INITIAL DEVELOPMENT AND ASSESSMENT OF THE MOTIVES FOR MANAGING SEDENTARY BEHAVIOUR – OLDER ADULTS (MMSB-OA) INSTRUMENT

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Abstract

Older adults have been recognized as the most sedentary age group globally. Although a growing body of literature has emerged surrounding older adults' motives to limit sedentary behaviour, there has been little done to develop practical tools to evaluate these motives. This is problematic as an instrument designed to evaluate motives could provide valuable insight for program developers to better tailor intervention designs which can effectively mitigate the detrimental consequences associated with prolonged sedentary behaviour. Two studies are presented within this thesis, both of which sought to evaluate the psychometric properties of an instrument designed to assess older adults' motives to sit less from the theoretical perspective of Self-Determination Theory. Results demonstrated satisfactory validity and reliability for the instrument; however further exploration is required to investigate larger and more representable samples as well as the utility of the instrument in an intervention context.

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List of Abbreviations

Most frequently appearing:

SB = Sedentary Behaviour

SDT = Self-Determination Theory

MMSB-OA = Motives for Managing Sedentary Behaviour – Older Adults

ESEM = Exploratory Structural Equation Modelling

Other important abbreviations:

CFI = Comparative Fit Index

TLI = Tucker Lewis Index

SRMR = Standardized Root Mean Residual

RMSEA = Root Mean Square Error of Approximation

CI = Confidence Interval

MLR = Robust Maximum Likelihood

CFA = Confirmatory Factor Analysis

PANAS = Positive and Negative Affect Schedule

MOS SF-36 = Medical Outcomes Survey Short Form 36-items

Miscellaneous

BREQ = Behavioural Regulation in Exercise Questionnaire

BRSQ = Behavioural Regulation in Sport Questionnaire

EFA = Exploratory Factor Analysis

MLSQ = Motivation to Limit Screentime Questionnaire

MVPA = Moderate-to-Vigorous Physical Activity

REBS = Regulation of Eating Behaviour Scale

SEM = Structural Equation Modelling

SMS = Sport Motivation Scale

SMS-II = Sport Motivation Scale Revised

Important Note

For the purpose of this thesis, both study 1 and study 2 will be outlined completely, however, it is important to note that much of the work that went into study 1 occurred either prior to the start of my MSc. pursuit, or was conducted by someone other than myself. Therefore, while everything will be included it should be highlighted that the application for ethics, initial content validation, item refinement, and creation of the item pool for study 1 was completed as part of a Chinook Summer Studentship I received in the Summer of 2019, whereas the participant recruitment/data collection for study 1 was conducted by an Undergraduate Student (Wes Bowie) during the Summer of 2020. With that said, for this MSc. pursuit, the data analysis of study 1 was conducted, as well as the study design, survey selection, ethic application, participant recruitment, and data analysis for study 2.

Chapter 1: Introduction and Literature Review

1.1 Introduction

Sedentary behaviour (SB) has been defined as any waking behaviour in a seated or reclined position that does not provoke an energy expenditure greater than 1.5 metabolic equivalents (Tremblay et al., 2017). Often misconstrued as physical inactivity, SB is a separate movement behaviour which can include waking activities such as watching television, using a computer, reading, or sitting while eating. Physical inactivity is not a particular movement behaviour, rather it is the absence of engagement in physical activity at light, moderate, or vigorous intensities at the recommended levels (typically 150 minutes of moderate-to-vigorous physical activity (MVPA) per week with engagement in resistance activities >2 times per week; Ross et al., 2020). The difference between physical inactivity and SB is that an individual can engage in SB – even at substantial levels - while also meeting the recommended physical activity guidelines outlined by which ever governing body one considers. Although regular participation in SB is not inherently negative, as sitting is a ubiquitous component of everyday life (Copeland, 2019), prolonged engagement in SB may be associated with numerous detrimental health consequences including cardiovascular disease, diabetes, cancer, reduced mobility, functional limitations, and all-cause mortality (Copeland, 2017; Saunders et al., 2020). When discussing the deleterious consequences of SB, a cautious approach must be taken as it is unclear whether these outcomes are independently associated with SB - and whether there are differences in outcomes depending on the types of SB's engaged in – or if it is a compounding effect with physical inactivity and other factors (Copeland et al., 2017; Copeland, 2019). Regardless, evidence exists to suggest that there should be focus on increasing MVPA as well as seeking to break up prolonged sedentary bouts (Copeland, 2019). Meeting the recommended guidelines for MVPA

but also engaging in extensive SB is not beneficial to overall quality of life; thus, seeking ways to encourage SB reduction alongside facilitating recommended MVPA is an important avenue for research (Copeland, 2019).

In Canada, older adults have been found to be the most sedentary age demographic, spending approximately 9.9 hours engaged in SBs per day according to accelerometer-derived data (Prince et al., 2020a). Similarly, at an international level, older adults are also the most sedentary age demographic, although only averaging around 9.4 hours of SB per day according to the most recent review of the literature (Harvey et al., 2015). Recently, in response to the lack of guidelines and recommendations surrounding engagement in daily SB, the Canadian Society for Exercise Physiology, in partnership with the Government of Canada, Queens University, and ParticipACTION released 24-hour movement guidelines for adults 65 years or older. In this document, it recommends that older adults limit daily sedentary time to 8 hours or less, with no more than 3 hours of recreational screen time (Ross et al., 2020). Additionally, it was suggested that prolonged engagement in SB should be broken up with frequent standing/movement breaks as this has been suggested to mitigate some of the detrimental impacts of prolonged SB time (Dogra et al., 2017; Ross et al., 2020; Sardinha et al., 2015). As the 65-year-old and above demographic is expected to exceed 30% in many North American, European, and Asian countries by 2050 (World Health Organization, 2015), these recommendations are an important first step to ensure successful and healthy aging in the years to come; however, recommendations without plans of action do little to incite change, and therefore more research is needed to create effective programs to target SB in older adults (Dogra et al., 2017).

Interventions designed to target older adult's SB have become more prevalent over the recent decade with many reporting significant post-test reductions in daily SB (e.g., Aunger et

al., 2018; Aunger at al., 2020; Crombie et al., 2021; Fitzsimons et al., 2013; Gardner et al., 2011; Rosenberg et al., 2015; Voss et al., 2020b); however, the actual effectiveness of previous interventions is questionable. Most studies have relied on self-reported sedentary time to assess intervention efficacy instead of more reliable objective measures (Aunger et al., 2018; Prince et al., 2020b); only two previous interventions have included post-intervention follow-ups (Aunger et al., 2020; Crombie et al., 2021) – one of which had a participant attrition rate of 45% (Aunger et al., 2020) and; sample sizes for previous interventions have ranged from 10 – 59 participants, with several studies underpowered to detect differences in outcome measures (Aunger et al., 2020; Voss et al., 2020b). This suggests that while the research regarding interventions to reduce older adults' SB seems fruitful, the limitations of the aforementioned studies make it difficult to ascertain the efficacy of these programs. Consequently, using the previous programs as a basis for future programs may not be an effective means of targeting older adults' SB as the programs lack sufficient evidence on how to facilitate long-term behaviour change. Therefore, rather than focusing on program development, the current focus should instead be on developing a foundation of knowledge regarding the antecedents to older adults' SB.

One way to address the lack of efficacious interventions targeting older adults' SB is to focus on the psychological factors involved in older adults' SB, specifically, what motivates them to limit their SB (Deci & Ryan, 2000). Understanding older adults' motives to limit SB may isolate modifiable mechanisms implicated with the behaviour, allowing for the development of specific and tailored strategies to encourage long-term behaviour change (e.g., Teixeira et al., 2020). According to a systematic review by Aunger and colleagues (2018), few interventions have incorporated motivation as an intervention component, and instead have relied heavily on goal setting and SB education as means to try and target older adults' SB. This is surprising

given that literature in other contexts has advocated that interventions would greatly benefit from establishing the types of things that older adults already find motivating and capitalizing upon those motives (Teixeira et al., 2020). Fortunately, this area of research has been gaining more attention over the last five years, with many studies attempting to enhance the knowledge surrounding older adults' motives towards limiting daily SB (e.g., Chastin et al., 2014; Collins & Pope 2021; Compernolle et al., 2019; Dontje et al., 2018; Greenwood-Hickman et al., 2016; Matson et al., 2018; McEwan et al., 2017; McGowan et al., 2020; Tam-Seto et al., 2016; Voss et al., 2020a); however, as soon will be established, there are many limitations to the previous research that prevents wide spread practical applications.

1.2 Motives to Limit Sedentary Behaviour

Within the literature, the terms 'motivation' and 'motives' are regularly used interchangeably with one another. Though similar, it is important to differentiate the two before moving forward. Motivation can be described as the driving force behind an individual's efforts towards a particular behaviour, constituting both the direction and intensity of said efforts (Ryan & Deci 2017). Motives – or 'reasons' – are the actual conscious or non-conscious desires, fears, reflective values, and goals that drives the action taking place (Ryan & Deci 2017). For the purposes of this thesis, an appropriate way to think about motives and motivation is that motives are the different types of reasons for engagement that comprises one's motivation. This topic will be discussed further, but again, motivation is an overarching category to which different motives fall under. Over the last decade, and especially in the last five years, several qualitative studies have utilized focus groups and interviews to investigate older adults motives towards limiting daily SB, both in the community-dwelling and assisted-living context (e.g., Chastin et al., 2014; Collins & Pope, 2021; Compernolle et al., 2019; Dontje et al., 2018; Greenwood-Hickman et al.,

2016; Matson et al., 2018; McEwan et al., 2017; McGowan et al., 2020; Tam-Seto et al., 2016; Voss et al., 2020a). Although the research has only begun to gain traction recently, consistent patterns in the motives older endorse for limiting daily SB have emerged, including; improving psychological and physiological health, relieving stiffness and pain, household activities, relieving boredom from sitting/participate in interesting non-sedentary activities, and social commitments (Chastin et al., 2014; Collins & Pope, 2021; Compernolle et al., 2019; Dontje et al., 2018; Greenwood-Hickman et al., 2016; Matson et al., 2018; McEwan et al., 2017; McGowan et al., 2020; Tam-Seto et al., 2016; Voss et al., 2020a). On a more novel and older adult-specific side, studies have also identified a desire from older adults to maintain their independence, enhance feelings of youthfulness/mitigate feelings associated with aging, and reduce SB as a form of self-care (Chastin et al., 2014; Collins & Pope, 2021). While there are some variations in environment-specific motives depending on living arrangements (community-dwelling versus assisted living facility) these patterns remain relatively consistent across different environments**.** For example, community-dwelling older adults frequently cite activities of daily living/household chores (e.g., cooking, cleaning, yard work) as motives to sit less (e.g., Chastin et al., 2014; Collins & Pope, 2021; Compernolle et al., 2019; Dontje et al., 2018; Greenwood-Hickman et al., 2016; Matson et al., 2018; McEwan et al., 2017; McGowan et al., 2020; Tam-Seto et al., 2016); however, for many older adults' residing in assisted living facilities, these opportunities no longer exist or are actively removed from older adults' routine (e.g., Giné-Garriga et al., 2019; Voss et al., 2020a).

Unfortunately, despite the increase in information surrounding the older adults' motives for limiting daily SB, the current literature is limited. Little to no guidance has been provided regarding the types of motives that are optimal and should be cultivated within the context of an

intervention setting by program designers. That is, while consistent patterns have emerged with regards to older adults' motives, the practical applications of the literature to guide efficacious interventions is insufficient. One cause for this limitation may be due, in part, to the absence of theory-driven research. Though many of the previously mentioned studies have relied on a conceptual framework to help guide study design and the data analysis process (e.g.,Chastin et al., 2014 Maher & Conroy, 2016; Nicolson et al., 2019; Tam-Seto, et al., 2016; Voss et al., 2020a), most have incorporated a model (Chastin et al., 2014; Nicolson et al., 2019; Tam-Seto et al., 2016; Voss et al., 2020a) with only one having utilized a theory (Maher & Conroy, 2016). Research rooted in a model constructs a picture of a phenomenon that, while valuable, does not provide the same depth of understanding that theory-based research might (Nilsen, 2015). This is because the purpose and function of a model differs fundamentally from the purpose and function of a theory. Models are designed to either (1) be an intentional simplification of a phenomenon under study, or (2) only represent a specific aspect of a phenomenon (Nilsen, 2015). Though closely intertwined with theories, a model is used more as a way to describe a phenomenon, whereas the scope of a theory is to both describe and attempt to explain a phenomenon (Nilsen, 2015). Referring back to the research within the context of older adults' motives to limit SB, most of the model-guided studies have relied on the Social Ecological Model **(**Chastin et al., 2014; Nicolson et al., 2019; Tam-Seto et al., 2016; Voss et al., 2020). Briefly, the Social Ecological Model identifies multiple levels of influence of a behaviour – individual, social organizational/community, environmental, and policy – and further acknowledges the complex interplay between these levels. But this model fails to outline specific strategies or processes that can facilitate or hinder one's motives to limit their sitting time at each level. More specifically, according to the Social Ecological Model, there are four domains of SB

– leisure time, household, transport, and occupation – with various contributing factors from the each of the different levels (Owen et al., 2011). However, there is no information as to which of the four SB domains is most critical to target when developing programs to try and limit SB nor is there information regarding which level of influence plays the greatest role in determining an individual's SB. Consequently, though the studies which have relied on the Social Ecological Model have provided invaluable information about older adults' motives to sit less – especially regarding what types of motives may be relevant to investigate and the emerging patterns about the different domains of SB – the practical applications of the data are limited. This is in part due to the lack of insight provided on how to translate the findings into effective strategies that have the ability to elicit long-term behaviour change or higher quality psychological outcomes.

Unlike a model, the purpose of a theory is to both describe and explain a particular phenomenon. Using a theory to assist in the understanding of a phenomenon has been endorsed across literature (Creswell 2013; Glesne, 2016) as theories can to help organize data in a meaningful manner, explain and predict behavior, and guide future actions. In particular, a theoretically driven study may help to organize and identify motives that are more or less likely to elicit positive experiences and the sustained reduction of SB among older adults. Furthermore, the addition of a theory to this research may enhance the understanding of the antecedents of optimal motives, and guide researchers and program developers in the creation of strategies to facilitate these motives to limit SB (Glanz & Bishop, 2010).

The strengths of theory-driven research over model-driven research further necessitates theory-driven research in the context of older adults' approach to limiting SB. As of 2020, only one study had been published using a theory to investigate older adults' motivation (Maher & Conroy, 2016); however, this study focused less on the specific motives that older adults'

endorse. Instead, using a dual process theory of motivation whereby behaviour is thought to be regulated by controlled ('conscious') processes and automatic ('nonconscious' or 'habit') processes, this study investigated the associations between the processes SB and the motivational constructs that may play a role in the amount of SB older adults engage in. From this study, it was identified that SB – self-reported and objectively measured SB – had a weak-to-moderate positive correlation with SB habit strength (*r*s = 0.22, 0.18 respectively), and weak-to-moderate negative correlations with planning to reduce SB (an aspect of controlled processes; *r*s = -0.10, -0.21 respectively). The study also identified different motivational constructs that should be targeted in interventions to reduce SB (e.g., task self-efficacy). In essence, this study demonstrated that participation in SB was correlated with automatic processes (habit strength) and controlled process (intentions) as well as the need to focus on psychological aspects to facilitate SB reductions which. The limitation of this study is its inability to address specific motives – motives are conscious or non-conscious reasons for engaging in a behaviour – that are important when reflecting on limiting daily SB. Consequently, though this study touched on the importance of motives for SB reduction, a gap in the literature remains. It is still unclear what specific motives guide older adults to reduce or break up the SB, and the differential importance of various motives – that is, are all motives equally influential when it comes to reducing SB, or are there motives that have a greater influence? Thus, a logical next step would be to incorporate a theory more centered on the specific types of motives and motivations itself to facilitate a greater understanding of older adults' motives to limit their daily SB.

1.3 Self-Determination Theory

Self-determination theory (SDT; Deci & Ryan, 1985) is a theory of motivation which may prove promising in this line of inquiry. First described in the mid-80s, SDT has been

extensively investigated and incorporated into research attempting to understand human motivation across various diverse contexts such as education (e.g., Reeve & Cheon, 2021), health and health care (e.g., Ntoumanis et al., 2021), dentistry (e.g., Halvari et al., 2017), parenting (e.g., Robichaud et al., 2020), physical activity (e.g., Hagger & Chatzisarantis, 2007), public safety (e.g., Van Petegem et al., 2021), religion (e.g., Brambilla et al., 2015), and the workplace setting (Slemp et al., 2018). Thus, while SDT has not been utilized extensively in interventions designed to target SB across different age groups (e.g., Aunger et al., 2019; Lewis et al., 2016; Van Hoecke et al., 2014), nor has it been used frequently in the investigation of motives to limit SB (e.g., Gaston et al., 2016; Lubans et al., 2013), the quantity and quality of support found elsewhere in the literature (e.g., Ryan & Deci, 2017) exceeds that of other theoretical frameworks and provides strong rationale for its use in the present context. Although there are many theories and models of human motivation that could be utilized in this context, including social ecological model (Owen et al., 2011), transtheoretical model (Prochaska & Velicer, 1997), theory of planned behaviour (Ajzen, 1991), or social cognitive theory (Bandura, 1986), an advantageous aspect of SDT for program design is the ability to identify various antecedents and consequences to explain the 'why' behind complex behaviours (Deci & Ryan, 2000).While this ability is present in the theory of planned behaviour and social cognitive theory, unlike the other aforementioned conceptual frameworks which could be utilized in this context, SDT also acknowledges the existence of several different forms of motivation along a continuum as opposed to motivation being a binary entity that an individual either possess or does not (Deci & Ryan, 1985). These factors, coupled with the demonstrated evidence that motives, as categorized per the SDT, can assist with not only predicting psychological, and behavioural outcomes, but also sustained participation for a behaviour (e.g., Ryan & Deci, 2017) necessitates the utilization

of SDT in the context of attempting to better understand older adults' motives to limit daily SB alongside the antecedents and outcomes of said motives. Lastly, the scope of SDT is important to emphasize. SDT is not a single theory, instead it is comprised of six mini theories: Cognitive evaluation theory, organismic integration theory, causality orientations theory, basic psychological needs theory, goal content theory, and relationships motivation theory (Ryan & Deci, 2017). Each of these six theories explain different components of the way humans interact within their environments including behaviours, experiences, and development. While not all six theories factor into the present thesis, approaching older adults' motives to limit SB from the perspective of SDT allows for future investigations to build upon the current investigation and explore other factors including the ways motives relate to goals (per the goal content theory), or how basic psychological needs may impact motives (per the basic psychological needs theory). This scope is not present with other theoretical frameworks.

