience and likely adapted through effective coping strategies (Finlay et al., 2021; McElroy-Heltzel et al., 2022; Pearman et al., 2021). Several studies have identified proactive coping behaviours such as maintaining a daily routine, engaging in outdoor activities, forming social connections, and utilizing anticipatory restructuring to manage the ongoing precariousness of the pandemic (Finlay et al., 2021; Fuller & Huseth-Zosel, 2021; Jaspal & Nerlich, 2020; Pearman et al., 2021). Although coping strategies were not examined in this thesis, it is a possible explanation for why older adults' stress and negative affect trended downward. Research also suggests individuals who used proactive coping strategies since the start of the pandemic were more likely to have better mental health when public health measures were introduced and faster improvements in mental health symptoms over time (Pearman et al., 2021).

Older adults' positive affect, social participation, light-intensity PA (LPA), and moderate-to-vigorous PA (MVPA) followed similar quadratic patterns, where the downward patterns of change reflected periods when there were greater restrictions in place and increases when restrictions were lifted. These variables were most sensitive to changes in public health measures and subsequent closures when the omicron variant peaked. During this time,

recreational and public facilities (e.g., swimming pools, gyms, and parks) were closed and opportunities for social participation were restricted. Similar to the trajectories reported in this thesis, existing research found PA and social participation initially declined but then trended upward during periods with fewer restrictions and prevention measures (Suzuki et al., 2020). It is also possible individuals may have had greater opportunities to pursue social participation opportunities when restrictions were relaxed and felt less risk to act on those desires when vaccinations were introduced and readily available (Lefferts et al., 2022; Suzuki et al., 2020).

Results from this thesis demonstrated the pandemic did alter the social participation, PA, and positive affect older adults but optimistically suggests these variables increased when public health directives were removed or lessened (Lefferts et al., 2022). Additionally, participants may have gradually increased their PA over time as more information became available on how to reduce or mitigate the transmission of the virus (i.e., physical distancing, wearing a mask, being outdoors when gathering with people outside of one's household; Joseph et al., 2021). Previous research has demonstrated higher levels of pre-pandemic PA are associated with greater decreases in PA during the pandemic (Browne et al., 2020; Joseph et al., 2021). Additionally, nearly half of community-dwelling older adults (47.3%) reported being less active when public health measures were put in place from March 2020 to May 2020 (Suzuki et al., 2020). Older adults' MVPA and LPA were primarily impacted during this time. Declines in PA may have been due to the closures of public spaces involving recreational and public facilities such as swimming pools, gyms, parks (Suzuki et al., 2020). The findings from Suzuki et al., (2020) were similar to those reported in this thesis, which suggest older adults who have higher hours of weekly MVPA at baseline are more likely to see initial declines in MVPA at the beginning of the study. Additionally, older adults who reported lower MVPA when facilities were starting to re-

open are also more likely to see declines in their MVPA at the end of the study. LPA followed similar patterns to MVPA reported in this thesis and on average decreased during periods when there were greater restrictions in place.

### **5.1.2 Conditional Multivariate Models Predicting Physical Activity Intensities and Psychological Well-being**

Through examining older adults' social connections, this thesis was also able to explore possible social mechanisms behind older adults' health behaviours and their psychological well-being during the pandemic (Joseph et al., 2021). Baseline reports of older adults' satisfaction with their social participation positively predicted the linear trajectory of negative affect and negatively predicted the quadratic trajectory of positive affect. Some participants may have adapted to disruptions in their social participation during the pandemic, and so decreases in social participation may not have negatively impacted their affect as expected. Participants who had greater social participation prior to the pandemic or even during earlier stages of the pandemic may have had more to lose when restrictions were in place during that time. Some researchers have also argued social participation can have a negative impact on older adults' psychological well-being. For example, obligatory social participation was not directly measured in this thesis, but findings suggest obligation to participate in social activities can create a negative interaction (e.g., impact opportunities for connection building) and may lead to undesirable mental health outcomes (Sasaki et al., 2021; Tomioka et al., 2017). This explanation is unlikely given many older adults who attend social activities (e.g., activities held at recreation facilities) do so voluntarily, and therefore the negative association found in this thesis may not be related to an interaction brought about during social participation. The items used to measure social participation did not explicitly capture social participation within the context of

recreational activities rather measured participants' satisfaction with their daily engagement in activity, quality of time use, social activities, and community engagement opportunities. Given that, it is unclear which social activities were consuming older adults' time during study enrollment and how that may have been associated with participants' affect trajectories.

While this thesis examined levels of social connections predicting the rate of change in PA and psychological well-being over time, the growth patterns among these variables are complex. Future research should consider examining the associations between different features of social connections, PA, and psychological well-being processes (e.g., level and rate of change) and how these processes simultaneously evolve. For example, it would be possible to examine correlations between rates of change in social connections and psychological well-being (e.g., do older adults whose social participation declines at a faster rate also demonstrate a faster rate of change of negative affect). This would build on existing knowledge of the nature of these relationships, help inform practices for how best to utilize social connections to promote greater PA and psychological well-being and may further explain why negative associations were reported among social participation and affect.

Additionally, greater endorsement of descriptive norms at baseline was negatively associated with the linear trajectory of perceived stress and positively predicted the quadratic trajectory of LPA. Findings demonstrate those who saw more examples of individuals being physically active in their social circle and saw PA as more typical for someone like themselves at baseline typically experienced greater decreases in their stress and greater increases in their LPA over time. Moreover, it is suggested that older adults having role models who engage in PA may make them more likely to do so (Priebe & Spink, 2011) and in turn may experience the stress reducing benefits associated with PA engagement (Howard et al., 2017). Participants who had

larger social networks at the beginning of the study typically experienced greater decreases in their MVPA over time. One interpretation of this finding is a possible ceiling effect. Having a larger social network may benefit older adults' PA opportunities, but there may be a threshold where the time and effort required to maintain a large social network might impact their PA. Nonlinear relationships between reported number of friends and psychological well-being have also been identified (Roberts et al., 2009). Research suggests there may be a limit to the beneficial effects of increasing the number of friends within one's network, as a larger social network after a certain point may reduce emotional closeness between network members (Roberts et al., 2009). Increases in general perceptions of social support and decreases in social networks and relatedness may also be attributed to shifts towards social ties being centralized within older adults' networks during the pandemic (Steijvers et al., 2022). Findings demonstrate that well-being and PA outcomes appear to have a variety of social factors that contribute to predicting these outcomes. These findings may also help providers who work with older adults to utilize role models and social networks to assist with increasing PA participation and to increase the likelihood of improvements in older adults' stress over time.

## **5.2 Limitations**

The findings of both studies should be interpreted in light of some limitations. Firstly, self-reported PA measures are associated with over reporting and may reflect greater reported values than objective measures of PA. It was not feasible at the time to evaluate the trajectories of different PA intensities using other measures of PA due to the study scope and the precariousness of the pandemic environment. The LTPAQ was well-suited to measure the average PA trajectories while minimizing participant burden. Future research may consider incorporating objective measures of PA, such as an accelerometer, alongside perceived measures

of PA to collect more complimentary and comprehensive data. However, careful consideration would be needed given the potential difficulties with participant compliance, cost, and possible misclassifications of a participant's PA profile (e.g., needing to remove the device during certain activities if it is not waterproof; Skender et al., 2016).

Modified versions and items from validated scales used to measure the study variables may have limited the validity of the study findings given measurement error was also not accounted for in the models. Time-invariant covariates related to participants' sociodemographic characteristics and recreation activity were not included in the conditional models and may have limited the interpretability of the average trajectories. Seasonal changes were also not accounted for in the models, and it is possible that environmental influences may have contributed to increases in average PA as winter moved into spring (Brandon et al., 2009; Merchant et al., 2007). Given the coronavirus outbreak was declared a pandemic in March 2020 and data collection was initiated October 2021, it is possible participants might have used coping mechanisms to adapt to the closures and related preventative measures prior to the study baseline. Lastly, the generalizability of the findings may be limited given the sample of older adults was relatively physically active, disproportionately White, and the majority of participants identified as women. The findings may not reflect the experiences of a more diverse population. Further investigations of older adults' social, PA, and psychological well-being trajectories should consider incorporating additional recruitment strategies to obtain a more diverse and representative community-based sample of older adults.