Proponents of SDT postulate that an individual's motives to participate in a particular behaviour differs in the degree to which they are self-determined and internalized (Ryan & Deci, 2017). Based on this difference in internalization, the motives can be categorized along the motivational continuum into one of six different types of motivation. The categories of motivation include intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation (Ryan & Deci, 2017). On the fully internalized and self-determined end of the spectrum is intrinsic motivation. *Intrinsic motivation* can be described as the process whereby an individual engages freely in a behaviour out of interest, challenge, or enjoyment in the absence of any external cues or feelings of pressure (Deci & Ryan, 2000). Intrinsic motivation is seen as the 'ideal' motivation and is subsequently used as the point to which all other motivated behaviour is compared to discern the degree of self-

determination and internalization. Next, *integrated regulation* represents a high-degree of internalization – though falling short of intrinsic motivation – and is characterized by engagement in a behaviour emanating from the identification and integration of a behaviours' importance/value into other aspects of oneself (Deci & Ryan, 2000). With integrated regulation, an individual is engaging in a behaviour because they view it as congruent with their core beliefs, and therefore it is 'who they are (Deci & Ryan, 2000). *Identified regulation* involves an individual engaging in a behaviour because they recognize/perceive the outcomes associated with participating in a particular behaviour to have value (Deci & Ryan, 2000). *Introjected regulation* represents a partially internalized, and an individual is engaging in a behaviour for self-imposed sources of pressures (e.g., guilt), and/or to enhance feelings of self-worth (Deci & Ryan, 2000). *External regulation* can be conceptualized as the complete lack of internalization of motives, whereby participation in a behaviour is dependent completely on external sources (Deci & Ryan, 2000). These external sources can be perceived external pressures imposed by others in the surrounding environment, a desire to obtain an external reward (social and/or tangible), or to avoid an external punishment (social and/or tangible). The final category of motivation outlined by the SDT motivation continuum in amotivation. *Amotivation*, as the name implies, is the process of engaging in a particular behaviour despite an absence of motivation or lack of intention. Interestingly, though individuals endorsing amotivated motives may still engage in a particular behaviour, it is more likely that if an individual is endorsing amotivation they will not engage in the behaviour at all (Deci & Ryan, 2000). When discussing measuring an individual's motivation from the perspective of SDT, the questions included in a survey represent specific motives – that is specific 'reasons' – for engaging in a behaviour. Responses collected from the survey are then used to ascertain the direction and intensity of an individual's motivation. That

is, if the individual responds more favorably to motives that reflect external pressures than anything else, then it would be interpreted that their underlying motivation is external regulation. In sum, for surveys in SDT the items represent specific motives, but the instrument measures specific motivation types along the motivational continuum.

1.3.1.1 Relationship between motivation and behaviour

It is important to highlight that the categories outlined by the SDT motivation continuum are, at the core, hypothetical concepts which serve to represent psychological processes and not phenomenon that are directly observable by researchers (Ryan & Deci, 2017). One's behaviour may be guided by a culmination of motives derived from different categories along the continuum, with individuals endorsing many reasons for a single behaviour either at different times or simultaneously. However, the ability and need to differentiate the driving force and degree of internalization behind an individual's motives should not be overlooked. This is because, across various contexts, the literature has convincingly demonstrated that motives differing in the degree to which they are internalized lead to qualitatively different outcomes (Ryan & Deci, 2017). Though there is a lack of evidence in the SB context due to a lack of empirical attention, evidence does exist in exercise behaviour research, which has been extensively investigated through the lens of SDT. In a systematic review conducted by Teixeira and colleagues (2012) motives which were more internalized (e.g., motives regulated through identification, integration, and intrinsic motivation), were consistently linked with initiation of exercise behaviour, greater likelihood of long-term maintenance of behaviour, as well as other positive outcomes which have been corroborated by other sources such as strong commitment and more focused effort towards a task, more positive experiences, lower anxiety and stress, and greater sense of well-being (e.g., Deci & Ryan 2008; Ng et al., 2012; Ryan & Deci, 2017).

External and introjected regulation can also play a role in initiating exercise behaviour (Teixeira et al., 2012). But these motives as well as amotivation have also been positively associated with detrimental outcomes such as burnout, dropout, feelings of discouragement, ill-being, and other negative cognitive and affective outcomes –the evidence regarding introjection and these outcomes can be contradictory with some studies indicating positive correlations between introjected regulation and positive outcomes (e.g., Ng et al., 2012; Rodrigues et al., 2019, Ryan & Deci, 2017). For example, in the exercise context, introjected regulation has also been shown to be either positively associated with exercise participation or not associated with exercise participation at all (Teixeira et al., 2012); however, regardless of the positive nature of some associations, the strength is typically weaker than intrinsic motivation, integrated regulation and identified regulation (Teixeira et al., 2012). The importance and influence of introjected regulation may also be sex-based (Teixeira et al., 2012). With females, introjected regulation seems to be more positively associated with exercise than for males (which typically shows a negative or non-significant association; Teixeira et al., 2012). Unfortunately, this is an area that requires more attention before any definitive conclusions can be drawn; however, from this the take-away is that introjected regulation may be a mixed bag of influence depending on who is endorsing it.

1.3.1.2 Relationship between motivation and indices of well-being

Focusing more on the psychological outcomes associated with different regulatory styles specific to older adults, a review and meta-analysis of 23 studies investigating motivation and well-being in older adults found that, in general: (1) intrinsic motivation was positively correlated with indices of well-being (indices including positive affect, and/or vitality; $r = 0.48$, $p < 0.001$) and life satisfaction ($r = 0.29$, $p < 0.001$); (2) identified regulation was positively

correlated with indices of well-being ($r = 0.43$, $p < 0.001$), life satisfaction ($r = 0.19$, $p < 0.01$), self-esteem ($r = 0.30$, $p < 0.001$), and subjective health ($r = 0.22$, $p < 0.01$); (3) amotivation was negatively correlated with indices of well-being ($r = -0.49$, $p < 0.001$), self-esteem ($r = - 0.50$, $p < 0.001$), and positively correlated with depression ($r = 0.24$, $p < 0.001$); (4) autonomous motivation (as a composite score of integrated and identified regulation), was positively correlated with subjective health ($r = 0.30$, $p < 0.001$), and; (5) Self-Determination Index – Self-Determination Index is determined by weighting each of the types of motivation based on their location on the motivation continuum. Intrinsic motivation is weighted at +2, +1 to integrated and identified regulation, -1 to introjected and external regulation, and -2 to amotivation (Philippe & Vallerand, 2008) – was positively correlated with indices of well-being ($r = 0.54$, $p < 0.001$; Tang et al., 2020). Interestingly, no correlations were reported for integrated regulation nor introjected regulation and psychological outcomes amongst older adults. Upon examining the included papers, neither of those regulatory styles were investigated as the instrument utilized to evaluate motivation did not included specific items to address either integrated regulation or introjected regulation (Elderly Motivation Scale; Vallerand & O'Connor, 1991). The instrument also does not explicitly investigate identified regulation, instead it refers to the subscales/factors as "intrinsic motivation", "self-determined extrinsic motivation", "non-self-determined extrinsic motivation", and "amotivation". Therefore, although the "self-determined extrinsic motivation" items seem to reflect identified regulation, the post-hoc assignment of that label for the meta-analysis brings to question the quality of the associations observed for identified regulation. As for the non-significant correlations, several of note included no significant correlations between external regulation and well-being, life satisfaction, self-esteem, or depression respectfully ($r = -0.23$, $p = 0.38$; $r = -0.03$, $p = 0.80$; $r = -0.14$, $p = 0.31$; $r = 0.17$, $p = 0.26$; Tang et al., 2020).

Nor were than any significant correlations between amotivation, life satisfaction or subjective health (r = -0.11, p = 0.30; r = -0.12, p = 0.41, respectively; Tang et al., 2020). Taken together, this suggests either one of two things: (1) life satisfaction and subjective health may be related to more self-determined motives, but unrelated to non-self-determined in older adults, or (2) more empirical evidence is needed to investigate this topic further. Though it is unclear which is the correct option, more empirical evidence would be beneficial as the number of studies which have investigated these correlations are severely lacking (Tang et al., 2020).

Looking specifically at some of the studies which comprised the review, particularly studies which looked at motivation and well-being in more generalized settings that older adults may find themselves (e.g., nursing homes or residential settings), Vallerand and colleagues (1995) observed significant negative associations between external regulation and life satisfaction (r = -0.28, $p < 0.05$) and between amotivation and life satisfaction amongst older adults living in nursing homes (r = -0.24, $p < 0.05$). Though similar significant observations were not reported in other studies from this context, the relationship between life satisfaction and motivation have been well documented in other contexts, such as volunteering (intrinsic motivation for volunteering with life satisfaction: r = 0.16, $p < 0.01$; Kwok et al., 2013), leisure behaviours in older adults (intrinsic motivation and life satisfaction: r = 0.19, $p < 0.01$; Guinn, 1999), and sport motivation (integrated regulation with life satisfaction 0.25, $p < 0.01$, identified 0.25, $p < 0.01$ and 0.20, $p < 0.05$, amotivation -0.30, $p < 0.01$. Pelletier, et al., 2013). Taken together this suggests a potential negative correlation between less self-determined motives and satisfaction with life and a positive correlation between more self-determined motives and satisfaction with life. Therefore, though the relationship between life satisfaction and motivation

from the perspective of SDT in the context of older adults is severely limited and mixed, looking at other contexts, life satisfaction and motivation may be inextricably linked.

Another study which was included in the review investigated the relationship between positive and negative affect and motives amongst older adults in a generalized context (Sheldon & Kasser, 2001). The researcher found that autonomous motives were positively associated with positive affect ($r = 0.24$, $p < 0.05$) and negatively associated with negative affect ($r = -0.29$, $p < 0.01$) as measured by the positive and negative affect schedule (PANAS; Watson et al., 1988). Unfortunately, despite the role that positive and negative affect have in determining an individual's subjective well-being (Ryan & Deci, 2001), no study has since looked at the relationship between positive and negative affect and motivation amongst older adults. Outside of the context of older adult research, for physical activity participation in individuals with affective disorders (M_{age}= 45.6) positive affect has been found to be positively correlated with autonomous motivation (intrinsic motivation and identified regulation combined; $r = 0.57$, $p < 0.001$) and negatively correlated with external regulation ($r = -0.25$, $p < 0.05$) and amotivation ($r = -0.49$, $p < 0.001$), while negative affect has been found to be positively associated with amotivation ($r = 0.25$, $p < 0.01$), external regulation ($r = 0.20$, $p < 0.01$), and introjected regulation ($r = 0.29$, $p < 0.001$), and negatively associated with autonomous motivation ($r = -0.31$, $p < 0.001$; Vancampfort et al., 2015). While individuals with affective disorders represent a different demographic than older adults, the study by Vancompfort and colleagues (2015) indicates a potential relationship between affect, motivation, and exercise behaviour. When coupled with the results of the study conducted by Sheldon and Kasser (2001), these studies suggests that in the context of older adults' motives for limiting SB, different motives may be correlated with qualitatively different levels of positive and negative affect.

1.3.1.3 Relationship between motivation and health indices

Regarding the subjective health aspect of the results of the meta-analysis (Tang et al., 2020), an exploration into the motivation for exercise in older adults (defined as 70 years and older) and its relationship with scores on the medical outcomes survey short form 36 items (MOS SF-36) observed that those found to be highly self-determined (endorsing more self-determined motives while not endorsing non-self-determined motives) reported significantly higher self-reported quality of life on role limitations due to physical health ($p = 0.01$, $\eta_p^2 = 0.06$) , bodily pain ($p = 0.01$, $\eta_p^2 = 0.07$), social functioning *(*$p = 0.001$, $\eta_p^2 = 0.11$), and role limitations due to emotional problems ($p = 0.006$, $\eta_p^2 = 0.08$) compared to those who were less self-determined after controlling for minutes of exercise per week and employment status (Ferrand et al., 2014). An additional study with a student population examined the relationship between motivation and a superordinate measure of physical health comprised of the physical functioning, role limitation due to physical problems, bodily pain, and general health perception (Marcinko, 2015). Marcinko (2015) observed a correlation between more self-determined motives and physical health ($r = 0.09$, $p < 0.50$) as well as between less self-determined motives and physical health ($r = -0.15$, $p < 0.01$). In the same study, a correlation was also observed between physical health and positive affect ($r = 0.13$, $p < 0.01$) and physical health and negative affect ($r = -0.33$, $p < 0.01$; Marcinko, 2015). Although no research exists regarding the relationship between motives to sit less from the lens of SDT and behaviour/psychological outcomes, the strength of the associations between motives of different degrees of internalization and outcomes may provide informative illumination. Across various contexts suggests consistent trends are seen, thus it should not be seen as too far of a stretch to assume that the same should

be true when it comes to motives and outcomes associated with older adults' approach to limiting daily SB.

1.3.2.1 Exploring older adults' motives to reduce SB through an SDT Lens

Interestingly, parallels can be drawn between the motivation categories outlined in the SDT literature and the motives to limit SB expressed by older adults in previous studies. For example, several studies (e.g., Chastin et al., 2014; Greenwood-Hickman, 2016; Voss et al., 2020a) have identified motives such as guilt associated with prolonged SB or feelings of obligation to complete non-sitting household task – both of which clearly are consistent with the internal pressure characteristic of introjected regulation. However, drawing these parallels should be done carefully and taken with little stock in an academic context as none of the previous studies which reported older adults' motives to sit less were designed with SDT nor differentiating the degree of internalization of motives in mind; therefore, while there are previously reported motives that neatly fit into the motivation categories along the SDT continuum, the lack of context and intention for other reported motives makes post-hoc categorization questionable at best. For example, referring back to the evidence collected by previous studies, 'relieving pain and stiffness' is commonly cited across multiple studies as a motive to sit less without any additional context (Chastin et al., 2014; Greenwood-Hickman et al., 2016; Voss et al., 2020a). On the surface this motive could be interpreted as 'I am motivated to sit less because doing so allows me to reduce the pain and stiffness associated with prolonged sitting, and that is something I personally value' which would be clearly indicative of identified regulation; however, that motive could also mean 'both my doctor and family members have told me to sit less because doing so could help relieve my pain and stiffness, and while I do not believe them, I do so to appease them'. In this case the motive is not internalized at all and is

instead regulated by external pressure. Thus, while both motives fit into the category of 'relieving pain and stiffness' the actual degree of internalization is substantially different which, in turn, could lead to qualitatively different outcomes for the behaviour.

The existence of such motives reflective of different degrees of internalization gives weight to an exploration into this context with an SDT lens. Post-hoc categorization creates problems due to previous studies not designed to discern the degree to which older adults' motives to sit less are internalized; therefore, it is necessary for a study rooted in SDT to evaluate older adults' motives.

1.3.2.2 Qualitative investigation into older adults' motives to sit less from the theoretical perspective of SDT

To address the lack of theory-based investigations into older adults' motives to limit daily SB, seven semi-structured focus groups rooted in SDT were conducted with community-dwelling older adults (M_{age} = 73.96, SD = 5.51) between January 2019 and March 2019 (Collins & Pope, 2021). Each focus group contained between three and six participants and lasted approximately 40 minutes (range 32-50 minutes). Participants were predominantly unemployed/retired (96%) and were able to walk without the assistance of an aid, such as a wheelchair, walking stick, or walker (89%). A semi-structured interview guide – grounded in SDT – containing 10 pre-determined questions was used (Collins & Pope, 2021) to provide structure to each focus group; however, the guide was flexible enough to allow the interviewer to follow the natural flow of the focus group discussion (Smith & Sparkes, 2016).

Focus groups were recorded and transcribed verbatim. Data were then coded – organized based on information contained in participant statements and assigned labels to indicate data meaning – and analyzed using thematic analysis following the guidelines outlined by Braun,

Clarke, and Weate (2016). Initially, coding of the data was performed using a deductive approach followed by a theory-guided inductive approach. That is, motives expressed by participants were first organized into categories based on the similarity of content (e.g., health management/improvement, relieving physical discomfort associated with prolonged SB, weight management, household chores, commitments to social groups/family/friends, and interesting activities). Next, to advance the literature and examine older adults' motivation through an SDT lens, motives were organized into each of the six motivation types along the motivation continuum, including: "amotivation"; "external regulation"; "introjected regulation"; "identified regulation"; "integrated regulation", and; "intrinsic motivation".

Results from this study were consistent with previous research (e.g., Chastin et al., 2014; Dontje et al., 2018; Greenwood-Hickman et al., 2016; Voss et al., 2020a) such that older adults reported to be motivated to limit daily SB from reasons such as improving or managing health, relieving discomfort, weight management, household activities, commitment to others, identity, and enjoyment of non-sedentary activities. Where the results differ is that motives previously organized based on similar content were split in some situations due to varied degrees of internalization. This difference is likely due to using a theory-guided approach to organize the data. Examples of this differing degree of internalization could be seen within each category of motives. As discussed by Collins and Pope (2021) weight management was dichotomized such that participants either endorsed motives indicative of external regulation or those aligning with identified regulation. In terms of external regulation, there were participants who mentioned that the external pressure from others for maintaining a specific physical appearance motivated them to sit less. With regards to identified motives, some participants recognized that having excess weight resulting from a more sedentary lifestyle contributed to a perceived lowered quality of

life (e.g., greater stress on joints). To improve their quality of life, these participants recognized that by limiting their daily SB they may be able to better manage their weight and thereby reduce the impact the perceived excess weight may have had on their overall health. Regardless of the driving factor behind the motive, both groups of people recognized weight management as a reason to limit daily SB; however, based on previous SDT literature, the driving factor (e.g., external pressure vs. perceived value) cannot be ignored as there may be qualitatively different outcomes depending on the driving factor. That is, those which endorsed weight management because they personally value the potential health-related outcomes obtained from limiting SB – identified regulation – are more likely to experience more positive outcomes than the participants who expressed motives congruent with external regulation.

Some participants in the study echoed this notion within the SDT literature that different motives lead to qualitatively different outcomes. As one participant stated:

> *If it comes right down to it though it's like any other dysfunctional behavior. Someone really has to want to do it to. Like we can be there, and we can force them and we can drag them out and make them do it, but if we're not there, then what happens? So, yeah, I think threats and coercion and all that stuff will work for a period of time.*

Though this study was not intended to provide answers or suggestions to program designers on how to best structure an intervention to effectively target older adults' SB, it provides a starting point. Specifically, it raises awareness that the previous way motives have been organized based on similarity of content overlooks a key component which may contribute to the types of outcomes older adults may experience when limiting SB. It is well established in the literature that motives with differing degrees of internalization lead to qualitatively different outcomes across a myriad of context (e.g., Deci & Ryan 2008; Ng et al., 2012; Rodrigues et al.,

2019; Ryan & Deci, 2017; Tang et al., 2020; Teixeira et al., 2012). Therefore, it can be assumed that in the context of SB this would also be true. Failing to take into consideration the degree to which motives are internalized, and instead focusing solely on motive content may have detrimental effects on certain individuals while also benefitting others. This highlights the need for program designers to be able to gain insight into the degree to which their participants' motives are internalized. To do that, a high-quality instrument rooted in SDT which can evaluate older adults' motives to limit daily SB must be developed. The development of an instrument may be critical to informing future interventions and programs designed to encourage long-term meaningful lifestyle changes. This is because with an understanding of the motives that drive older adults to limit their SB and the nomonological network which surrounds those motives, program designers will be more able to tailor programs to the specific motivational needs of the participants to ensure a conducive and supportive environment at specific points in time – essentially meeting the individual where they are at – while also facilitating the high-quality motives emphasized by the SDT literature. Furthermore, given that the degree of internalization for a motive can change over the course of an intervention as demonstrated by previous studies (e.g.,Teixeira et al., 2012; Teixeira et al., 2020), and the knowledge that improper environments can have deleterious effects on the motivational process of an individual (e.g., Philippe & Vallerand, 2008; Vansteenkiste & Ryan, 2013), developing an instrument can ensure that if/when motives of a participant change during an intervention, the strategies and mode of intervention delivery can adapt accordingly.