### **5.3 Conclusion**

This thesis adds to the growing literature on social connections and their associations with health behaviors and the psychological well-being of older adults. Findings from these studies



revealed disruptions to many older adults' social connections, PA, and psychological well-being that persisted beyond the initial stages of the pandemic. The outcomes suggest there may be a need to balance necessary public health measures with the impacts they may have on older adults' social, PA, and psychological well-being patterns over time. Increasing opportunities for older adults to have meaningful social connections and engage in PA are important considerations for future emergencies. Future research may also consider examining changes over time in different social connections and PA and psychological well-being simultaneously. This approach would build on findings from this thesis and provide additional insights into the nature of these relationships and how social connections can be optimized to promote greater PA and psychological well-being outcomes among this population.

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## Appendices

### Appendix A: Study Implied Consent Form



#### UNIVERSITY OF CALGARY IMPLIED CONSENT TO PARTICIPATE IN RESEARCH

**TITLE:** Effects of Recreation Reopening on Physical Activity and Social

Outcomes in Older Adults: Phase 1

**SPONSOR:** University of Calgary

**FUNDER:** Brawn Family Foundation

**INVESTIGATOR:** Dr. Meghan McDonough, Faculty of Kinesiology

Email: [REDACTED]

Phone: [REDACTED]

#### INTRODUCTION

Meghan McDonough, Ph.D. and associates from the Faculty of Kinesiology at the University of Calgary are conducting a research study.

This consent form is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Take the time to read this carefully and to understand any accompanying information.

You are invited to be in this study because you are an adult age 55 or older. Your participation in this research study is voluntary.

#### WHY IS THIS STUDY BEING DONE?

As the COVID-19 pandemic took hold, public health measures including physical distancing and self-isolation were introduced, and many services were suspended at times, including in-person recreation programs. We are conducting a research study about how the reopening of recreation facilities and programs affects older adults.

The purpose of this research study is to examine how social outcomes, physical activity, program participation, and well-being change among adults age 55 and older following the lifting of COVID-19 closures and restrictions on recreational programs.

#### HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

About 2000 people will take part in this study through the University of Calgary.

#### WHAT WILL HAPPEN IF I TAKE PART IN THIS RESEARCH STUDY?

If you volunteer to participate in this study, the researcher will ask you to do the following:  
Complete an online survey once a month for 6 months.  
Questions will ask about your physical, social, and recreational activities, social and psychological outcomes, and demographic information.

**ARE THERE ANY POTENTIAL RISKS OR DISCOMFORTS THAT I CAN EXPECT FROM THIS STUDY?**

You will be responding to questions similar to those that have been used in many studies. There are minimal risks to answering these questions. You may refuse to answer any questions that you do not wish to answer.

**HOW LONG WILL I BE IN THIS STUDY?**

You will be in the study for 6 months. You will be asked to complete a survey once a month. The first survey will take about 20-40 minutes to complete.  
The remaining surveys will take about 15-20 minutes to complete.

**ARE THERE ANY POTENTIAL BENEFITS IF I PARTICIPATE?**

There will be no direct benefit to you from participating in this study. However, this study may help us learn more about how to provide better physical activity and social opportunities in the future.

**CAN I STOP BEING IN THE STUDY?**

Being in the study is voluntary. You may withdraw from the study at any time with no negative consequences. If you choose to withdraw, you can stop answering questions, and close your browser.

**WITHDRAWAL OF STUDY DATA**

You may withdraw your permission to use information that was collected about you for this study by letting the principal investigator know. Data can be withdrawn up to one month after you complete your last survey. If you wish to withdraw please contact Dr. Meghan McDonough by email at [REDACTED] or by phone at [REDACTED]. Please note that although on request data may be withdrawn from the study analyses, the raw data must be kept for 5 years after the study is closed.