1.4 Instrument Development

Instrument development is a multiphase-process which encompasses the steps required to take a set of items and turn it into a psychometrically-sound instrument that can provide

information about a specific theoretical variable – 'latent variable' or 'phenomenon' – not directly observable by a researcher (DeVellis, 2017). For a psychometrically-sound instrument to be achieved, repeated and rigorous testing of a set of items is required with specific emphasis on a set of items ability to consistently and accurately measure the attributes of the latent variable being observed (DeVellis, 2017). An instruments' ability to consistently and accurately measure the attributes of a latent variable is referred to as reliability and validity respectively– which together fit under the umbrella term of 'psychometric properties'. Reliability specifically refers to an instrument performing in a consistent and predictable way whereas validity refers to the ability of an instrument to measure the intended attributes of the phenomenon under study instead of any unintended attributes as well as correlate and not correlate with particular variables in an expected manner (DeVellis, 2017; DeVon et al., 2007; Drost, 2011; Heale & Twycross, 2015). Though the purpose of this thesis will be expanded on in later sections, to contextualize this current section, the general purpose of this thesis is to develop an instrument to evaluate older adults' motives to limit daily SB from the theoretical perspective of SDT.

1.4.1 Reliability

Another way to conceptualize reliability is 'repeatability', or the ability of an instrument to produce similar results on separate occasions and/or under different conditions when similar results are expected (Drost, 2011). This is not to say slight variations in responses are not permitted to consider an instrument reliable. No measure can ever be perfect, and therefore, the true state of the attributes of a phenomenon can never completely be known (DeVellis, 2017). Thus, reliability is not defined based on whether an instrument can achieve a completely true score, rather reliability is seen as a ratio of the estimated true score over the observed score. That is,

$$Reliability = \frac{True\ Score}{Observed\ Score}$$

Where,

$$True\ Score = Observed\ Score\ \pm Error\ Score$$

Along with the inability to accurately identify the values of the 'true score', it is impossible to know the error score (DeVellis, 2017). Error can be minimized by controlling for systematic and random errors through specific study design; however, error can never be truly eliminated nor accurately identified (DeVellis, 2017).

There are several different types of reliability - two which are most critical to ascertain when developing an instrument are test-retest reliability and internal consistency reliability. Test-retest reliability fits under the umbrella term of 'stability reliability', and its function is to determine whether instrument remain consistent for the attributes of a phenomenon when said attributes are expected to remain stable over time (DeVon et al., 2007). To determine test-retest reliability, participants are presented with the exact same instrument on two occasions separated by some set time interval that is not expected to influence responses (e.g., one week). Scores from the first administration are then correlated with scores obtained from the second administration. The rationale for this process is that the influence exerted by the true score on the observable score should by comparable for both administrations, whereas the error score should change (DeVellis, 2017). This thereby allows for an observable correlation between the scores obtained on the two administration that more accurately represents the extent that the attributes of a phenomenon determines observed scores (DeVellis, 2017). For an instrument to demonstrate exceptional test-retest reliability, it must be assumed that the phenomenon under study remains

completely stable for the time interval between the two administrations of the instrument, and therefore, the scores obtained at both data collection points should be similar. If this stance is taken, any substantial changes in scores should be attributed to the instrument being unreliable; however, this is not always the case (DeVellis, 2017). Transient fluctuations in the properties of the phenomenon under study, changes in measurement method, measurement time (morning, afternoon, evening) and even participant state (mental/emotional) can lead to differences in scores obtained between the two time points, causing an instrument to appear 'unreliable' (DeVellis, 2017). Alternatively, an instrument may appear to demonstrate good test-reliability for reasons not attributable to the instrument itself. The carryover effect, whereby an individual responds in a similar way to the second survey as the first, not because their answers are the same, but rather because they want to appear consistent, has been noted as an issue when it comes to determining the test-retest reliability of an instrument (DeVellis, 2017). Despite the inherent limitations associated with test-retest reliability, the benefits should not be understated. In the case of developing an instrument to evaluate older adults' motives to sit less from the theoretical perspective of SDT, one of the ways that the instrument may be used is to assess changes in motives over time. Test-retest reliability assists in discerning the temporal stability of an instrument from one measurement period to another. Motives to limit SB are unlikely to fluctuate extensively without external influence; therefore, determining if the instrument demonstrates temporal stability in situations when changes should not be observed provides critical information if/when changes are observed over time in an experimental setting.

Internal consistency reliability is also important to consider when developing an instrument as it refers to the degree of interrelatedness and homogeneity among items in a scale/subscale (DeVellis, 2017). That is, whether the items included in an instrument

demonstrate a strong relationship with one another and the variable under investigation. One of the ways to measure internal consistency reliability is to use Cronbach's alpha. First discussed in detail by Cronbach in 1951, and currently is one of the most common indicators for internal consistency, Cronbach's alpha estimates the proportion of a scale's total variance that can be attributed to a common source (e.g., true score of the latent variable; Cronbach 1951). Cronbach's alpha can be calculated using either covariances – which is also known as the *raw score* formula for alpha - or correlations – also known as the *standardized score* formula (DeVellis, 2017). The formula for alpha using covariances is:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_y^2}\right)$$

Where,

k = *Number of indicators (i.e., items)*

$\sum \sigma_i^2$ = *Sum of variance for each indicator*

σ_y^2 = *Total variance*

Whereas the formula for estimating alpha with correlations is:

$$\alpha = \frac{k\bar{r}}{1 + (k-1)\bar{r}}$$

Where,

k = *Number of indicators (i.e., items)*

$\bar{r}$ = *Mean inter-indicator (or item) correlation*

Cronbach alpha scores are expressed as a number between 0 and 1, with alpha scores between 0.65 - 0.80 considered adequate and scores between 0.8 - 0.95 considered good to excellent (Tavakol & Dennick, 2011; Vaske et al., 2017). Values below 0.65 are considered unacceptably low, whereas alpha values above 0.95 may suggest redundancy in the items (Tavakol & Dennick, 2011).

1.4.2 Validity

Validity can be broken down into two overarching categories: translation validity and criterion-related validity (Drost, 2011). There are some discrepancies about these overarching categories depending on different sources, as well as if these categories are the only categories of validity (e.g., Heale & Twycross, 2015), however, for the sake of clarity only these two categories will be discussed, with translation validity encompassing content and face validity and criterion-related validity encompassing concurrent validity, predictive validity, convergent validity and discriminant validity. Though some sources use face validity and content validity interchangeably (e.g., Rubio et al., 2003), face validity and content validity will be viewed as separate entities. Factorial validity is also an important form of validity in scale development, however, does not fit neatly into either of the two categories of validity, nor is it commonly discussed as a type of validity despite its ubiquity in scale development research.

The first type of validity that is typically established during the instrument development process is content validity (Benson & Clark, 1982). As the name suggests, content validity is concerned with the specific content contained in the instrument, and whether the items reflect the complete range of the phenomenon under investigation (DeVellis, 2017). Simply put, content validity is concerned with whether or not the item pool is adequate both in representation and relevance. To determine the content validity of an instrument, a pool of items alongside an

accepted definition of the theoretical concept that the items are intended to represent is submitted to a panel of experts in the appropriate field who are then asked to determine if they are relevant indicators for the intended phenomenon (DeVellis, 2017). During this review process, face validity can also be determined (Hardesty & Bearden, 2004). Face validity is one of the easiest forms of validity to ascertain, however, it is also the weakest (DeVellis, 2017). Unlike content validity that is concerned with the content of the items, face validity is only concerned with the presentation of the items; that is, how the items look. Because of the weaknesses associated with face validity, it will not be discussed nor investigated for this scale development process. With that in mind, there are several technical aspects of an item pool, that while distinct from face and content validity, may be confused with the umbrella term of 'translational validity'. Regardless of not fitting under a validity category, these technical aspects are important to ascertain alongside content validity to ensure greater impact and understanding. These aspects include: (1) item length – longer items may add to the complexity and readability, potentially allowing for misinterpretations; (2) reading difficulty level – greater complexity of items can cause difficulty for interpretation/understanding, and; (3) whether the items are double/multi-barreled – items that contain multiple ideas (DeVellis, 2017).

Once content validity is established, items are then placed in a survey and presented to the intended demographic, with the results used to evaluate factorial and criterion validity. Factorial validity is an essential and ubiquitous component of the scale development process, much to the point where, despite its ever presence in scale development studies, few, if any, papers offer a definition of what factorial validity is. With that in mind, the *Encyclopedia of Quality of Life and Well-being Research* defines factorial validity as the process of examining whether the presumed structure of a set of items within an instrument is observable in the data

collected (Piedmont, 2014). That is, when developing an instrument, researchers create items they hypothesize represent specific latent variables – with each instrument containing one or multiple latent variables. Therefore, the process of collecting data from the target demographic is done to confirm whether the item structure fits the hypothesized structure put forth by the researchers. Factorial validity is the result of a confirmatory process – typically confirmatory factor analysis (CFA) and structurally equation modelling (SEM), or exploratory structural equation modelling (ESEM), to determine if items 'load' above a specified threshold on the intended factors and demonstrate 'model fit' (Piedmont, 2014): model fit is the degree to which the observed item structure fits with the expected item structure – it works in tandem with item loading, but instead of assigning values for each specific item, it instead provides a general overview of the model using fit indices.

The criteria for item loading and model fit differ depending on the researcher/study, but there are general rules of thumb. For item loading, the minimum threshold that items must achieve on their intended factor is 0.32 (Tabachnick & Fidell, 2013). It is said that factor loadings above 0.71 are excellent, above 0.63 is very good, above 0.55 is good, and above 0.45 is fair (Tabachnick & Fidell, 2013). In addition to these criteria, items must also not load onto any other factors above 0.32 (Tabachnick & Fidell, 2013). Speaking to model fit, there are various indices that are investigated to determine whether the observable data matches with the expected data. Five of the main indices investigated with model fit include: the chi-square statistic (χ^2), the comparative fit index (CFI), the Tucker Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean residual (SRMR) (Hu & Bentler, 1999).

Discussions about each index are limited; however, understanding what each represents and the strengths and limitations of each is critical to interpreting and contextualizing the observed data in a scale development study. Thus, though an extensive overview will not be provided, each of the five will be briefly discussed. Beginning with the most basic and commonly reported model test statistic, the chi-square statistic is a test of significance to evaluate whether the covariance matrix of the sample is equal to the model-implied covariance matrix (Schermelleh-Engel et al., 2003). Essentially, it is conducted to see if there are differences between the observed covariance matrix and the expected covariance matrix, where a value of 0 would indicate that the model perfectly fits the data (no differences; Schermelleh-Engel et al., 2003); however, if the chi-square value is high, the covariance matrix obtained from the sample and specified from the model differ significantly from one another. Therefore, when conducting chi-square test, the desire is to have the chi-square value as close to zero as possible, as well as have a p-value greater than 0.05 – significant p-value would signify a significant difference between the two covariance matrices (Schermelleh-Engel et al., 2003). As alluded to, this statistic tests the null hypothesis that the differences between the covariance matrix of the model-implied and the observed data is equal to zero. The formula for the chi-square test is below:

$$\chi^2(df) = (N-1)F[\mathbf{S}, \mathbf{\Sigma}(\hat{\theta})]$$

With $df = s - t$ degrees of freedom, where

s is the total number of nonredundant elements in $\mathbf{S}$,

t is the total number of parameters to be estimated,

N is the sample size

$\mathbf{S}$ is the obtained, empirical, covariance matrix, and,

$\Sigma(\hat{\theta})$ is the model-implied covariance matrix.

F [$\mathbf{S}$, $\Sigma(\hat{\theta})$] is the fit function value

Though this test statistic is informative, convenient and straightforward under certain circumstances, there are several limitations to it. First, it is heavily dependent on sample size (Kline, 2015; Schermelleh-Engel et al., 2003). As indicated with the formula, chi-square is calculated by multiplying the sample size – 1 by the fit function value. As the sample size increases, and assuming the degrees of freedom remains consistent – which it should given no changes to the instrument itself – the chi-square value will inevitably increase. If the chi-square value increases, the difference may venture into significance territory. Consequently, a plausible model may be rejected on the basis of a significant chi-square value despite the significance stemming from a sample size issue rather than a valid discrepancy between the obtained covariance matrix and the model implied covariance matrix (Kline, 2015; Schermelleh-Engel et al., 2003). On the flip side, if the sample size is too small, a model might not be rejected despite considerable discrepancy between the empirical covariance matrix and the model-implied covariance matrix (Schermelleh-Engel et al., 2003). A second limitation is that model complexity can also bias the results. Briefly, a more complex model – a model with more parameters – will have fewer degree of freedom. A model with fewer degrees of freedom, especially if the number of free parameters approaches or equals the number of variances and covariances found in the empirical covariance matrix, will yield a smaller chi-square value. As a result, a model may be retained either because it has been specified correctly, or because it has been over-parameterized (Schermelleh-Engel et al., 2003). Two other factors that can impact the chi-square value is multivariate non-normality and correlation size (larger correlations between

observed variables can lead to greater chi-square values for incorrect models. Bigger correlations → bigger discrepancies between observed and expected covariances and correlation; Kline, 2015).

Where chi-square is used to test significance, CFI and TLI are descriptive measures that are based on model comparisons. CFI is an incremental fit index which gives an indication of the relative improvement in model fit compared to that of a baseline model (Kline, 2015). An independence model is typically used as the baseline for comparison, where the independence model operates under the assumption that the observed variables are being measured without error. More specifically, it operates with all factor loading fixed to one, all error variances fixed to zero, and that all variables are uncorrelated (Schermelleh-Engel et al., 2003). This is a heavily restrictive model and under most – if not all circumstances – will be a bad fit for the data. But having an extreme model to use as a comparison better assists in determining model improvement when adjustments to the model are made. To estimate CFI, the following formula is used:

$$CFI = 1 - \frac{\max\left[(\chi_t^2 - df_t), 0\right]}{\max\left[(\chi_t^2 - df_t), (\chi_i^2 - df_i), 0\right]}$$

Where:

χ_i^2 = Chi-square statistic for the independence model (baseline model),

χ_t^2 = Chi-square statistic for the target model

df = Degrees of freedom

CFI is a noncentrality-based normed fit index and ranges from 0 – 1 (Kline, 2015; Schermelleh-Engel et al., 2003). Better fitting models have values closer to 1, suggesting that

relative to the independence model the target model is the best possible improvement. Generally, the rule of thumb is that CFI values ≥ 0.95 indicates a good fit (Hu & Bentler, 1999). For both CFI and TLI, 0.95 is the threshold as at this value type-II error rates are minimized. As the value decreases, type-II error rates increase. Alternative thresholds have been put forth as Hu and Bentler's (1999) have been criticized for being too strict. One such alternative is Hair et al. (2010) which suggested a CFI >0.90 is acceptable. With the present study, 0.95 will be used as the acceptable threshold to ensure rigor. CFI is limited in its reliance on a restrictive independence model as it is unlikely that in a practical setting there would be zero covariances among observed variables. Therefore, comparing an independence model with zero covariances to one with covariances, and suggesting that the one with covariances represents a better fitting model may not be an accurate reflection of the scale of the model fit (Schermelleh-Engel et al., 2003). CFI has also been found to be sensitive to misspecified factor loadings, which is why it is suggested to be used in tandem with SRMR as SRMR seems to be most sensitive to misspecification of factor covariances with CFA when testing measurement models (hence why SRMR has also been included; Hu & Bentler, 1999; Kline, 2015). Additionally, the CFI is useful as it may be used to avoid the underestimation of fit observed when other fit indices – such as the normed fit index (NFI) – are used with smaller samples (Schermelleh-Engel et al., 2003)

TLI is a similar incremental fit index, however unlike CFI, TLI is an index which is non-normed (Hu & Bentler, 1999). What this means is though the TLI value is generally in the range from 0-1, it can sometimes exceed 1, with greater values indicating a better fitting model (Hu & Bentler, 1999). Similar to CFI, the general rule of thumb is that values exceeding 0.95 indicate a good fitting model. The formula for TLI is:

$$TLI = \frac{(\chi_i^2/df_i) - (\chi_t^2/df_t)}{(\chi_i^2/df_i) - 1} = \frac{(F_i/df_i) - (F_t/df_t)}{(F_i/df_i) - 1/(N-1)}$$

Where

χ_i^2 = Chi-square of the independence model (baseline model)

χ_t^2 = Chi-square statistic for the target model

F = Corresponding minimum fit function value

df = Degrees of freedom

The advantage to TLI is that it is one of the fit indices less impacted by sample size; however, as degrees of freedom for both the independence and target model are taken into consideration, more complex models are punished (Kline, 2015; Schermelleh-Engel et al., 2003). That is, more complex models are less likely to achieve the threshold for adequate fit, whereas less-complex models are more likely to achieve or exceed the cut-off.

The final category of fit indices are those that provide an indication of overall model fit. This category is similar to the chi-square test of model significance, however, as the chi-square statistic is limited – especially when it comes to sample size – RMSEA and SRMR have been developed as alternate measures of overall model fit (Schermelleh-Engel et al., 2003). Beginning with RMSEA, this fit statistic is based in non-centrality. That is, instead of approximating a central chi-square distribution, it allows for some discrepancies between the model-implied covariances and the observed covariances of the sample (Kline, 2015; Schermelleh-Engel et al., 2003). So rather than null hypothesis of an exact fitting model – as found with the chi-square statistic – the null hypothesis is more of a 'close fit'. This is an important consideration as a null hypothesis of exact fit will commonly be rejected in a practical situation if a sample size gets too

large – which is a limitation with the chi-square test statistic (Schermelleh-Engel et al., 2003). Similar to the chi-square test statistic, the closer the value is to zero, the better the model fit; however, as this is an approximation of best fit, achieving a value of zero is unnecessary and incredibly unlikely in a practical setting. Therefore, the benchmark for RMSEA is typically ≤ 0.06 (Hu & Bentler, 1999). Though it should be highlighted that other accepted thresholds do exist, with others suggesting that >0.05 indicate 'close fit' but up to 0.08 can still be within the realm of reasonable fit (Marsh et al., 2004) . The formula for RMSEA is

$$RMSEA = \sqrt{\frac{\chi_M^2 - df_M}{df_M(N-1)}}$$

Where

χ_M^2 = The model chi-square

df_M = The model degrees of freedom

N = Sample size

As the name suggests, RMSEA is primarily interested in the error of approximation. A lower value indicates less error – better model fit – and a higher value indicates more error – poor model fit (Kline, 2015; Schermelleh-Engel et al., 2003). When reporting the RMSEA estimate, it is standard to also report the 90% confidence interval (CI) to enhance precision and compensate for the threat of sampling error (Kenny et al., 2015; Schermelleh-Engel et al., 2003). Reporting the CI highlights the degree of uncertainty with the RMSEA estimate, however, it also provides an optimistic estimate with the lower value but a pessimistic value with the upper value (Kenny et al., 2015; Schermelleh-Engel et al., 2003). Though RMSEA was developed to counteract some of the limitations of chi-square, with smaller sample sizes RMSEA may still run

the risk of rejecting true models (Hu & Bentler, 1999; Kenny et al., 2015). Thus, RMSEA is not recommended for small samples.

The final fit index of note is the SRMR. SRMR is an update to root mean square residual (RMR) which was designed to measure the mean absolute covariance residuals: differences between observed and predicted model covariances (Kline, 2015; Schermelleh-Engel et al., 2003). Similar to RMSEA, RMR is a badness-of-fit index whereby the greater the value is the worse the model fit is. A limitation observed with the RMR was, because it did not use standardized variables in the estimation, the range of the output depended on the scale of the observed variables, or the size of variance and covariance of the observed variables (Kline, 2015; Schermelleh-Engel et al., 2003). If the scales were different, interpretation of the output would be flawed. Thus, the SRMR was designed to overcome this problem by first standardizing the residuals by dividing the values by the standard deviations of the observed variables. When estimating SRMR, the accepted threshold is ≤ 0.08 (Hu & Bentler, 1999; Marsh et al., 2004). Though, there are some critiques to this threshold, such as the value not being stringent enough (Kline, 2015), for the purposes of this thesis, 0.08 will be used as a threshold.

The rationale behind using five different fit indices instead of one is that no single index is perfect, each fit index has limitations, but these limitations are compensated for by including other fit indices which complement each other. There is no golden rule nor perfect number that distinguishes a good model from a poor model (Kline, 2015; Schermelleh-Engel et al., 2003). The more indices included, the more representative the image is for model fit (Kline, 2015; Schermelleh-Engel et al., 2003).

Generally, assessed at the same time as factorial validity is criterion-related validity. Criterion-related validity is described as the degree to which the scores on an instrument

corresponds to external referents. That is, criterion validity is the extent to which the scores on a particular measure correlate with other variables in an expected manner based on previous evidence (DeVellis, 2017; DeVon, 2007; Drost et al., 2011). Comprising criterion related validity is concurrent, predictive, convergent, and divergent/discriminant validity (DeVon et al., 2007; Drost, 2011). Predictive validity refers to the degree to which scores obtained on a particular measure predict performance on a future measure (DeVellis, 2017). For example, if an instrument was being developed to evaluate motives to engage in exercise from the theoretical lens of SDT an important thing to determine would be whether the scores on the instrument predicted future engagement in exercise behaviour. For the purposes of the present thesis, predictive validity will not be further expanded on as it will not be a psychometric property assessed. There are several reasons as to why predictive validity will not be assessed at this time. Such reasons include: (1) an inability to objectively measure older adults SB due to the constraints placed by the COVID-19 pandemic, and (2) concerns regarding the extent to which the restrictions in place to limit the spread of COVID-19 has impacted overall activity levels of older adults. Additionally, with regards to psychometric properties, other types of validity and reliability take priority (e.g., internal consistency reliability, factorial validity) and must be established before moving on to predictive validity.

Concurrent validity is similar to predictive in that the objective is to predict performance on a particular criterion (DeVellis, 2017). However, unlike predictive validity, concurrent validity is not concerned about future performance, rather it is about an instruments ability to predict current performance (DeVellis, 2017, Drost, 2011). For an instrument developed to evaluate older adults' motives to limit daily SB from the theoretical perspective of SDT, determining concurrent validity may involve including an in instrument in the survey package

that assessed current SBs (e.g., current daily amount of time spent sitting), or other psychological variables that are known to be associated with motives to engage in particular behaviours and then correlating those responses to those obtained with the motives scale.

Convergent and divergent/discriminant validity are similar in that the purpose of investigating these two types of validity is to understand the extent to which items included in an instrument are inter-correlated with other theoretical constructs (DeVellis, 2017). Where the two types of validity differ is the theoretical similarity of the construct being compared relative to the instrument under investigation and the desired levels of inter-correlations. To determine convergent validity, one would compare the inter-correlations of an instrument's items to scores obtained on an instrument representing a theoretically similar construct (e.g., Behavioral Regulation in Sport Questionnaire (BRSQ) and Sports Motivation Scale revised (SMS-II) – both instruments are rooted in SDT, and both measure motivation in the sporting context; Lonsdale et al., 2008; Pelletier et al., 2013). Convergent validity would be confirmed if the scores obtained on both measures were observed to be significantly inter-correlated (e.g., if the BRSQ identifies ones motives to be regulated through integration, convergent validity would be confirmed if the SMS-II did as well); however, convergent validity will not be demonstrated if significant inter-correlations between theoretically similar constructs are not observed, or if significant unanticipated correlations are observed (DeVellis, 2017). On the other end of the spectrum is divergent/discriminant validity. To determine divergent/discriminant validity one would compare the inter-correlations of an instrument's items to scores obtained on an instrument representing a theoretically dissimilar construct (e.g., life satisfaction and negative affect). Divergent/discriminant would be confirmed if the scores obtained on both measures were observed to be unrelated/ demonstrated low inter-correlations (DeVellis, 2017).

Necessary to determining criterion validity – predictive, concurrent, convergent, and divergent/discriminant – is to include high-quality measures alongside the instrument of interest that can help establish a nomonological network: A network of different measures that, based on past literature, should be related in a certain way to the instrument of interest (Cronbach & Meehl, 1955). These measures could include ones that measure a theoretically similar concept to assess convergent validity, those that measure theoretically opposed concepts to assess divergent/discriminant validity, and measures to evaluate current performance for concurrent validity. With predictive validity, one assesses the relationship between scores on a particular measure with outcome variables at a separate time point using a longitudinal design. Human thoughts, behaviours, and feelings can be conceptualized as a spider web, where there is an interrelationship between seemingly dependent and independent processes. As mentioned earlier in the realm of SDT, different motives are correlated with qualitatively different behavioural and psychological processes towards a particular behaviour (Deci & Ryan, 2008). Therefore, to test whether a measure rooted in SDT is truly evaluating what it is intending to evaluate, measures of those behavioural and psychological processes should be included to see if the appropriate variables are correlating as previously described in the literature. For example, the literature suggests that, within the context of older adults' motivation and well-being, older adults who endorse more self-determined motives (e.g., intrinsic motivation or identified regulation) for a particular behaviour typically score higher on indices of well-being and life satisfaction compared to individuals who are amotivated for the same behaviour (Tang et al., 2020); thus, when evaluating if an instrument designed to ascertain older adults' motives to engage in a particular behaviour from an SDT lens, measures of well-being and satisfaction with life should be included to see if previously established relationships between motives and well-being/life

satisfaction exist, in doing so, one would be investigating the concurrent validity of the measure. If the relationships do exist, then that is evidence to support the concurrent validity of the instrument being developed; however, if the relationships do not exist, or the relationships observed are not consistent with previously established findings (e.g., individuals scoring high on amotivation for a particular behaviour but also demonstrating high well-being and life satisfaction) then there may be a potential issue with the instrument under development (DeVellis, 2017).

Mentioned earlier, this thesis will not delve into predictive validity. Additionally, it will also not delve into convergent nor divergent/discriminant validity. Unlike with predictive validity whereby the rationale for omission stems from feasible and logistical reasons such as concerns surrounding lack of objective measures and generalizability of results obtained in a pandemic setting, the rationale for omitting convergent and divergent/discriminant validity stems from the complete lack of literature surrounding older adults' motives for SB from the perspective of SDT. No previous instrument has been constructed to evaluate older adults' motives to reduce any type of SB from the perspective of SDT, meaning there is nothing to compare an instrument developed for this purpose to. Furthermore, though it could be argued that including a measure to assess motives for physical activity from the perspective of SDT could act as a comparison point to evaluate convergent validity and/or divergent/discriminant validity of a measure to evaluate motives to sit less, it is well known that SB is dissimilar from physical inactivity (and presence of physical activity is not always an absence of SB; Dontje et al., 2018; Owen et al., 2010; van der Ploeg & Hillsdon, 2017). Older adults have many ways to limit daily SB that does not involve physical activity, thus using physical activity motivation may not be an accurate comparison point (Dontje et al., 2018). On the other hand, it is also

known that physical activity is one of the ways that can be used to limit sedentary by older adults (Dontje et al., 2018). Therefore, the convergent and/or divergent/discriminant validity results obtained by using this method would be heavily dependent on whether an individual relies on physical activity as one of the only ways to limit their daily SB. This would inevitably introduce unnecessary bias into the study that cannot be controlled for in an uncomplicated manner. Consequently, of the criterion validity, only concurrent will be assessed for this thesis.

1.4.3 Scale development and SDT

Numerous scales guided by SDT have been developed to understand motives for particular behaviours across a wide variety contexts including exercise ((e.g., Behavioral Regulation in Exercise Questionnaire (BREQ-2); Markland & Tobin, 2004)), sport participation (e.g., BRSQ: Lonsdale et al., 2008; SMS & SMS-II: Pelletier et al., 2013)), education (e.g., Academic Motivation Scale (AMS): Utvær & Haugan, 2016)), and health behaviours (e.g., Regulation of Eating Behavior Scale (REBS): Pelletier et al., 2004). While an instrument has never been developed to specifically investigate older adults' motives to limit daily sitting time, an instrument has been developed to investigate adolescents' motives for limiting screen time (Lubans et al., 2013). Although screen time and SB are not synonymous, and adolescents' reasons will differ from older adults' reasons, screen time does comprise a large proportion of older adults' SB (Dontje et al., 2018); therefore, understanding the process and the results obtained during the scale development process of said instrument is critical to the current research as it demonstrates the utility of an instrument in the present context.

Published in 2013, Lubans and colleagues developed an instrument to evaluate adolescents' motives to limit screen time – the *Motivation to Limit Screen-time Questionnaire* or 'MLSQ'. The instrument contained nine items representing three subscales/factors: (1)

autonomous motivation; (2) controlled motivation, and (3) amotivation. The initial study to determine the internal consistency reliability and factorial validity scores of the three-factor MLSQ amongst 342 adolescent boys (M_{age} = 12.7 years) demonstrated good model fit: $\chi^2_{(24)}$ = 61.89, $p < 0.01$; CFI = 0.96; and SRMR = 0.07. Factor loadings of standardized loadings for autonomous motivation, controlled motivation, and amotivation ranged from 0.76 to 0.83, 0.51 to 0.77, and 0.67 to 0.74 respectively. Internal consistency reliability (Cronbach alpha) scores of each of the factors included in the instrument were: 0.75 for autonomous motivation, 0.65 for controlled motivation, and 0.84 for amotivation, meaning that although autonomous motivation and amotivation demonstrated acceptable internal consistency reliability, controlled motivation failed to meet acceptable levels. One-week test-retest of the MSLQ was evaluated with a different sample of adolescent boys (N = 48, M_{age} = 14.3 years) using intraclass correlation as the mode for investigating the correlations from time 1 to time 2. Results of the test-retest were as follows: autonomous motivation = 0.82, p = 0.148; controlled motivation = 0.70, p = 0.138, and amotivation = 0.67, p = 0.792. As the p-value indicates the significance of the difference between the first and second trial, the results clearly demonstrate good 1-week test-retest reliability for the instrument. Although the controlled motivation subscale/factor on the MLSQ did not demonstrate strong internal consistency reliability, the MLSQ has been used to inform an intervention designed to prevent obesity in 'at-risk' adolescents (Lubans et al., 2016). Though the details of the program are irrelevant to the present discussion, it is important to highlight that understanding the participants motives helped tailor specific programs to participants' motives, and facilitated more optimal outcomes (Lubans et al., 2016). This highlights the utility of an instrument rooted in SDT to evaluate motives to sit less as a practical assessment tool that can be used to facilitate optimal intervention outcomes.

Despite the promise displayed by the MLSQ and subsequent interventions (e.g., Lubans et al., 2016), there were several limitations that are crucial to address moving forward with an instrument designed to evaluate older adults' motives to sit less. The first is that for MLSQ the authors compressed intrinsic, integrated, and identified regulation into a single subscale/factor, external and integrated regulation into a composite score, and left amotivation as its' own separate category. Though this is a common practice with instrument development in the SDT setting, it undermines utility of the theory and the distinguished differences between each of the six types of motivation. Numerous investigations into SDT have confirmed a six-factor structure (e.g., Lonsdale et al., 2008; Pelletier et al., 2004; Pelletier et al., 2013), and studies have consistently confirmed that different motives lead to qualitatively different outcomes (e.g., Deci & Ryan 2008; Ng et al., 2012; Rodrigues et al., 2019; Ryan & Deci, 2017; Tang et al., 2020; Teixeira et al., 2012), therefore, an instrument rooted in SDT should work to best represent the six-factor structure of the theory. A three-factor structure may have some utility, but the more in-depth an instrument can be the better a program designer may be at implementing effective strategies to transition participants to more optimal forms of motivation. Though an argument for a three-factor structure could be that the more self-determined motives are regularly linked with similar outcomes, therefore grouping them may not be an issue overall, it is important to recognize that while the outcomes may be the similar, the strength of relationship between motives and outcomes differs. But, this argument cannot be maintained for grouping introjected and external motives. Observations between motives and outcomes, as highlighted previously, demonstrates that the association between more optimal outcomes and motives is stronger the more self-determined the motives are (e.g., Teixeira et al., 2012), but with external motives and introjected motives, the outcomes may not even be the same. External motives consistently are

associated with less than desirable outcomes, however, the same cannot be said about introjected motives as, at times and with certain people, introjected motives may be associated with optimal outcomes (e.g., Teixeira et al., 2012) Furthermore, even if the outcomes are similar, the approaches to fostering optimal outcomes is dependent on the type of motives endorsed. Similar strategies can be used depending on the motives, especially when motives are more self-determined, but there are nuanced strategies that may elevate the quality of a program if applied correctly to individuals who endorse motives regulated by specific styles. Another limitation of the MLSQ are the low coefficient/Cronbach alpha scores for each of the factors. While two of the factors achieved alpha scores ≥ 0.75, it is recommended for alpha scores to be in the range of 0.80-0.95 to be considered good-excellent. The fact that alterations were not made to the factors that only achieved an alpha value of 0.65 (controlled motivation) is detrimental to the overall quality of the instrument. It is true that smaller item pools may result in lower alpha scores (DeVellis, 2017), and that the low Cronbach alpha score could be because the authors combined different regulatory styles. The final limitation is that the MLSQ only evaluated screen-time, thereby under-representing the SB. Even with the limitations, it should be reiterated that evidence surrounding MLSQ, and subsequent interventions demonstrate the utility and necessity of a theory-driven motivation instrument to assist program designers in developing higher quality interventions.

Referring back to the previous point about overlap within the SDT motivation continuum, one observation that has arisen with the advent of scales developed to assess motivation from an SDT lens is that regulatory styles appearing closer together on the motivation continuum are more highly correlated with one another than regulatory styles that appear further apart on the continuum. This pattern is termed ‘simplex pattern’ or ‘simplex structure’ and while first

confirmed in 1989 by Ryan and Connell, a simplex pattern has been identified throughout the SDT instrument development literature. The finding is intuitive as according to proponents of SDT, regulatory styles which are situated closer on the SDT continuum should demonstrated stronger correlations, whereas regulatory styles further apart should demonstrate weaker correlations. The rationale for the increase in correlation strength based on proximity comes down to the idea of motivation existing along a 'continuum'. For a continuum to exist, there must be a unifying dimension to which the regulatory styles are ordered according to. For example, Pelletier and colleagues (2013) found with the revised sport motivation scale (SMS-II) that intrinsic motivation was positively correlated with integrated ($r = 0.63$), identified ($r = 0.56$), introjected ($r = 0.26$) and external regulation ($r = 0.16$) ($p < 0.01$); integrated regulation was positively correlated with identified ($r = 0.59$), introjected ($r = 0.42$) and external regulation ($r = 0.19$) ($p < 0.01$); identified regulation was positively correlated with introjected ($r = 0.46$) and external regulation ($r = 0.24$) ($p < 0.01$); introjected regulation was positively correlated with external regulation ($r = 0.36$) and amotivation ($r = 0.16$) ($p < 0.01$), and; external regulation was positively correlated with amotivation ($r = 0.38$) ($p < 0.01$). As is evident, the strength of the correlations between motive categories decreases in a stepwise fashion the further away from the reference point that correlation is observed. For intrinsic motivation, it is strongly correlated with its neighbour integrated regulation, followed by identified regulation, introjected, and then external. Likewise, integrated regulation was correlated strongest with identified regulation, followed by introjected and external, etc. While this observation is important as it highlights the type of pattern that should be observed in the intercorrelations of regulatory styles when developing an instrument, it better demonstrates why researchers developing instruments to evaluate motives for a particular behaviour from the perspective of SDT should be reluctant to

take shortcuts when developing item pools. Each regulatory style shares similarities with its' closest neighbor, but each regulatory style is also a distinct entity. Because of this, ensuring that the entirety of the SDT motivation continuum in encapsulated by an instrument becomes more important as omitting items to represent specific regulatory styles could result in an instrument mis-identifying the degree of internalization of an individual's motives thereby leading to inappropriate application of strategies to transition the individual to more optimal motives.

1.4.4 Development of an instrument to evaluate older adults' motives to limit SB

Following the study in which focus groups were conducted to gain insight into older adults' motives to limit daily SB from an SDT perspective (Collins & Pope, 2021), initial item development began. First, based on motives expressed by participants and a scoping review of relevant literature and surveys, items representing each of the six categories of motivation were generated. Several meetings were held to review the results of the previous study and the review of the literature to determine a pool of items which best represented each of six regulatory styles per the SDT. In total, 61 items were generated, with a range of 7 to 14 per category (See Table 1.1 for items). The items were then placed into an online survey and experts in the fields of SDT, SB, older adults, and instrument development were contacted to assess the content validity of the items. Though experts did not need experience in all of the fields, all the experts that were contacted had previously been involved with published research in the fields of SDT and instrument development, with some also specifically contacted for their experience with either SB research or older adult research.