**WILL I BE PAID FOR PARTICIPATING, OR DO I HAVE TO PAY FOR ANYTHING?**

For each survey you complete, you will be entered into a draw for 1 of 10 prizes of a \$50 prepaid Visa card. Your odds of winning for each survey/entry are at least 1 in 200. You can be entered in up to 6 draws if you complete all 6 surveys.

**WILL INFORMATION ABOUT ME AND MY PARTICIPATION BE KEPT CONFIDENTIAL?**

Only the study team will have access to the information collected. You will be assigned a study number. A list linking your study number with your name will be kept by the principal investigator in a secure place, separate from your study file. All of your answers are confidential. You will be identified with a study number only. Records identifying you, including your name, phone number, and email address will be kept confidential. All research data and records will be

maintained in a secure location at the University of Calgary, or will be stored electronically on a secure network with encryption and password protection.

Qualtrics is an online survey platform with servers located in Toronto, Ontario, Canada. All data are encrypted and stored directly on its servers. Researcher access to the survey data is password-protected and the transmission is encrypted. The Qualtrics survey will collect your computer's IP number so that we can ensure that each person has only responded to each survey once, but this information will not be used for any other purpose, and will be destroyed no more than 2 months after you complete your last survey.

### **HOW LONG WILL INFORMATION FROM THE STUDY BE KEPT?**

The researchers intend to keep the research data and records for at least 5 years after the study is closed.

Any future use of this research data is required to undergo review by a Research Ethics Board.

### **CONTACT FOR FUTURE RESEARCH**

University of Calgary researchers may contact me in the future to ask me to take part in other research studies.

- YES
- NO

### **WHOM MAY I CONTACT IF I HAVE QUESTIONS ABOUT THIS STUDY?**

The Research Team:

You may contact Meghan McDonough at [REDACTED] or [REDACTED] with any questions or concerns about the research or your participation in this study.

Conjoint Health Research Ethics Board (CHREB):

If you have any questions concerning your rights as a possible participant in this research, please contact the Chair, Conjoint Health Research Ethics Board, University of Calgary at [REDACTED].

### **AGREEMENT TO PARTICIPATE**

Your decision to complete this survey will be interpreted as an indication of your agreement to participate. In no way does this waive your legal rights nor release the investigators or involved institutions from their legal and professional responsibilities.

You are free to withdraw from the study at any time.

## Appendix B: Study Questionnaire

1. Please provide your full name and contact information so that we are able to contact you to ask you to complete the monthly surveys, and to enter you into the draw for prizes for participating:

- First name: \_\_\_\_\_
- Last name: \_\_\_\_\_
- Email address: \_\_\_\_\_
- Phone number: \_\_\_\_\_

**Please tell us about you. The purpose of these questions is so that we can describe the population who participated in this study.**

2. How old are you? \_\_\_\_\_
3. What is your gender identity? Please check all that apply to you.

- Woman
- Man
- Transgender
- Two-spirit
- Non-binary
- Gender queer
- Gender fluid
- Gender non-conforming
- Agender
- Questioning
- Do not know
- Not listed (please specify): \_\_\_\_\_
- Prefer not to answer

4. How would you describe your ethnic and/or racial background? Please check all that apply to you. *Note: We recognize that ethnicity is complex and sociopolitical in nature, and that the categories listed below may not fit for you. Please feel free to use the response space provided if you prefer not to select from the listed categories.*

- Indigenous (e.g., First Nations, Métis, Inuit)
- Arab (e.g., Egyptian, Lebanese)
- Black (e.g., African, African American, Haitian, Jamaican, Somali)
- Chinese
- Filipino
- Japanese
- Korean
- Latin American / Spanish / Hispanic / Latino/ Latina
- South Asian (e.g., Pakistani, Punjabi, Sri Lankan)



- South East Asian (e.g., Cambodian, Indonesian, Vietnamese)
- West Asian / Middle Eastern (e.g., Afghani, Iranian)
- White / Caucasian
- Not listed. Please specify: \_\_\_\_\_
- Prefer not to answer

5. Were you born in Canada?

- Yes
- No. How many years have you lived in Canada? \_\_\_\_\_

6. What is the highest level of education you attained?

- Some high school
- Completed high school
- Some university or college
- Completed university or college
- Some graduate school
- Completed graduate school
- Other. Please specify: \_\_\_\_\_
- Prefer not to answer

7. What is your annual household income (the income of all members of your household combined, before taxes and deductions)?