For the survey, the items were grouped based on the regulatory style they were intended to represent. The experts were presented with a theoretical definition of each regulatory style

before examining the items[1] After reading the definition, experts were then asked to indicate on a five-point likert scale (where 1 = poor match and 5 = excellent match) the degree to which each item was consistent with the outlined definition. Experts were also asked to indicate if they felt the items were unclear, exceptionally lengthy, difficult to read, or multi-barreled (asking about more than one concept). Of the thirty experts contacted, seven responded to the survey. Average age of participants was 43 years, 71.4% were male, five were full professors, one was a post-doc, and one was a research scientist. Seven of the participants indicated that they had experience with SDT, six with scale development, one with older adult research, and two with SB research. Based on the expert feedback the item list was revised. Specifics of the revision process can be seen in Table 1.1. Items which received an average reviewer score of <3/5 were either (1) modified, if modifications could be made, or (2) rejected. Items were also modified if reviewers indicated that the item did not satisfy all four face-validity criteria. Of the 61 items, 24 items were retained in the original form, 15 items were modified, 23 items were removed, and 3 items were added. The final instrument – entitled the 'Motives for Managing Sedentary Behaviour – Older Adults' or 'MMSB-OA' – contained 41 items, with 6 – 8 items per subscale/factor.

[1] The following definitions were used:
Intrinsic motivation refers to the process of engaging in a particular behaviour for the inherent interest, enjoyment, and personal challenge derived from the activity itself. Motives are fully internalized, and completely volitional
Integrated regulation represents engaging in a behaviour because it is congruent with personally endorsed values, beliefs, and one's identity. This regulatory style reflects the most internalized for of extrinsic motivation.
Identified regulation refers to the process of engaging in a particular behaviour because the individual personally values the outcomes that result from the behaviour. This regulatory style has an internal locus of control their actions are driven by the attainment of the outcome which is personally important, however it is not completely internalized into one's core values and beliefs.
Introjected regulation refers to the process of engaging in a particular behaviour as a result of self-imposed sources of pressure (guilt, shame), and/or to enhance feelings of self-worth. This form of regulation represent partial internalization, yet is perceived to be quite controlling.
External regulation refers to process of engaging in a particular behaviour for the purpose of obtaining an external reward (social and/or tangible) or avoid an external punishment (social and/or tangible). This form of regulation is not internalized at all, but rather derived from external demand.
Amotivation refers to the process of engaging in a particular behaviour despite the lack of intent or absence of motivation, or complete failure to engage in a particular behaviour at all.

Purpose

The evidence surrounding older adults' motives to limit SB has become expansive over the last decade; however, the practical applications of the information are limited. Therefore, the logical next step is to develop an instrument rooted in SDT to evaluate older adults' motives to limit daily SB. A psychometrically sound instrument will provide program designers with insight surrounding the degree to which their participants' motives are internalized, allowing them to tailor the strategies that can encourage long-term and meaningful lifestyle changes. Initial steps have been taken to develop such an instrument, including: (1) conducting focus groups to gather older adults' perspectives about the types of things that motivate them to limit their daily sedentary time (Collins & Pope, 2021), and (2) generation and initial content validation of an item pool which seeks to evaluate older adults' motives from the perspective of SDT. As well, though not mentioned, the generated item pool has also been placed into an online survey which was filled out by 319 older adults (the specifics will be discussed in the subsequent chapter). Therefore, the overarching purpose for the present thesis project will be to further evaluate the psychometric properties of the measure and further refine the item list in attempt to construct a comprehensive and theoretically-guided instrument – demonstrating strong reliability and validity – to evaluate older adults' motives to limit daily SB. This purpose will be achieved with two studies guided by two different objectives. The first study will use the previously collected data from the MMSB-OA to investigate factorial validity, internal consistency reliability, and inter-factor correlations. Item refinement will also take place during this study. The objective of the second study will be to investigate the criterion validity, test-retest reliability, factorial validity, internal consistency reliability, and inter-factor correlation of the revised item pool. As

this study is multi-phased, sequential and highly dependent on the results from previous phases, hypotheses will be presented at the beginning of each study as opposed to in this introduction.

Tables and Figures

Table 2.1. Initial Items Generated for the MMSB-OA and the Results from the Initial Content and Face Validation Phase

SDT Category	Item Label	Item Description	Reviewer Score	Decision
Intrinsic Motivation	IM1	So that I can do the activities I love	3.3/5	**Retained**
	IM2	Activities that get me up and moving are fun	3.3/5	**Modified to**: Activities in which I don't sit are fun **Rationale**: "Get up and moving" made the item double-barrelled
	IM3	I enjoy trying new activities that get me moving	3.3/5	**Modified to**: I enjoy trying activities that get me moving **Rationale**: Removed "new" as it misrepresented the intended meaning
	IM4	In order to do activities I'm interested in	3/5	**Retained**
	IM5	Being more active is stimulating for me	3/5	**Retained**
	IM6	I simply don't like to sit	2/5	**Rejected** **Rationale:** Low reviewer score
	IM7	I get pleasure from moving	3.2/5	**Retained**
	IM8	I enjoy being on the go	2.7/5	**Rejected**

				Rationale: Low reviewer score
	IM9	I get lost in activities that I don't sit for (e.g., gardening)	2/5	**Rejected** **Rationale:** Low reviewer score
	IM10	I am passionate about things that I don't sit for	1.7/5	**Rejected** **Rationale:** Low reviewer score
Integrated Regulation	IG1	I'm not the type of person that sits a lot	3.5/5	**Retained**
	IG2	Doing so is in line with my core values	3.3/5	**Modified to**: It's in line with my core values **Rationale:** Altered to simplify the language complexity
	IG3	I have never been one to sit much	3/5	**Retained**
	IG4	I'm an active person by nature	3/5	**Retained**
	IG5	That's who I have been all my life	3.6/5	**Retained**
	IG6	That's just who I am	3.5/5	**Modified to:** It's consistent with who I am as a person **Rationale:** Language altered to better convey the intend meaning of the item. Previous version was vague,
	IG7	It's part of my personality to be on the go	3.2/5	**Modified to:** It fits with my personality **Rationale:** Altered to simplify the language complexity

	IG8	I do not consider myself to be the type that sits a lot	2.8/5	**Rejected** **Rationale:** Low reviewer score
	IG9	That's just how I grew up	1.7/5	**Rejected** **Rationale:** Reviewers suggested that this item may be unclear to readers, and that integrated regulation is 'not just being an active type or something by nature. One fully endorses the activity and it fits with values'. Low reviewer score
Identified Regulation	ID1	In order to be at my best mentally (e.g., alertness, mood)	3/5	**Modified to:** To be at my best mentally **Rationale:** Altered to simplify the language complexity
	ID2	I want to maintain my independence (e.g., mobility, chores)	3/5	**Retained**
	ID3	So that I can feel better physically and/or emotionally	3/5	**Modified to:** So that I can feel my best **Rationale:** Item modified to eliminate the double-barrelled nature ("physically and/or emotionally")
	ID4	To increase the number of quality years I have left	3.2/5	**Retained**
	ID5	So that I stay engaged in the community	3/5	**Retained**

ID6	Non-sitting activities provide more options to be social	2.5/5	**Modified to:** For social reasons **Rationale:** Altered to simplify the language complexity
ID7	To maintain or improve my physical health (e.g., strength, balance)	3/5	**Modified to:** For health reasons **Rationale:** Altered to simplify the language complexity
ID8	So that I can get out and spend time with friends and family	2.8/5	**Rejected** **Rationale:** Reviewers indicated that this item may be too specific and may not be relevant for all participants. Low reviewer score
ID9	To manage pain and stiffness	2.7/5	**Rejected** **Rationale:** Double-barreled. Low reviewer score
ID10	I get bored if I sit for too long	2/5	**Rejected** **Rationale:** Low reviewer score
ID11	I get restless or anxious if I sit too much	1.7/5	**Rejected** **Rationale:** Double-barreled. Reviewers indicated that this item may be too specific and may not be relevant for all participants. Low reviewer score
ID12	To enhance my quality of life	2.5/5	**Rejected** **Rationale:** Reviewers indicated that this item may be too specific and may not be relevant for all participants. Low reviewer score

	ID13	I try to limit my sitting time in order to manage my weight	2.5/5	**Rejected** **Rationale:** Reviewers indicated that this item may be too specific and may not be relevant for all participants. Low reviewer score
	ID14	I try to manage my sitting time so that I can sleep better at night	2.2/5	**Rejected** **Rationale:** Reviewers indicated that this item may be too specific and may not be relevant for all participants. Low reviewer score
Introjected Regulation	IJ1	I know I shouldn't sit a lot	3.7/5	**Retained**
	IJ2	I would feel bad about myself if I didn't	4.3/5	**Retained**
	IJ3	I feel guilty if I sit on my butt for too long	4.3/5	**Retained**
	IJ4	I feel obligated to get up and do other things	3.5/5	**Modified to:** I feel obligated to **Rationale:** Altered to simplify the language complexity
	IJ5	I have stuff I need to do	1.7/5	**Rejected** **Rationale:** Reviewers indicated that item may be too ambiguous. Low reviewer score
	IJ6	I feel better about myself if I don't sit too much	2.8/5	**Modified to:** I feel better about myself when I do **Rationale:** Altered to simplify the language complexity

	IJ7	I get upset with myself if I sit too much	3.5/5	**Retained**
	IJ8	I don't want to feel lazy	3.3/5	**Retained**
	IJ9	I feel better about myself if I get up and move	2.8/5	**Rejected** **Rationale:** Low reviewer score
	IJ10	I'm afraid that "if I don't move it, I'll lose it"	1.7/5	**Rejected** **Rationale:** Low reviewer score
	IJ11	I am committed to something that requires me to move	1.3/5	**Rejected** **Rationale:** Low reviewer score
External Regulation	EX1	People whose opinions I value (doctor, family, friend) tell me to	2.8/5	**Modified to:** People whose opinions I value tell me to **Rationale:** The text in brackets was removed to make the item more generalized
	EX2	I feel pressure from important others to sit less	4/5	**Modified to:** Important people in my life pressure me to
	EX3	Other people pressure me to get up and move	4/5	**Rationale:** Items were similar, therefore they were combined to make a single item
	EX4	Others (people, pets) need me to do things that require me to stand or move	2.7/5	**Modified to:** Others need me to do things that require me to not sit **Rationale**: The text in brackets was removed to make the item more generalized

	EX5	I don’t want others to see me as if I’m old	1.2/5	**Retained** **Rationale:** The idea of maintaining the appearance of youth was brought up in multiple focus groups. Item was retained as, while the reviewers did not see the relevance, from discussions with older adults, this is a real motive for many older adults.
	EX6	Others will be upset with me if I don’t	4.5/5	**Retained**
	EX7	I don’t want others to treat me like I can’t do things for myself	1.8/5	**Retained** **Rationale:** Similar to EX5. Additionally, removing both EX5 and EX7 would eliminate much of the aspects of the item pool specific to older adults.
Amotivation	AM1	I don’t want to	3.3/5	**Retained**
	AM2	I don’t see why I should	3.5/5	**Retained**
	AM3	I don’t care how much I sit	3.7/5	**Retained**
	AM4	It’s easier to sit	2/5	**Rejected** **Rationale:** Low reviewer score
	AM5	It hurts too much to stand or move	1/5	**Rejected** **Rationale:** Low reviewer score
	AM6	It hasn’t crossed my mind that I should sit less	2.7/5	**Rejected** **Rationale:** Low reviewer score
	AM7	It’s not worth the effort	3/5	**Retained**

AM8	I have earned the right to sit as much as I want	1.5/5	**Rejected** **Rationale:** Low reviewer score
AM9	Sitting is just what you do at my age	1.8/5	**Rejected** **Rationale:** Low reviewer score
AM10	I enjoy sitting activities (e.g., reading, puzzles)	1/5	**Rejected** **Rationale:** Low reviewer score
AM11	I don't see how sitting less could benefit me	3/5	**Retained**

Items Added

Intrinsic Motivation	IM11	Because I don't enjoy sitting	Added as a general item to replace the rejected, and more specific, items: IM5, IM7, and IM9
Identified Regulation	ID15	Because it's personally important to me	Added because several reviewers identified a lack of items representing the 'personal value' of an activity
Amotivation	AM12	I don't try to	Added because the amotivation subscale/factor was lacking a general item

Note. IM = Intrinsic motivation, IG = integrated regulation, ID = identified regulation, IJ = introjected regulation, EX = external regulation, AM = amotivation

Stem for items IM11 – EX7 was *'I try to limit my sitting time…'* Stem for items AM1 – AM12 was *' I don't try to limit my sitting time…'.*

Chapter 2: Study 1

2.1 Introduction

Following the creation and initial content validation of the 41 item MMSB-OA, this study was designed to test the instrument with the target population – older adults. The present study had two overarching purposes: (1) Evaluate the internal consistency reliability, inter-factor correlations, and factorial validity of the MMSB-OA, and (2) further refine the item pool to ensure four to five representative items of high quality (excellent factor loading of ≥ 0.71; Tabachnick & Fidell, 2013) for each of the six factors. Determining internal consistency reliability, inter-factor correlations, and factorial validity is critical to the scale development process as without an understanding of each of these three components of the MMSB-OA, using the instrument in a practical setting is ill-advised. The information that is provided from investigating these three components indicates whether the items contained in the instrument measures what they are intended to measure, determines whether there is any problematic overlap that may mis-attribute an individual's motives, and whether the instrument is consistent with SDT. Refining instrument length is also critical as, in the current state, the MMSB-OA adds unnecessary burden to participants. Long instruments, although typically demonstrating increased reliability, increase the risk of participant dropout (Devilles, 2017), whereas shorter instruments increase likelihood of completion. To be explicit, the purpose is not to unnecessarily reduce item pool for the sake of brevity; rather, the goal is to refine the item pool to contain three to four representative items that best encapsulate the regulatory styles outlined in SDT in the context of older adults' motives to sit less. Having three to four items per factor will reduce the instrument length from 41 to 18 – 24, which is comparable to many other surveys in the field

(e.g., MLSQ: Lubans et al., 2013; BREQ-2: Markland & Tobin, 2004; SMS-II: Pelletier et al., 2013).

Considering the two purposes of this study, three hypotheses were formed based on the literature with scales in varied contexts rooted in SDT (e.g., BRSQ: Lonsdale et al., 2008; MLSQ: Lubans et al., 2013; BREQ-2: Markland & Tobin, 2004; REBS: Pelletier et al., 2004; SMS & SMS-II: Pelletier et al., 2013). First, it was hypothesised that each factor would demonstrate internal consistency values exceeding the 0.80 threshold indicative of 'good to excellent' internal consistency. When developing the MMSB-OA, semi-structured focus groups and a scoping review of high-quality instruments rooted in SDT were used to inform the construction of the item pool. Therefore, it is anticipated that the items included in the MMSB-OA should perform similarly to other instruments given the similarity in composition. Furthermore, items have previously undergone content validation with experts in relevant fields. Thus, the rigour involved in constructing the item pool should be reflected in the internal consistency scores, where each item within each factor correlating highly with one another, but not with items from other factors. Second, it was anticipated that the inter-factor correlations will demonstrate a simplex structure. That is, factors representing regulatory styles closer on the continuum outlined in the SDT literature will demonstrate stronger inter-factor correlations compared to regulatory styles with greater degrees of separation from one another (Ryan & Connell, 1989). Simplex structures have repeatedly been demonstrated with instruments rooted in SDT (e.g., BRSQ: Lonsdale et al., 2008; MLSQ: Lubans et al., 2013; BREQ: Markland & Tobin, 2004; REBS: Pelletier et al., 2004; SMS & SMS-II: Pelletier et al., 2013), therefore, if this instrument functions as intended then a simplex structure should be observable. The third hypothesis was that the items created will load more strongly onto the intended factors than onto

unintended factors, as well that the instrument would demonstrate good model fit scores. Similar to the rationale for the first hypothesis, the development of the items for each factor was extensive and evidence based. Thus, items should, if operating as intended, load more strongly onto intended factors than unintended factors. If this occurs, the model fit indices should meet the threshold criteria – as specified in the previous chapter - for a 'good model fit'. for all hypotheses formulated, it is not anticipated that the aforementioned criteria nor anticipated outcomes will be met in the first iteration of the model will all 41 items, but rather at the final model after items have been refined.

2.2 Methods

2.2.1 Procedures

Prior to data collection, ethical clearance was obtained from the host university. Upon obtaining ethics approval from the host university, older adults throughout Canada were recruited between Summer 2019 and Fall 2020 through a variety of different online means, including (but not limited to): posts on social media (e.g., Facebook), posters placed at community centres frequented by the target demographic, and newsletters sent out by community organizations. Recruitment was predominately focused on communities throughout Alberta, with some recruitment occurring in major cities located in Saskatchewan and British Columbia. Although much of the organizations contacted were seniors-focused (e.g., seniors clubs or seniors activity centres), clubs and groups that seniors may have been apart of were also contacted (e.g., horticultural societies, craft clubs, choirs). All recruitment information contained a link to a Qualtrics survey. In the informed consent for the survey, potential participants were informed that their participation was anonymous and confidential, as well it was made clear that the purpose of the survey was to assess the accuracy and reliability of the item pool being

developed. The inclusion criteria for this study required individuals to be older than 65 years, understand English, and be able to stand without the assistance of an aid (walking stick or walker). 394 individuals consented to participate, however, only 319 completed surveys were submitted. 58 participants started the survey but closed it prior to completion and 17 participants submitted incomplete data. Missing values for the 17 incomplete submissions were not replaced as each of the responses were missing >25% of the data. Therefore, rather than potentially impacting the overall data by replacing missing values, the 17 incomplete responses were removed.

2.2.2 Participants

319 completed responses were submitted for this survey, 152 participants were men (47.6%) and 167 were women (52.4%). Average age of participants was 71.92 (range = 65-91, *SD* = 5.71). The majority of participants were community dwelling (98.4%), retired or unemployed (81.2%), and able to walk without the assistance of an aid (94.4%). Additional information about participant residence status, employment status and mobility of participants can be found in Table 2.1.

2.2.3 Measures

The informed consent, specific questions, and response options included in the survey package for this study can be found in Appendix A.

2.2.3.1 Demographics

For demographics, participants were asked to indicate their age, gender, current residence, current employment status, and their mobility status. The specific questions and choices that were provided can be found in Appendix A.

2.2.3.2 MMSB-OA

Alongside the demographic's questionnaire, participants were also asked to complete the MMSB-OA: a survey developed to evaluate older adults' motives to limit daily SB from the theoretical framework of SDT. The MMSB-OA contains 41 items which evaluates motivations across six-factors (intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation) with 6-8 items per factor All statements were responded to using a 5-point Likert scale (0, *not at all true for me*; 1, *slightly true for me*; 2, *moderately true for me*; 3, *very true for me*; and 4, *completely true to me*) in response to the stem "In this section, please think about the reasons you choose to limit your sitting time in general, considering sitting time as anything you do while seated or reclined and awake. Please read each statement and respond to the bolded question, using the response scale provided" and question "why do you limit your sitting time?" Items contained in the MMSB-OA can be found in Table 2.2.

2.2.4 Data Analysis

Prior to analysis, data was checked for missing values and univariate and multivariate outliers. Aside from the previously mentioned 17 participants removed for missing >25% of the data, no other missing values were identified. Further, no univariate nor multivariate outliers were identified, and acceptable normality of data was confirmed. Factorial validity of the MMSB-OA was determined through exploratory structural equation modeling (ESEM; Asparouhov & Muthén, 2009) using the Mplus latent variable modeling program version 8 (Muthén & Muthén, 1998 – 2017). ESEM is a contemporary approach to factor analysis which integrates features of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), and addresses the limitations present in both (Marsh et al., 2014). Similar to CFA, ESEM is a confirmatory approach which provides information about model fit statistics; however, most

relevant to the present study is that, unlike CFA, ESEM permits items to cross-load onto different factors. The inability for items to cross-load on to different factors – such as with CFA – may lead to overestimations of factor correlations resulting in biased structural relations. More specifically, allowing nonzero cross-loadings to be specified as zero constrains items to load solely onto their intended factor instead of loading onto the different factors that the item may unintentionally represents thereby providing an altered model (Asparouhov & Muthén, 2009). For instrument development, ESEM is recommended not only to mitigate the pitfalls of CFA, by providing a less biased perspective on the instrument quality, but also to yield information about potential cross-loading items. This is beneficial because it allows for adjustments to be made to the item pools (e.g., removing items that do not load > 0.32 on any factor, items that load stronger onto unintended factors, or items that strongly cross-load onto multiple factors) to ensure items accurately represent intended factors and that items are of the highest quality.

For this particular analysis, the robust maximum likelihood (MLR) estimator was chosen as it provides information about model fit and standard errors that are robust to data not normally distributed (Wang & Wang, 2019). Oblique target rotation was specified with unintended factor loadings set to be near zero as, while the items developed for the MMSB-OA were designed to specifically load onto one of the six motivation type according to the SDT motivation continuum, cross-loading of items onto multiple factors was permitted during the analysis. An oblique rotation was specified in favour of an orthogonal rotation as it can be hypothesized based on previous SDT scales that the factors would be correlated with one another (i.e., simplex structure; Ryan & Connell, 1989).

Various indices were used to determine goodness-of-fit of the model including: the chi-square statistic (χ^2), the comparative fit index (CFI), the Tucker Lewis index (TLI), the root

mean square error of approximation (RMSEA), and the standardized root mean residual (SRMR) (Hu & Bentler, 1999). The criteria for each index used to indicate good model fit were CFI ≥ 0.95, TLI ≥ 0.95, RMSEA ≤ 0.06, and SRMR ≤ 0.08 (Hu & Bentler, 1999). Items which loaded < 0.32 on intended factors, or ≥ 0.32 on unintended factors, or cross-loaded onto multiple factors were removed from the model one at a time to improve fit indices (Tabachnick & Fidell, 2013). If the removal of an item did not make conceptual sense, or did not improve fit indices, the item was retained to be tested with future samples. The removal of items stopped once all items that (1) improved fit indices when removed and (2) proved to be conceptually problematic (e.g., highly correlated with items intended for other factors) or were redundant with other items were removed from the instrument. Once the model was finalized, internal consistency reliability of each of the factors was estimated using Cronbach's alpha. Specifically, Cronbach alpha of each factor was estimated by hand using standardized score formula (see chapter 1). Inter-factor correlations were also estimated using the TECH4 specification in the output command. The TECH4 specification provides information about estimated means, covariance, and correlations for each of the latent variables in the model, further specifying standard errors and p-values.

2.3 Results

2.3.1 ESEM

The initial 41-item, 6-factor model demonstrated satisfactory scores on several measures of model fit while also failing to meet other criteria for good-fit: $\chi^2_{(589)} = 1{,}188.93$ $p < 0.001$; *CFI* = 0.910; *TLI* = 0.875; SRMR = 0.030; and RMSEA = 0.057 (90% confidence interval [CI] = 0.052, 0.061). Six items loaded above 0.32 on more than one factor (IM1, IM3, IM5, IM6, IG2, IG7) including the intended and an unintended factor, six items loaded above 0.32 only on an

unintended factor (IM7, ID6, ID7, ID8, IJ1, EX4), and two items failed to load on any factors above 0.32 (EX3, EX6). See Table 2.3 for factor loadings of each item.

2.3.2 Post-hoc modifications

Following the initial model, problematic items were removed one by one based on the criteria outlined in the method section. A rationale for the removal of each item is stated in Table 2.4. Items that only loaded strongly onto unintended factors or cross loaded stronger onto unintended factors were removed first. Once those items were removed, items that did not loaded above 0.32 on any factor were subsequently removed. Model fit indices were evaluated following the removal of each item. For a detailed breakdown of the process, and the rationale behind why specific items were removed see Table 2.4. A total of eight items were removed during this process: IM1, IM7, IG7, ID6, IJ1, IG2, EX4, and EX6. Results for the 33-item model indicated a better fit: $\chi^2(345) = 586.74$, $p < 0.001$; CFI = 0.952; TLI = 0.926; SRMR = 0.026; and RMSEA = 0.047 (90% confidence interval [CI] = 0.040, 0.053). Four problematic items remained in the model: ID7, which loaded only on an unintended item; ID8 and EX3, which did not load on any factor above 0.32, and; IJ2, which cross-loaded on two factors above 0.32. Though removing these items may improve model fit indices, removal did not make sense from a theoretical perspective and therefore the items were retained. See Table 2.5 for factor loadings of each item in the 33-item model.

The inter-factor correlations and Cronbach alphas for each subscale can be viewed in Table 2.6. Briefly, it was observed that intrinsic motivation was positively correlated with integrated ($r = 0.65$), identified ($r = 0.54$), and introjected regulation ($r = 0.41$;$p < 0.01$); integrated regulation was positively correlated with identified ($r = 0.50$) and introjected regulation ($r = 0.37$; $p < 0.01$); identified regulation was positively correlated with introjected

regulation (r = 0.57; p < 0.01) and external regulation (r = 0.13; p < 0.05), and negatively correlated with amotivation (r = -0.22; p < 0.01); introjected regulation was positively correlated with external regulation (r = 0.28; p < 0.01), and external regulation was positively correlated with amotivation (r = 0.14; p < 0.05). Alpha values for five of the factors (intrinsic motivation, integrated regulation, identified regulation, introjected regulation, and amotivation) were ≥ 0.83 (range 0.83 – 0.91), with only the external regulation factor falling below 0.65.

2.4 Discussion

The purpose of this study was to explore the internal consistency reliability, inter-factor correlations, and factorial validity of the MMSB-OA with a sample of older adults using ESEM, as well as to refine the number of items included in the MMSB-OA. Although the initial model did not demonstrate good model fit, the model fit improved following the removal of eight items such that only one index of model fit did not satisfy the outlined criteria (TLI was below 0.95). Several items which were retained could be removed to improve model fit; however, removing the items would not be supported from a theoretical standpoint as the items encapsulate the intended motivation type and concepts not addressed by other items. Furthermore, removal of several of the items would result in insufficient item pool (< 3 items) for specific motivation types (e.g., external regulation), tapping into one of the limitations of the current study: lack of strong items for the external regulation factor. In the version of the MMSB-OA presented to participants, only six items represented external regulation. Results from the ESEM of the 41-item model showed that of those six, only three (EX1, EX2, EX5) loaded onto the external factor above 0.32 (range: 0.40 – 0.71) with the other three either (EX3, EX4, EX6) not strongly loading onto the external regulation factor and/or loading onto an unintended factor by more than 0.32. Even after removing two of the problematic items (EX4, EX6), the factor loading values for the

three which originally loaded onto the external regulation factor did not improve substantially (range 0.428 – 0.767), and EX3 still failed to load ≥ 0.32. The desire for the MMSB-OA is to have at least three strong and comprehensive items for each of the motivation type according to the SDT motivation continuum. Additional, in order to calculate Cronbach alpha, a minimum of three items is needed. With the current data, the external regulation factor is lacking in representative items and must be addressed before the MMSB-OA can be used in future research to evaluate older adults' motives to sit less.

Alongside the factor validity, internal consistency and inter-factor correlations were also investigated. All but one of the factors (external regulation), following the removal of the eight problematic items, achieved α values exceeding 0.80 (range 0.83 – 0.91). This suggests that five of the factors demonstrate high internal consistency reliability scores. Though a number of reasons may underpin why external regulation did not achieve an α value above 0.80, such as the limited number of items contained in the external regulation factor compared to the other factors, the low factor loading scores both prior to item removal and following item removal suggests that there may be problems with how well the items work together to represent external regulation. Specifically, the current pool of items representing external regulation may not be completely comprehensive of the types of external reasons that older adults may choose to limit daily sedentary time with items being either to specific or unrelated to current motives.

As anticipated, the inter-factor correlations demonstrated a simplex structure. That is, regulatory styles appearing closer on the motivation continuum per SDT were significantly and positively correlated with one another compared to regulatory styles appearing further apart on the continuum. Interestingly, identified regulation was negatively correlated with amotivation at

the $p > 0.01$ level, adding more evidence to the idea that the further apart motives appear on the continuum the less positive the correlations are.

2.5 Future Directions

To rectify the limitations presented with the weak item pool for external regulation, the MMSB-OA will be further tested with a large sample of older adults with one modification: an additional nine items will be included to the item pool for external regulation (See the bottom of Table 2.2 for the items that will added to the MMSB-OA). All items, including those which were deemed problematic, will be carried forward for additional testing. Retaining all items is critical when adding items to an instrument as new items may alter the factor structure. Removing items at this phase is ill-advised as the new items may result in a worse-fitting model in the subsequent study, therefore causing additional studies to be conducted.

In the present study, the MMSB-OA demonstrated promising model fit indices, internal consistency reliability, and inter-factor correlations consistent with other instruments based in SDT. Though this study demonstrated that the external regulation factor requires further refinement before the MMSB-OA can be used to evaluate older adults' motives to limit daily SB from the perspective of SDT, other aspects of the MMSB-OA's validity and reliability must also be investigated. Specifically, convergent, divergent, and discriminate validity, test-retest reliability, and measurement invariance need to be ascertained. Therefore, the next step will be to further explore the aforementioned psychometric properties of the MMSB-OA with a large sample of older adults.

Tables and Figures

Table 3.1. Residence, Employment, and Mobility Status of Participants in Study 1

Variable	Total	Percent
Residence		
Personal or family members home	314	98.4
Retirement home	5	1.6
Employment		
Contract, freelance, or temporary	22	6.9
Part time (<30 hours per week)	19	6.0
Full time (>30 hours per week)	19	6.0
Retired or unemployed	259	81.2
Mobility		
Unable to walk independently, but able to stand and transfer to a wheelchair independently	1	0.3
Able to walk independently with the assistance of an aid (walking stick or walker)	17	5.3
Able to walk independently without the assistance of an aid	301	94.4

Table 2.2. Items Included in the MMSB-OA

SDT Category	Item Label	Item Description
Intrinsic Motivation	IM1	So that I can do the activities I love
	IM2	Because activities in which I don't sit are fun
	IM3	Because I enjoy trying activities that get me moving
	IM4	In order to do activities that I am interested in
	IM5	Because being more active is stimulating for me
	IM6	Because I get pleasure from moving
	IM7	Because I don't enjoy sitting
Integrated Regulation	IG1	Because I am not the type of person that sits a lot
	IG2	Because it's in line with my core values
	IG3	Because I have never been one to sit much
	IG4	Because I am an active person by nature
	IG5	Because that's who I've been all my life
	IG6	Because it's consistent with who I am as a person
	IG7	Because it fits with my personality
Identified Regulation	ID1	To be at my best mentally
	ID2	Because I want to maintain my independence
	ID3	Because it's personally important to me
	ID4	So that I can feel my best
	ID5	To increase the number of quality years I have left
	ID6	So that I stay engaged in the community
	ID7	For social reasons
	ID8	For health reasons
Introjected Regulation	IJ1	Because I know I shouldn't sit a lot
	IJ2	Because I would feel bad about myself if I didn't
	IJ3	Because I feel guilty if I sit on my butt for too long
	IJ4	Because I feel obligated to
	IJ5	Because I feel better about myself when I do

	IJ6	Because I get upset with myself if I sit too much
	IJ7	Because I don't want to feel lazy
External Regulation	EX1	Because people whose opinions I value tell me to
	EX2	Because important people in my life pressure me to
	EX3	Because others need me to do things that require me to not sit
	EX4	Because I don't want others to see me as if I'm old
	EX5	Because others will be upset with me if I don't
	EX6	Because I don't want others to treat me like I can't do things for myself
Amotivation	AM1	I don't limit my sitting time because I don't see why I should
	AM2	I don't limit my sitting time because I don't want to
	AM3	I don't try
	AM4	I don't limit my sitting time because I don't care how much I sit
	AM5	I don't limit my sitting time because I don't see how sitting less could benefit me
	AM6	I don't limit my sitting time because it is not worth the effort.
Items Added	**EX7**	**To satisfy others**
	EX8	**To help me look younger**
	EX9	**Because people in my life want me to**
	EX10	**Other people close to me insist that I do**
	EX11	**People around me nag me to do it**
	EX12	**Because other people say I should**
	EX13	**Because I may be rewarded if I do**
	EX14	**Because others encourage me to**
	EX15	**Because I will be praised for doing it**

Table 2.3. Results of Exploratory Structural Equation Modelling for the Initial 41-item MMSB-OA

	IM	IG	ID	IJ	EX	AM
IM1	0.39	-0.01	**0.47**	0.06	-0.03	-0.14
IM2	**0.57**	0.14	0.16	0.00	0.09	-0.07
IM3	**0.53**	0.33	0.07	0.03	-0.08	0.11
IM4	**0.68**	-0.02	0.12	0.07	-0.01	-0.04
IM5	**0.61**	0.35	-0.06	0.12	-0.06	0.01
IM6	**0.49**	0.34	0.07	0.05	-0.07	0.07
IM7	-0.10	**0.42**	0.11	0.14	-0.01	0.20
IG1	-0.07	**0.75**	0.25	-0.07	-0.07	-0.04
IG2	0.13	**0.36**	0.35	0.07	0.04	-0.15
IG3	-0.12	**0.93**	0.06	0.02	-0.08	0.05
IG4	0.26	**0.76**	-0.08	-0.02	-0.03	-0.01
IG5	0.14	**0.72**	-0.08	0.08	0.03	-0.03
IG6	0.19	**0.50**	0.11	0.09	0.03	-0.02
IG7	**0.41**	0.38	0.01	0.21	0.02	-0.02
ID1	0.13	0.12	**0.43**	0.11	0.14	-0.07
ID2	0.00	0.23	**0.60**	0.03	0.14	0.00
ID3	-0.01	0.27	**0.67**	0.05	0.08	-0.07
ID4	0.22	0.12	**0.55**	0.17	0.02	-0.11
ID5	0.21	0.02	**0.53**	0.21	0.09	-0.06
ID6	**0.37**	0.13	0.30	0.03	0.20	0.05
ID7	**0.42**	0.05	0.13	0.07	0.26	0.17
ID8	0.19	0.06	0.24	**0.34**	-0.01	-0.11
IJ1	0.00	-0.06	**0.68**	0.20	-0.11	-0.03
IJ2	-0.08	0.03	0.31	**0.47**	0.06	-0.05
IJ3	-0.12	0.10	-0.23	**0.94**	0.05	-0.02
IJ4	-0.16	0.00	-0.04	**0.61**	0.26	-0.01
IJ5	0.32	-0.09	0.19	**0.53**	-0.07	-0.08
IJ6	0.04	0.02	-0.05	**0.72**	0.09	0.05

IJ7	0.15	0.07	0.02	**0.54**	0.12	0.08
EX1	-0.13	-0.06	0.16	0.12	**0.40**	-0.14
EX2	-0.15	-0.04	0.08	0.00	**0.61**	0.11
EX3	0.08	0.00	0.08	0.01	**0.29**	-0.01
EX4	-0.15	0.07	0.23	**0.36**	0.31	0.08
EX5	-0.01	-0.09	-0.03	-0.05	**0.71**	-0.04
EX6	0.08	-0.06	0.10	0.28	**0.31**	0.14
AM1	0.00	-0.08	0.01	0.14	-0.15	**0.90**
AM2	-0.02	-0.09	0.13	0.10	-0.19	**0.91**
AM3	-0.04	0.02	0.01	-0.03	0.09	**0.38**
AM4	0.06	-0.03	0.00	-0.32	0.15	**0.48**
AM5	-0.02	0.16	-0.11	-0.08	0.21	**0.59**
AM6	0.04	-0.06	0.02	-0.01	0.14	**0.69**

Note. Factor loadings ≥ 0.32 on intended factors are highlighted in green. Factor loadings ≥ 0.32 on unintended factors or items cross-loading higher on unintended factors than intended factors are highlighted in red. Items cross-loading weaker on unintended factors ≥ 0.32 compared to loading on intended factors are highlighted in yellow. Largest factor loadings for each item are bolded.