- Less than \$20,000
- \$20,000 to \$39,999
- \$40,000 to \$59,999
- \$60,000 to \$79,999
- \$80,000 or over
- Prefer not to answer

8. What is your current employment status?

- Retired
- Employed full-time
- Employed part-time
- On disability or sick leave
- Temporarily unemployed
- Student
- Homemaker
- Other. Please specify: \_\_\_\_\_
- Prefer not to answer

9. What is your current marital status?

- Single
- Married
- Common-law
- Separated
- Divorced
- Widowed
- Other. Please specify: \_\_\_\_\_
- Prefer not to answer

10. How many people live in your household?

- You live alone
- You and one other person
- You and two other people
- You and three other people
- You and four other people
- You and five other people
- You and six or more other people
- Prefer not to answer

11. Do you self-identify as a person living with a disability?

- No
- Yes
- Prefer not to answer

12. Are you the primary caregiver to a person with a disability or chronic health condition?

- No
- Yes. How long have you been a primary caregiver? \_\_\_\_\_
- Prefer not to answer

**In the next set of questions, we are interested in your experiences IN THE MONTH PRIOR TO when COVID- 19 resulted in the shutdown of recreation facilities (i.e., February 15-March 15, 2020).**

13. Were you participating in physical activity (e.g., sport, exercise, other physical activity) programs, classes, or self-directed physical activities (e.g., using a weight room, etc.) at a recreation facility (e.g., City recreation centers, private gyms, etc.) **PRIOR TO COVID-19:**

- Yes
- No

14. What recreation facilities were you attending for physical activity purposes in the month **PRIOR TO COVID-19**? Please list all facilities that you were attending at that time.

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15. How many times per week did you typically participate in physical activities at a recreation facility in your local area in the month **PRIOR TO COVID-19**?

Times/week \_\_\_\_\_

16. Which of the following physical activities were you participating in PRIOR TO COVID-19? Check all that apply.

- In-person fitness classes at a recreation facility
- Self-directed physical activities (e.g., lane swimming, using a weight room, skating, etc.) at a recreation facility
- Outdoor fitness classes or organized outdoor activities provided by a recreation facility or organization in your local area
- Online fitness classes provided by a recreation facility in your local area
- Online fitness classes provided by a person or organization outside of your local area
- Self-directed physical activities performed on your own or with an informal group (e.g., family or friends) at home, outside, or otherwise not at a recreational facility (e.g., walking in your neighborhood, self-directed at-home exercise, etc.)
- Other physical activities not included above. Please describe:  
\_\_\_\_\_
- I was not participating in regular physical activity prior to COVID-19

17. Think about your level of physical fitness (compared to other people your age and gender) **PRIOR TO COVID-19** and select the best answer for you for each question:

	Very poor	Poor	Average	Good	Very good
Your general physical fitness was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your cardiorespiratory fitness (capacity to do exercise, for instance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

walking, for a long time) was:

Your muscular strength was:

Your speed and agility was:

Your flexibility was:

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**In the next question, we are interested in your experiences DURING COVID-19, when various public health related restrictions were in effect (i.e., March 15, 2020-July 1, 2021). We understand that the restrictions fluctuated during that period, and at times some activities were not allowed, while at other times they were.**

18. Which of the following physical activities did you participate in between **March 15 2020 and July 1, 2021**? We are interested if you did any of the following at any point during that time period, whether it was a new type of activity for you, and whether you plan to continue doing it after the pandemic. Check all that apply.