Table 2.4. Summary of Fit Indices for each Model Iteration for Initial MMSB-OA

Model	Scaled χ^2	d.f	CFI	TLI	SRMR	RMSEA	90% CI for RMSEA	IM FL_{range}	IG FL_{range}	ID FL_{range}	IJ FL_{range}	EX FL_{range}	AM FL_{range}
Initial (41 items)	1188.930	589	0.910	0.875	0.030	0.057	0.052; 0.061	-0.1; 0.68	0.36; 0.93	0.129; 0.671	0.198; 0.935	0.285; 0.714	0.379; 0.913
40-items • **Removed IM1**	1089.982	555	0.917	0.883	0.029	0.055	0.050; 0.060	-0.09; 0.62	0.34; 0.92	0.194; 0.71	0.173; 0.942	0.286; 0.731	0.381; 0.903
Removed Item: IM1; Rationale: Item was removed because of ambiguous wording that may make it difficult to understand. Item was also worded similarly to stronger loading IM3. IM1 was also loading stronger onto the ID factor than the IM factor.													
39-items • **Removed IM1, IM7**	1029.949	522	0.919	0.886	0.029	0.055	0.050; 0.060	0.47; 0.62	0.36; 0.92	0.195; 0.704	0.173; 0.937	0.287; 0.731	0.381; 0.909
Removed Item: IM7; Rationale: Item was removed for being conceptually different from other IM items (framed as 'avoidance-orientated' instead of 'approach orientated') which may cause problems for interpretation. Though regardless of framing the item still represented intrinsic motivation; however, the difference in wording may explain why the item loaded greater onto other factors than it did onto the IM factor													
38-items • **Removed IM1, IM7, IG7**	899.132	490	0.932	0.902	0.029	0.051	0.046; 0.056	0.52; 0.64	0.36; 0.90	0.206; 0.69	0.169; 0.948	0.287; 0.726	0.381; 0.909

Removed Item: IG7; Rationale: Item may be redundant with the stronger loading IG6. Both items get at the idea of 'personality' or 'person-hood', which though important to integrated regulation, the wording of both items may overlap unnecessarily, with IG7 being the weaker of the two. Furthermore, though improved from the initial model following the removal of IM1 and IM7, IG7 crossloaded above 0.32 on the IM factor.													
37-items													
• **Removed IM1, IM7, IG7, ID6**	832.532	459	0.935	0.906	0.028	0.051	0.045; 0.056	0.53; 0.67	0.36; 0.91	0.169; 0.679	0.153; 0.955	0.27; 0.763	0.384; 0.904
Removed Item: ID6; Rationale: Both identified items that were designed to get at the social element of limiting SB (ID6 and ID7) loaded more strongly on IM factor than the intended ID factor. Social benefits of limiting SB have been highlighted previously by older adults, therefore it is critical to include an item getting at that idea. As both items were problematic, ID6 was removed because, compared to removal of ID7, removal of ID6 improved model fit indices to a greater extent. Further, ID7 is less specific than ID6, meaning that it is something that more individuals may be able to identify with.													
36-items													
• **Removed IM1, IM7, IG7, ID6, IJ1**	777.092	429	0.938	0.908	0.028	0.051	0.046; 0.056	0.52; 0.67	0.32; 0.89	0.206; 0.793	0.427; 0.95	0.236; 0.766	0.393; 0.89
Removed Item: IJ1; Rationale: item may not be distinct enough to set itself apart in concept with identified regulation. Other IJ items better address the idea that IJ1 attempts (e.g., IJ3), therefore, to limit redundancy in content, IJ1 was removed. Further, IJ1 loaded stronger on the ID factor despite previous item removals, and thus removing it was seen as necessary to improve model fit.													
35-items	713.157	400	0.941	0.913	0.028	0.050	0.044; 0.055	0.52; 0.66	0.47; 0.86	0.206; 0.864	0.431; 0.942	0.232; 0.763	0.392; 0.887

• **Removed IM1, IM7, IG7, ID6, IJ1, IG2**													
Removed item: IG2; Rationale Similar to the point that IG6 is illustrating. Though 'core values' is used in many other SDT surveys, 'core values' may be too abstract and/or ambiguous, leading to a misunderstanding or misinterpretation of the statement. Although IG2 loaded poorly throughout the first and subsequent iterations of the model, the item was retained to see if it would improve following the removal of other items. This was not the case, and therefore it was subsequently removed.													
34-items													
• **Removed IM1, IM7, IG7, ID6, IJ1, IG2, EX4**	631.810	372	0.949	0.924	0.026	0.047	0.041; 0.053	0.53;0 .66	0.47; 0.86	0.21; 0.876	0.451; 0.952	0.205; 0.771	0.394; 0.887
Removed item: EX4; Rationale: Though this item gets at ideas specific to older adults, the connection between sitting and perceived age is not well-defined by this item. This item may be too specific, and may not apply to many people who complete this survey. As this item did not load above 0.32 on the EX factor, it was removed.													
33-items													
• **Removed IM1, IM7, IG7, ID6, IJI,**	586.739	345	0.952	0.926	0.026	0.047	0.040; 0.053	0.52; 0.66	0.47; 0.87	0.215; 0.877	0.46; 0.956	0.291; 0.767	0.397: 0.89

IG2, EX4, **EX6**	Removed item EX6; Rationale: Contains a double negative which are not recommended as double negatives may make understanding the item difficult.

Table 2.5. Results of Exploratory Structural Equation Modelling for the 33-item MMSB-OA

	IM	IG	ID	IJ	EX	AM
IM2	**0.59**	0.08	0.20	-0.01	0.07	-0.08
IM3	**0.59**	0.26	0.08	0.01	-0.07	0.08
IM4	**0.64**	-0.05	0.19	0.02	0.00	-0.06
IM5	**0.66**	0.28	-0.03	0.11	-0.04	-0.02
IM6	**0.52**	0.26	0.11	0.05	-0.09	0.05
IG1	-0.09	**0.70**	0.29	-0.06	-0.08	-0.03
IG3	-0.06	**0.87**	0.05	0.05	-0.06	0.05
IG4	0.31	**0.73**	-0.10	0.00	-0.01	-0.04
IG5	0.16	**0.70**	-0.05	0.10	0.06	-0.03
IG6	0.18	**0.47**	0.13	0.09	0.06	-0.03
ID1	0.12	0.06	**0.47**	0.08	0.11	-0.05
ID2	-0.09	0.14	**0.79**	-0.03	0.05	0.05
ID3	-0.11	0.18	**0.88**	-0.03	0.00	-0.01
ID4	0.16	0.03	**0.68**	0.10	-0.04	-0.08
ID5	0.18	-0.07	**0.63**	0.15	0.03	-0.03
ID7	**0.38**	0.01	0.22	0.09	0.18	0.18
ID8	0.19	0.00	**0.31**	0.29	-0.02	-0.10
IJ2	-0.12	0.05	0.32	**0.46**	0.03	-0.04
IJ3	-0.10	0.11	-0.19	**0.96**	-0.01	-0.01
IJ4	-0.16	0.02	-0.01	**0.66**	0.19	0.01
IJ5	0.29	-0.15	0.29	**0.46**	-0.09	-0.08
IJ6	0.06	0.01	-0.01	**0.73**	0.07	0.05
IJ7	0.12	0.04	0.12	**0.54**	0.01	0.10
EX1	-0.11	-0.02	0.13	0.15	**0.43**	-0.13
EX2	-0.10	-0.01	0.04	0.07	**0.60**	0.12
EX3	0.06	0.02	0.08	0.04	**0.29**	0.00
EX5	0.02	-0.04	-0.02	0.01	**0.77**	-0.02
AM1	-0.01	-0.04	-0.03	0.13	-0.13	**0.88**
AM2	-0.03	-0.06	0.08	0.07	-0.16	**0.89**

AM3	-0.03	0.00	0.04	-0.01	0.07	**0.40**
AM4	0.05	-0.01	0.00	-0.30	0.17	**0.49**
AM5	0.02	0.14	-0.11	-0.01	0.14	**0.59**
AM6	0.03	-0.05	0.03	0.03	0.08	**0.70**

Note. Factor loadings ≥ 0.32 on intended factors highlighted in green. Factor loadings ≥ 0.32 on unintended factors or items cross-loading higher on unintended factors than intended factors highlighted in red. Items cross-loading weaker on unintended factors ≥ 0.32 compared to loading on intended factors highlighted in yellow. Largest factor loadings for each item are bolded.

Table 2.6. Exploratory Structural Equation Modelling Latent Factor Correlations and Internal Consistencies

Factors	IM	IG	ID	IJ	EX	AM
IM	(0.90)					
IG	0.65**	(0.91)				
ID	0.54**	0.50**	(0.89)			
IJ	0.41**	0.37**	0.57**	(0.85)		
EX	-0.02	-0.10	0.13*	0.28**	(0.64)	
AM	-0.03	0.03	-0.22**	-0.03	0.14*	(0.83)

Note. Internal consistencies are on the diagonal. *$p < 0.05$, **$p < 0.01$

Chapter 3: Study 2

3.1 Introduction

The previous study provided preliminary evidence of several psychometric properties of the MMSB-OA, demonstrating promise for the instrument; However, there were several limitations that must be addressed. Particularly, the items comprising the external regulation factor were insufficient, demonstrating low internal consistency reliability and poor factor loadings. Thus, several items were added to the factor that must be evaluated. With these additions, factorial validity, internal consistency, and inter-factor correlations must once again be assessed as the addition of the new items could influence the psychometric properties of the instrument. Though analyzing the revised MMSB-OA for internal consistency reliability, inter-factor correlations, and factorial validity is crucial before moving forward, the results from the previous study do suggest that the MMSB-OA is in a position where other psychometric properties can be assessed. That is, it demonstrates enough promise that the natural next step would be to further enhance the understanding of the MMSB-OA's psychometric properties, namely the criterion validity and test-retest reliability of the instrument. Therefore, this study will have three overarching objectives to be evaluated with a completely independent and unique sample from study 1: (1) evaluate the internal consistency reliability, inter-factor correlations, and factorial validity of the revised MMSB-OA, (2) refine the item pool to ensure four to five representative items of high quality for each of the six factors, and (3), investigate the one-week test-retest reliability and criterion validity of the MMSB-OA.

The first two objectives were identical to the first study; however, the third objective was specific to the present study. As addressed in chapter 1, test-retest reliability is necessary to determine the temporal stability of a particular instrument (DeVellis, 2017). When developing an

instrument of this nature, unless acted on by an outside force, it is expected that an individual's motives should remain consistent over time. Thus, temporal stability is essential to establish so that in situations where external pressures are applied it is clear as to whether any observable differences in an individual's motives can be attributed to the external pressure or to measurement error (DeVellis, 2017).

Criterion validity, specifically concurrent validity, was used to investigate whether previously established relationships between motivation types and other variables were observable in the present context. As mentioned, to determine the criterion validity of an instrument it is critical to establish the nomonological network, or a network of different measures that, based on past literature, should be related in a certain way to the current measure (Cronbach & Meehl, 1955). In the context of older adults' sedentary behaviour from the perspective of SDT, two constructs that may prove beneficial to investigate are subjective well-being and subjective health (Tang et al., 2020). These constructs were selected because previous studies have repeatedly observed correlations between these constructs and older adults' motives for other behaviours (e.g., exercise) from an SDT perspective (e.g., Tang et al., 2020). For the present study, subjective wellbeing was conceptualized as an individual's feelings of pleasure and happiness (Ryan & Deci, 2001). Specifically, three aspects of subjective wellbeing were included in the investigation of the criterion validity of the MMSB-OA, these were: presence of positive mood, absence of negative mood, and life satisfaction (Ryan & Deci, 2001). To avoid redundancy with chapter 1, in a generalized context with older adults, more self-determined motives – those reflecting intrinsic motivation, integrated regulation, and identified regulation – have been found to be positively correlated with different indices of subjective well-being such as positive affect and life satisfaction (Tang et al., 2020) with some evidence to suggest

significant negative correlation between more self-determined motives and negative affect (e.g., Sheldon & Kasser, 2001). In contrast, less self-determined motives – those reflecting introjected regulation, external regulation, and amotivation – seem to be more negatively correlated with positive affect and potentially life-satisfaction, but positively correlated with negative affect (Tang et al., 2020; Vallerand et al., 1995). As this evidence holds true not only in generalized contexts, but also in more specific contexts such as with exercise (Tang et al., 2020), investigating it in the context of sedentary behaviour was warranted.

Alongside subjective well-being, investigating the correlations between the MMSB-OA and older adults' subjective health was also warranted. Simply put, subjective health is one's perceived overall physical and mental health (Ware & Sherbourne, 1992). As mentioned previously, it has been demonstrated in the exercise context that older adults endorsing more self-determined motives for participating typically report greater overall quality of life compared to those endorsing less-self-determined motives (Tang et al., 2020). The areas where this is most apparent are bodily pain, social functioning, role limitations due to physical health, and role limitations due to emotional problems (Ferrand et al., 2014). While the exercise context is separate from the SB context, the correlations previously mentioned necessitates the inclusion of subjective health in the nomonological network alongside subjective wellbeing to ascertain the criterion validity of the MMSB-OA.

The overall objective of this entire thesis has been to construct an instrument which can evaluate older adults' motives to limit daily SB from the theoretical perspective of SDT with the hope that it can be utilized in a practical setting to assist program designers in constructing efficacious interventions to limit older adults daily SB. This objective is built upon one critical assumption: time spent engaged in SB is correlated with motives to sit less from the perspective

of SDT. Though evidence from other contexts supports the assumption that motives to limit SB would be correlated with engagement in SB (e.g., Ryan & Deci, 2017), this assumption has yet to be tested. While unlikely, there is still a possibility that SB engagement is independent from motives. Therefore, to justify the creation of this instrument, daily SB will also be assessed within this study to ascertain if there is a relationship between SB and motives to limit SB.

Given the three objectives, six hypotheses were formulated for this study. The first three were the same as in the previous study, whereas the final three are unique to the present study. These first three hypotheses were: (1) each factor would demonstrate internal consistency values greater than the 0.80 threshold indicative of 'good to excellent' internal consistency, (2) inter-factor correlations will demonstrate a simplex structure whereby factors nearest to each other will correlate highly but factors further away would correlate less, and (3) items will load more strongly onto the intended factors than onto unintended factors, while also possessing good model fit scores. In the previous study, all but one factor achieved an internal consistency score above 0.80, the inter-factor correlations were indicative of a simplex structure, and the factorial validity of the instrument was – for the most part – satisfactory by the final model iteration. Thus, it is expected that similar results will be achieved for this study.

In relation to the new hypotheses for the present study, little evidence has been collected and presented in the literature that could be used as a reference point for the present study. Regardless, based on what is available three things were anticipated. The first – and fourth hypothesis – is that the MMSB-OA would demonstrate satisfactory test-retest reliability. Only one other instrument has been developed similar to the MMSB-OA: the MLSQ (Lubans et al., 2013). Although screen time is not quite representative of SB, and adolescents are not a similar demographic to older adults, the test-retest reliability data from this study is informative in that

the were no significant differences in response to an instrument rooted in SDT and measuring an aspect of SB from time one to time two (Lubans et al., 2013). It should be highlighted that for the MLSQ, test-retest was only measured at the factor/aggregate-level instead of the item-level (Lubans et al., 2013). That is, test-retest reliability was assessed based on the average score for each factor rather than each item. It is unclear whether test-retest reliability will be as strong at the item-level, especially given all the potential threats to test-retest reliability outlined in chapter 1.

For the fifth hypothesis, it was anticipated that correlations would be observed between the measures of subjective wellbeing and motives to limit SB, as well as between subjective health and motives to limit SB. Specifically, based on previous literature (e.g., Tang et al., 2020) it was anticipated that positive affect and life satisfaction would be positively correlated with more self-determined motives (representing intrinsic motivation, integrated regulation, and identified regulation) but negatively correlated with motives representing external regulation and amotivation. Negative affect was anticipated to be negatively correlated with more self-determined motives, but positively correlated with motives representing external regulation and amotivation. Speaking to subjective health, it was anticipated that the more self-determined motives would be positively correlated with subjective health, whereas motives representing external regulation and amotivation would be either not at all correlated with subjective health, or negatively correlated with subjective health. Motives representing introjected regulation were purposefully omitted from the previously mentioned anticipated results as it was unclear how those will interact with other variables based on previous literature (Ryan & Deci, 2017). To put forth an anticipated outcome, the most likely outcome was that the introjected motives would either not be significantly correlated with any subjective wellbeing or subjective health variables

(e.g., Teixeira et al., 2012), slightly positively associated with subjective wellbeing and health variables similar to more self-determined motives (e.g., Teixeira et al., 2012) or act more like the less-self-determined motives they are typically categorized with and be negatively correlated with the wellbeing and health indices. Again, it was unclear how the motives will interact with other variables based on previous literature.

Lastly it was anticipated that engagement in SB would be negatively correlated with more self-determined motives, but positively correlated with less self-determined motives. SDT literature is brimming with studies that have demonstrated more self-determined motives are positively correlated with sustained engagement in particular behaviours whereas less-self-determined motives are negatively correlated with sustained engagement in a particular behaviour (e.g., Ryan & Deci, 2017). Even in the context of engagement in different movement behaviours (e.g., MVPA), this relationship has been extensively observed (e.g., Teixeira et al., 2012). Thus, it was anticipated that given previous evidence, these correlations would be observed in the collected data. Similar to the previous study, it was not anticipated that the aforementioned criteria nor outcomes would be achieved in the first iteration of the model with 50-items. Instead, these anticipated results were hypothesised to occur once the final model had been achieved.

3.2 Methods

3.2.1 Procedures

Prior to data collection, ethical clearance was obtained from the host university. Upon obtaining ethics approval from the host university, an independent sample of older adults were recruited to participate in the study between April 2021 and December 2021 through a variety of different online means, including (1) social media posts, (2) contacting local and national organizations, and (3) distribution through local newsletters. Unlike in the previous study where

recruitment was predominately focused on communities throughout Alberta, for this study recruitment was focused more within Ontario and smaller cities within Manitoba and British Columbia, with some recruitment occurring at an international level through social media posts. For this phase, an emphasis was placed on recruiting from organizations/clubs/groups that lend themselves to more sedentary behaviours (e.g., knitting clubs, painting groups) to differentiate from the more active groups that were recruited in the previous phase. All recruitment information contained a link to a Qualtrics survey. In the informed consent for the survey, potential participants were informed that their participation was anonymous and confidential, as well it was made clear that the purpose of the survey was to assess the accuracy and reliability of the item pool being developed. The inclusion criteria for this study required individuals to be 65 years or older, understand English, and be able to stand without the assistance of an aid (walking stick or walker).

As one of the purposes for this study was to evaluate the test-retest reliability of the item pool, participants who completed the first survey were given an opportunity to indicate whether they would like to participate in the second survey. The second survey was sent to participants exactly one week after they completed the first survey through an automated process. For the second survey, only the MMSB-OA was included. No demographic information was collected.

3.2.2 Participants

517 responses were submitted for the first survey, of which 269 were deemed to be legitimate[2]. Upon initial data cleaning for the data analysis, 253 participants remained. 53.8% of

[2] Upon reviewing the data, it became apparent that many of the responses were of questionable quality and could potentially bias the data. Particularly the response patterns, email addresses, and IP address locations of certain respondents raised some questions and warranted further investigations. For example, several respondents answered the questions either in a diagonal fashion (e.g., 1,2,3,4,5,4,3,2,1 etc.) or in a complete vertical fashion (e.g., all 1's.). Removing data based on hunches, however, is unscientific and thus several criteria were created that all responses had to pass in order to be deemed 'legitimate'.

participants were women (n = 136), 45.5% were men (n = 115), with the mean age of participants being 68.91 years (SD = 3.96). Average BMI was recorded to be 25.00 (SD = 5.36). Participants were on average Caucasian (75.5%)**,** possessing some form of post-secondary education (68.4%)**,** community dwelling (80.6%)**,** retired/unemployed (78.7%), and able to walk independently without the assistance of an aid (79.8%). For more information about participant demographics see Table 3.1.

127 responses were submitted for the second survey. Of those 87 were removed: 85 were removed because they had no accompanying data for survey 1 and two responses were removed as they were duplicate responses. This left 40 responses available for analyses. Demographic information was not collected for the second survey, thus the characteristics of the participants is not known.