	Did you do this activity at any point between March 15, 2020-July 1, 2021?		Was this type of activity new for you?		Do you plan to continue this type of activity now/following the pandemic?	
	Yes	No	Yes	No	Yes	No
In-person fitness classes at a recreation facility	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Self-directed physical activities (e.g., lane swimming, using a weight room, skating, etc.) at a recreation facility	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Outdoor fitness classes or organized outdoor activities provided by a recreation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

facility or organization in your local area  
online fitness classes provided by a recreation facility in your local area

Online fitness classes provided by a person or organization outside of your local area

Self-directed physical activities performed on your own or with an informal group (e.g., family or friends) at home, outside, or otherwise not at a recreational facility (e.g., walking in your neighborhood, self-directed at-home exercise, etc.)

Other physical activities not included above.  
Please describe:

I was not participating in regular physical activity during the period from March 15, 2020-July 1, 2021.

19. Think about your level of physical fitness (compared to other people your age and gender) **between March 15, 2020 and July 1, 2021** and select the best answer for you for each question:

	Very poor	Poor	Average	Good	Very good
Your general physical fitness was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your cardiorespiratory fitness (capacity to do exercise, for instance walking, for a long time) was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your muscular strength was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your speed and agility was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your flexibility was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

20. Did you experience any new physical problems, and/or declines in your physical function and/or physical ability between **March 15, 2020 and July 1, 2021** that negatively affected your ability to do physical activity?

- No
- Yes. Please describe the problems you experienced, and how it affected your physical activity: \_\_\_\_\_

**In the next set of questions, we are interested in your experiences with physical activity IN THE PAST MONTH (30 days).**

21. Did you participate in physical activity (e.g., sport, exercise, other physical activity) programs, classes, or self-directed physical activities (e.g., lane swimming, using a weight room, etc.) at a recreation facility (e.g., City recreation centers, YMCA locations, private gyms, etc.) in the past 30 days:

- Yes
- No

22. What recreation facilities did you attend for physical activity purposes **in the past 30 days**. Please list all facilities (e.g., City recreation centers, YMCA locations, private gyms, etc.) that you attended.

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23. How many times per week did you typically participate in physical activities at a recreation facility in your local area in the past **30 days**?

times/week: \_\_\_\_\_

24. What were your reasons for starting to or returning to going to a recreation facility to do physical activity after COVID-19?

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25. Which of the following physical activities did you participate in the past 30 days? Check all that apply.

- In-person fitness classes at a recreation facility
- Self-directed physical activities (e.g., lane swimming, using a weight room, skating, etc.) at a recreation facility
- Outdoor fitness classes or organized outdoor activities provided by a recreation facility or organization in your local area
- Online fitness classes provided by a recreation facility in your local area
- Online fitness classes provided by a person or organization outside of your local area
- Self-directed physical activities performed on your own or with an informal group (e.g., family or friends) at home, outside, or otherwise not at a recreational facility (e.g., walking in your neighbourhood, self-directed at-home exercise, etc.)
- Other physical activities not included above. Please describe:  
\_\_\_\_\_
- I was not participating in regular physical activity in the past 30 days

26. We would like you to recall your *average weekly exercise over the past month*. How many times per week on average did you do the following kinds of exercise, and for how long?

**STRENUOUS EXERCISE (Heart beats rapidly, sweating)**

(e.g., running, jogging, hockey, soccer, squash, cross country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling, vigorous aerobic dance classes, heavy weight training)

- Number of times per week: \_\_\_\_\_
- Average duration of each session (minutes): \_\_\_\_\_

**MODERATE EXERCISE (Not exhausting, light perspiration)**

(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

- Number of times per week: \_\_\_\_\_
- Average duration of each session (minutes): \_\_\_\_\_

**MILD EXERCISE (Minimal effort, no perspiration)**

(e.g., easy walking, yoga, archery, fishing, bowling, lawn bowling, shuffleboard, horseshoes, golf, snowmobiling)

- Number of times per week: \_\_\_\_\_
- Average duration of each session (minutes): \_\_\_\_\_

**RESISTANCE TRAINING EXERCISE**

(e.g. exercises with dumbbells, body weight, bands, such as squats, bicep curls, etc.)

- Number of times per week: \_\_\_\_\_
- Average duration of each session (minutes): \_\_\_\_\_

**FLEXIBILITY TRAINING EXERCISE**

(e.g. yoga, stretching)

- Number of times per week: \_\_\_\_\_
- Average duration of each session (minutes): \_\_\_\_\_

27. Think about your level of physical fitness (compared to other people your age and gender) **over the past month** and select the best answer for you for each question:

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	Very poor	Poor	Average	Good	Very good
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Your general physical fitness was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your cardiorespiratory fitness (capacity to do exercise, for instance walking, for a long time) was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your muscular strength was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your speed and agility was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your flexibility was:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

28. Did you experience any new physical problems, and/or declines in your physical function and/or physical ability **during the past month** that negatively affected your ability to do physical activity?

- No
- Yes. Please describe the problems you experienced, and how it affected your physical activity: \_\_\_\_\_

29. How does your current physical activity level compare to prior to **COVID-19 (prior to March 15, 2020)**?

- I do a lot less
- I do somewhat less
- I do about the same amount
- I do somewhat more
- I do a lot more

30. Do you plan to continue to be, or return to being, as active or more active than you were before **COVID-19 (before March 15, 2020)**?

- Probably not
- Maybe not
- Unsure
- Maybe
- Probably

31. Are there any barriers that prevent you from being as active or more active than you were before COVID-19 (before March 15, 2020)?

- No
- Yes. Please list: \_\_\_\_\_

**In the next section, we are interested in understanding your social interactions in the past 30 days. We are interested in a number of different kinds of social interactions, so there are some questions that may appear similar to each other. All of them are important to this research.**

32. How much do you agree or disagree with each of the statements below?

Most people who are important to me:

	Strongly disagree							Strongly agree						
Think I should exercise regularly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Would encourage me to exercise regularly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Would support me exercising regularly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Exercise regularly themselves.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are extremely active.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Have an extremely	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

high  
exercise  
level.

33. Indicate the response that most closely describes your current situation:

	None	1-2	3-5	6-9	10 or more	unknown
How many close friends do you have, people that you feel at ease with, can talk to about private matters?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How many of these close friends do you see at least once a month?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

34. The following question asks about how completely you experience or were able to do certain things in the last 30 days.

	Not at all	A little	Moderately	Mostly	Completely
To what extent do you feel that you have enough to do each day?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The following questions ask you to say how satisfied, happy, or good you have felt about various aspects of your life over the last 30 days.

	Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
How satisfied are you with the way you use your time?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How satisfied are you with your level of social activity?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How satisfied are you with your opportunity to participate in community activities?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

35. The following statements represent different feelings people have when they exercise. Please answer the following questions by considering how you typically feel while you are exercising.

	Not at all true				Completely true
I feel that the people I care about also care about me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I feel connected with people who care for me, and for whom I care.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I feel close and connected with other people who are important to me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I experience a warm feeling with the people I spend time with.

36. You may have a number of individuals in your life who provide you with help and/or support, including people you exercise with. For the next questions we want to know how you feel about your overall social support.

	Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
Currently, how satisfied are you with the <b>amount</b> of social support you receive overall?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Currently, how satisfied are you with the <b>quality</b> of social support you receive overall?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

37. The following questions ask about different types of help or support other people, including people you exercise with, may provide to you. Read the definition of the type of support being considered and indicate how many people provide that type of support, and how satisfied you are with the amount of that type of support you receive.

**Listening Support:** People who listen to you without giving advice or being judgmental

How many individuals provide you with listening support?

- 0-1
- 2-3
- 4-5
- 6-7
- 8 or more

In general, how satisfied are you with the overall quality of listening support you receive?

- Very dissatisfied
- 
-

- 
- Very satisfied

**Task challenge:** People who challenge your way of thinking about your work or activity in order to stretch you, motivate you, and lead you to greater creativity, excitement, and involvement in your work or activity.

How many individuals provide you with task challenge support?

- 0-1
- 2-3
- 4-5
- 6-7
- 8 or more

In general, how satisfied are you with the overall quality of task challenge support you receive?

- Very dissatisfied
- 
- 
- 
- Very satisfied

**Emotional support:** People who comfort you and indicate to you that they are on your side and care for you.

How many individuals provide you with emotional support?

- 0-1
- 2-3
- 4-5
- 6-7
- 8 or more

In general, how satisfied are you with the overall quality of emotional support you receive?

- Very dissatisfied
- 
- 
- 
- Very satisfied

**Reality confirmation:** People who are similar to you-see things the way you do-who help you confirm your perceptions and perspectives of the world and help you keep things in focus.

How many individuals provide you with reality confirmation support?

- 0-1
- 2-3
- 4-5
- 6-7
- 8 or more

In general, how satisfied are you with the overall quality of reality confirmation support you receive?

- Very dissatisfied
- 
- 
- 
- Very satisfied

**Tangible assistance:** People who provide you with either financial assistance, products, and/or gifts.

How many individuals provide you with tangible assistance support?

- 0-1
- 2-3
- 4-5
- 6-7
- 8 or more

In general, how satisfied are you with the overall quality of tangible assistance support you receive?

- Very dissatisfied
- 
- 
- 
- Very satisfied

38. The following questions ask about the support you receive for physical activity or exercise:

	Very dissatisfied	Dissatisfied	Neither Satisfied nor dissatisfied	Satisfied	Very satisfied
Currently, how satisfied are you with the amount of support you receive for participating in physical activity or exercise?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Currently, how satisfied are you with the quality of support you receive for participating in physical activity or exercise?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

39. Physical activity can be related to stress and how we feel emotionally. The following questions ask about your feelings during the past month (i.e., the past 30 days).

In the last month, how often have you...

	Never	Almost never	Sometimes	Fairly often	Very often
Been upset because of something that happened unexpectedly?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Felt that you were unable to control the important things in your life?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Felt nervous and “stressed”?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Found that you could not cope with all the things that you had to do?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

40. Below are a number of words that describe different feelings and emotions. Read each item and choose the appropriate answer in the space next to that word. *Indicate to what extent you typically feel this way during the past month.*

	Not at all	A little	Moderately	Quite a bit	Extremely
Alert	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ashamed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Upset	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inspired	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nervous	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Determined	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Attentive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hostile	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Active	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Afraid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**In the next section, we would like to know about your perspectives on precautionary health measures used in exercise or physical activity settings. Please do your best to answer each question based on what you think and know today. We understand that your thoughts on these issues may change in the future as conditions and the information available changes, but we would like to know your perspectives as best as you can answer with what you know today.**

41. What precautions or conditions would make you more comfortable participating in in-person, indoor exercise classes or drop-in exercise at a recreation facility? (check all that apply)

- Reminding people to maintain social distancing of 2 meters
- Markers on the floor to show where people should stand/be to ensure social distancing
- Signage indicating safety expectations
- Reducing class sizes to allow for social distancing
- Increasing times between classes to reduce crowding and allow for cleaning
- Recommending participants wear face masks or face coverings during strenuous activities
- Recommending participants wear face masks or face coverings during non-strenuous activities
- Requiring participants wear masks or face coverings
- Requiring staff to wear masks or face coverings
- Requiring all participants to answer a health screening questionnaire before participating
- Cleaning the facility more frequently
- Cleaning the equipment more frequently
- Providing hand sanitizer and/or additional hand washing stations throughout the facility
- Cleaning all items participants touch after each user is finished using them
- Improving ventilation in rooms where classes are held
- Offering classes or activities outdoors
- Other \_\_\_\_\_
- I do not know what precautions would make me feel more comfortable to attend in-person exercise classes or drop-in exercise at an exercise facility
- No precautions will make me comfortable to return to in-person exercise classes or drop-in exercise at an exercise facility before the COVID-19 pandemic is over.
- No precautions will make me comfortable to return to in-person exercise classes or drop-in exercise at an exercise facility in the future, ever.

**42. Thank you for completing this survey. We will email you in approximately 30 days to invite you to complete the next survey.**

**If you wish to receive a copy of a report of the results of this research when the study is complete, please check here:**

- Yes, please email me a report of the results.