3.2.3 Measures

3.2.3.1 Demographics

The first of the criteria to be established was that all surveys response durations had to exceed 900 seconds. When reviewing the data, data of questionable origin seemed to have been submitted on four specific dates. Many of the response duration on those dates were shorter than 10 minutes. Prior to submitting ethics for this study, the anticipated duration (30-40 minutes) was established by getting non-participants (e.g., people under the age of 65, other graduate students, etc) to complete the survey and averaging out the times as well as anticipating additional time needed for older adults to read through all the instructions. The fastest time that was collected from the non-participants was 12 minutes, but as that time was one of the people involved in constructing the survey (Liam Collins), it was omitted from the average. Consequently, responses shorter than 10 minutes were completely unexpected. To establish the minimum duration, the mean and SD of response duration was taken from all responses not submitted on the four days where questionable data was submitted. The mean duration came to be 1321 seconds, with the standard deviation equalling 208 seconds. Data up to two standard deviations less than the mean duration (905 seconds) were retained.

Duplicate email addresses and IP addresses were also identified for removal. Though this may have removed people who did it with their partner, each of the duplicates were systematically checked to see if there were consistencies in the data that would be expected from partners (e.g., current resident status – partners typically reside at the same location) but differences in data that would not be expected to be the same from partners (e.g., height and weight). If the responses seemed to come from partners, then the rest of the survey was compared to see if there were similarities. If the data was 100% identical, or seemed to come from only one person, only the first response (or in one case, the data which was most complete) was maintained.

To avoid future problems, the survey that collected the questionable data was closed and a copy of the survey was created. This copy served as the new survey which data was collected from, and the recruitment methods were approached with more caution.

Participants were asked to complete a demographics questionnaire whereby they were asked to indicate their age, gender, race, height, weight, level of education, employment status, current residence status, and mobility status. The specific questions asked and response options provided can be found in Appendix B.

3.2.3.2 Revised MMSB-OA

Alongside the demographic questionnaire, five other questionnaires were included in the first survey package. The revised MMSB-OA contained 50 items which evaluated motivation across six-subscales (intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation). The range of items for each subscale was 6-8, however for external regulation 15 items were included (see previous study for rationale). All statements were judged on a 5-point Likert scale (0, *not at all true for me*; 1, *slightly true for me*; 2, *moderately true for me*; 3, *very true for me*; and 4, *completely true to me*) in response to the stem "There are many reasons as to why someone may choose or not choose to limit their daily sedentary behaviour. For this section, please think about the reasons you choose, or don't choose, to limit your sitting time in general**,** considering sitting time as anything you do while seated or reclined and awake. Please read and respond to each statement following the bolded question using the response scale provided" and question "Why do you limit your sitting time?" Items contained in the revised version of the MMSB-OA can be found in Table 2.2.

3.2.3.3 Measure of Older Adults' Sedentary Time (MOST)

The MOST is a self-report sedentary time instrument which asks participants to reflect on their past-week sedentary behaviour across seven different categories: (1) watching television or videos/DVDs; (2) using the computer/internet; (3) reading; (4) socializing with friends or family; (5) driving or riding in a car, or time on public transport; (6) doing hobbies (e.g., crafts,

crosswords, woodworking), and; (7) doing any other activities (Gardiner et al., 2011). Though an objective measure would have been more ideal to evaluate sedentary behaviour given the inherent limitations of subjective, self-report measures – self-report measures have been shown to underestimate daily sedentary behaviour by ~1.74 hours compared to objective measures when used with adults (Prince et al., 2020b) – the COVID-19 pandemic made objective measures unfeasible considering the desired sample size (>300) and time constraints. Regardless, the MOST has been used frequently with older adults and has been shown to have acceptable test-retest reliability (Spearman's $\rho = 0.52$ [0.27 to 0.70]) and validity when compared to accelerometer derived SB ($\rho = 0.30$ [0.02-0.54]; Gardiner et al., 2011). Though the MOST measures SB across seven different activities over the course of a one week period, most relevant to the present study was the average daily SB. Thus, reported SB was summed and then divided by seven to achieve the daily average SB.

3.2.3.4 Positive and Negative Affect Schedule (PANAS)

To evaluate the presence, or lack thereof, of positive and negative affect – an aspect of subjective wellbeing – the PANAS was included in the survey package. The PANAS is a 20-item scale that consists of words describing feelings and emotions in which participants are asked to indicate the extent to which the word is relevant to them on a five-point Likert scale (1, *very slightly or not at all;* 2, *a little*; 3, *moderately*; 4, *quite a bit*; 5, *extremely*). Scores from items representing positive affect are summed as are scores from items representing negative affect. The range for scores is 10-50. Words included in the PANAS that the participants are asked to respond to are; interested, distressed, excited, upset, strong, guilty, scared, hostile, enthusiastic, proud, irritable, alert, ashamed, inspired, nervous, determined, attentive, jittery, active, and afraid (Watson et al., 1988).

Over the last several decades, the psychometric properties of the PANAS have been extensively investigated with a variety of different samples including non-clinical, clinical, and older-adult specific samples (e.g., Crawford & Henry, 2004; Merz et al., 2013; Von Humboldt et al., 2017; Watson et al., 1988). In the initial development and validation paper by Watson and colleagues (1988), and without time instructions (e.g., in the past few days), the internal consistency (Cronbach's alpha) of the positive affect and negative affect subscales were 0.88 and 0.87 respectively. The positive affect-negative affect intercorrelation was -0.17. Eight-week test-retest reliability for the same scale was 0.68 and 0.71 for the positive affect and negative affect scale, respectively (Watson et al., 1988). More relevant, a recent investigation of the PANAS with older adults found the two-factor model (positive and negative affect) to present a good fit ((χ^2/df = 3.369; CFI = 0.977; GFI = 0.958; RMSEA = 0.043); strong internal consistency for positive affect (α = 0.92) and negative affect (α = 0.88); and a positive association between PANAS composite score and SWLS (a measure of life satisfaction: r = 0.092; p = 0.001; Von Humboldt et al., 2017). Other studies involving older adults have also found similar Cronbach alpha scores for the positive and negative affect scale, such as Simone and Haas (2013) who indicated that with their sample Cronbach alphas were 0.83 and 0.88 for positive and negative affect respectively.

3.2.3.5 Satisfaction With Life Scale (SWLS)

Though the PANAS measures two aspects of subjective wellbeing – presence of positive affect and absence of negative affect – the PANAS does not address the third aspect of subjective wellbeing: life satisfaction. To address life satisfaction, the SWLS was included. The SWLS is a five-item questionnaire consisting of statement in which participants are asked to indicate the extent to which they agree or disagree on a seven-point Likert scale (1, *strongly disagree*; 2,

disagree; 3, *slightly disagree*; 4, *neither agree nor disagree*; 5, *slightly agree*; 6, *agree*; 7, *strongly agree*). Scores from the instrument are summed together and then divided by the number of questions to get an average satisfaction with life score from 1-7. A general approach to interpretating is: 1-2 = extremely dissatisfied, 2-3 = dissatisfied, 3-4 = slightly dissatisfied, 4-5 = slightly satisfied, 5-6 = satisfied, and 6-7 = extremely satisfied (Pavot & Diener, 2008). Investigations of the SWLS psychometric properties have found that the scale demonstrates strong internal consistency, with coefficient alpha's ranging from 0.79 – 0.89, as well as high test-retest reliability scores which decrease over an extended period of time (0.83 for 2-week, but 0.54 for 4-years: Pavot & Diener, 2008). Looking at the correlations of emotion variables with the SWLS, satisfaction with life is positively correlated with positive affect (correlation coefficient = 0.36 – 0.55) and negatively correlated with negative affect (correlation coefficient = -0.40 – -0.57: Pavot & Diener, 2008).

3.2.3.6 Medical Outcomes Survey Short Form 36-items (MOS SF-36)

The PANAS and the SWLS address the key components of subjective wellbeing; however, the scales are limited in that they focus on the emotional and psychological wellbeing rather than addressing any form of physical wellbeing. Prolonged time spent sedentary is associated with a number of detrimental physical and psychological health consequences (Copeland, 2017; de Rezende et al., 2014) which are not considered with the PANAS nor SWLS, therefore it is important to include an instrument that can assess these health consequences. Though there are many different versions of the medical outcome survey (12-item, 20-item, 36-item) to ensure the most representative depiction of participant wellbeing, while not increasing the burden on participants to extensively the MOS SF-36 was included.

Comprising the MOS SF- 36 are eight subscales with between two and ten items each. The eight subscales are (1) physical functioning, (2) role limitation due to physical health, (3) bodily pain, (4) general mental health, (5) role limitation due to emotional problems, (6) social functioning, (7) vitality, and (8) general health perceptions (Ware & Sherbourne, 1992). The labels assigned to each subscale can be a little misleading as they imply that a higher score obtained indicates a greater presence of whatever latent construct is being measured. This is not the case for *role limitations due to physical health*, role limitations due to emotional problems, and *bodily pain*. For these subscales, it is scored in such a way that having less of the latent construct leads to a greater score. That is, the less bodily pain present, the greater the score on the subscale one would receive. When interpreting the correlations between these three subscales and other variables, the sign should be interpreted in an inverse fashion. That is a negative correlation between one of those three subscales indicates an increase in either bodily pain, role limitations due to emotional problems, or role limitations due to physical health. A more accurate name for the subscales are: (1) Absence of role limitations due to physical health, (2) absence of role limitations due to emotional problems, (3) absence of bodily pain. Investigations with older adults has revealed that the eight-factor structure is supported (Haywood et al., 2005), the internal consistency for each subscale exceeds 0.70 in most studies, with that number typically exceeding 0.90 when examining the mental and physical summary scores. As for the test-retest reliability, studies have found it to be acceptable (on average exceeding a correlation coefficient of 0.70; Haywood et al., 2005). Unlike the previously mentioned instruments, the response scale for the MOS – SF36 is not consistent throughout. The instrument alternates between different Likert-type response options (3-point to 6-point), yes-no questions, and true-or-false questions. A revised version of the instrument was published in the early 2000s which addressed the

inconsistencies in question response type (Ware, 2000); however, due to licensing requirements the revised version was not included in this survey.

3.2.4 Data Analysis

3.2.4.1 ESEM, CFA, internal consistency reliability, and inter-factor correlations

Similar to the previous study, ESEM with a MLR estimator and oblique target rotation was used to determine factor loadings and model fit of the MMSB-OA for the data collected in the initial survey using Mplus latent variable modeling program version 8 (Muthén & Muthén, 1998 – 2017). Prior to analysis, data were screened for missing values, univariate outliers, multivariate outliers, and normality. Sixteen cases were removed because they were missing more than 25% of the data for the MMSB-OA. This left 253 cases remaining for analysis. Ninety-five missing variables in the MMSB-OA data were replaced using series median, representing 0.77% of the data. Though other methods of replacing data are stronger, such as single imputation and multiple imputation methods (Donders et al., 2006), series median – or replacing the data with the median value of the column – was opted for as any approach would yield similar results given that less than 1% of the data were missing (Tabachnick & Fidell, 2013). No univariate or multivariate outliers were identified, and the data for each item was normally distributed. Goodness-of-fit of the model was once again determined using the chi-square statistic (χ^2), the comparative fit index (CFI), the Tucker Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean residual (SRMR) (Hu & Bentler, 1999) whereby the following criteria were used as benchmarks: CFI $\geq$ 0.95, TLI $\geq$ 0.95, RMSEA $\leq$ 0.06, and SRMR $\leq$ 0.08 (Hu & Bentler, 1999). Items which loaded < 0.32 on intended factors, or $\geq$ 0.32 on unintended factors, or crossloaded onto multiple factors were once again removed from the model one at a time to improve fit indices (Tabachnick & Fidell, 2013).

Going into the analysis, the item pool was dominated by items for the external regulation factor, therefore refinement of the external items – especially redundant items and those which crossloaded onto other factors – was undertaken whenever possible. Further, results from the previous data analysis also guided the removal of items. Specifically, when removing items, those that were deemed to be problematic in the previous study and which appeared problematic in the present study were removed prior to items that did not appear problematic in the previous study but did so in the present study. The removal of items stopped once all items that (1) improved fit indices when removed and (2) proved to be conceptually problematic (e.g., highly correlated with items intended for other subscales) were removed from the instrument. Once the model was finalized, as suggested by Asparouhov and Muthén (2009), a confirmatory factor analysis (CFA) was conducted. CFA is similar to ESEM, however as mentioned previously, it constrains the loading of items to their intended factor and sets loadings on unintended factors to zero. As a result, compared to the model fit derived from ESEM, the model fit from a CFA will be less 'good'. This is especially true in the case of the current study as with SDT it is anticipated from a theoretical standpoint that an individual may endorse motives representing different motivation types simultaneously, especially motives representing neighbouring motivation types, and thus cause crossloading for items on neighboring factors (e.g., individuals whose motives are predominantly introjected may also identify with certain external items or identified items). Internal consistency reliability of each of the subscales was estimated using Cronbach's alpha. Specifically, Cronbach alpha of each subscale was estimated by hand using standardized score formula (see chapter 1). Inter-factor correlations were also estimated using the TECH4 specification in the output command. The TECH4 specification provides information about

estimated means, covariance, and correlations for each of the latent variables in the model, further specifying standard errors and p-values.

3.2.4.2 Criterion validity

Two approaches were completed to evaluate criterion validity: (1) Spearman's rank correlation (Spearman's ρ or 'ρ') and (2) Kendall's Tau-b correlation coefficient (Kendall's τ-b or 'τ-b') using Rstudio (2021). Prior to analysis, data was inspected for missing values, outliers, and normality. Ten cases were removed as they lacked >50% of data for the PANAS, SWLS, and MOS SF-36, making them unviable for the analysis. - leaving 243 cases for analysis. Five missing variables were identified; however, these were not replaced as missing data represented less than 5%, and therefore negligible (Tabachnick & Fidell 2013). Of the 243 cases, only 231 had completed data for the MOST. As this this was less than 5% of the overall data, missing values were not replaced. Data recorded for the PANAS, SWLS, MOS SF-36, and MOST were observed to be non-normally distributed. Consequently, rather than attempting to transform the data – as this was deemed unfeasible given the directions of the data distribution – non-parametric tests were opted for. As mentioned, the two tests conducted were Spearman's ρ and Kendall's τ-b. These two tests are non-parametric bivariate correlation analyses that measure the degree of association between two variables of interest. For both Spearman's ρ and Kendall's τ-b, values for a variable are assigned ranks, where the rank indicates the relative placement of the value compared to all other data collected for the particular variable (i.e., the lowest value receives a rank of 1, second lowest receives a rank of 2, etc.). All variables undergo this process, then the relative ranks are compared to one another to determine the degree of association between the variables. The coefficient is measured from -1 to +1. The sign indicates the direction of the relationship whereas the number indicated the strength of the correlation. For Kendall's τ-

b, recommended interpretations are: < ± 0.10 = very weak, ± 0.10 – 0.19 = weak, ± 0.20 – 0.29 = moderate, and > ± 0.30 = strong (Botsch, n.d.). For Spearman's ρ, the general interpretation rule of thumb is 0.10-0.39 = weak correlation, 0.40-0.69 = moderate correlation, 0.70-0.89 = strong correlation, and > 0.90 = very strong correlation (Schober et al., 2018). However, these interpretations are up for debate, and not everyone agrees that these are correct (Schober et al., 2018). Spearman's ρ is one of the most commonly appearing approaching in the literature for evaluating bivariate correlations between non-normally distributed data (e.g., De Ridder et al., 2019), however, this method is limited in that in presence of tied ranks, the test statistic is artificially inflated. Consequently, Kendall's τ-b was also included as this is not an issue faced with this method.

Criterion validity was evaluated at an aggregate level as opposed to an item-level. That is, scores from each item reflecting a particular factor were summed, and then divided by the number of items for each factor. This approach (as opposed to item-level bivariate correlations) was utilized because one of the purposes of this study was determine how the latent variables the MMSB-OA is supposed to measure – intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation – correlate with other latent variables of interest.

3.2.4.3 Test-retest reliability

Test-retest reliability was estimated using Pearson's product moment correlation coefficient (Pearson's *r*) and intraclass correlation coefficient (ICC) in Microsoft Excel Version 16.56 with the Real Statistics Resource Pack software version 7.10 (Zaiontz, 2020). For test-retest reliability, only the MMSB-OA was evaluated. No other measures were included in the second survey. Initially, data from the survey at the first time point was corroborated with data

from the second survey. 127 responses were submitted for the second survey. Of those 87 were removed: 85 were removed because they had no accompanying data for survey 1 – likely removed for being incomplete or questionable as survey 2 was only accessible to those who completed survey 1 – and two responses were removed as they were duplicate responses. This left 40 responses available for analyses. Demographic information was not collected for the second survey. After removing the associated data from the items eliminated during the ESEM process, data was screened for missing values, univariate outliers, multivariate outliers, and normality. Three missing values were identified from the data collected during the second survey. Missing values were not replaced as they represented less than 5% of the data (Tabachnick & Fidell 2013). No univariate or multivariate outliers were identified, and distribution of the change scores[3] from data collected during survey 1 and survey 2 were normal. Prior to running the analysis for test-retest reliability, a paired-sample t-test was conducted to evaluate if there were any significant differences between scores obtained from survey 1 and survey 2. It should be noted that an aggregate score for each factor was also created by summing the scores obtained on each item representing that factor and dividing it by the number of items representing the factor. This aggregate score was also evaluated for outliers, normality, and screened to see if there were any significant differences between the score from the first survey and the score obtained on the second survey. Once the data were properly cleaned, test-retest reliability was evaluated using two different approaches: (1) Pearson's *r*, and (2) ICC.

Pearson's *r* is a common approach for evaluating test-retest reliability as it measures the degree of linear association between two normally distributed variables (Tabachnick & Fidell 2013). Specifically, with this method a line of best-fit is drawn through the data points collected

[3] Change scores were calculated by subtracting the scores obtained for an item during survey 1 from the scores obtain for an item during survey 2

from both variables – or time points – and the r-value indicates how far away the data points are from this line of best fit. Though frequently used, it has been argued that Pearson's *r* may not be the most appropriate approach for evaluating test-retest reliability as it is unable to detect systematic errors that may be present (Vaz et al., 2013; Weir, 2005). Therefore, to address this, ICC was also utilized. ICC is a relative measure of reliability in that it is the ratio of between-groups variance to total variance measured. It is unitless, and instead quantifies the direction and strength between the variables measured typically from 0 – 1, where 0 = no correlation, and 1 = perfect correlation. Pearson's *r* is also a relative measure of reliability – where -1 and 1 = perfect correlation and 0 = no correlation – quantifying the direction and strength between variables being measured. However, the two methods diverge in that ICC accounts for the consistency – or lack thereof – of a performance at two time points as well as the change in the overall average score of participants as a group overtime, whereas Pearson's *r* does not (Vaz et al., 2013). Though for both methods 0 = no correlation and 1 = perfect correlation (as well as -1 for Pearson's *r*), there is a difference in how results are interpreted. For Pearson's *r*, researchers have proposed varied ways to interpret the correlation coefficient. Schober and colleagues recommended that < 0.10 = negligible correlation, 0.10-0.39 = weak correlation, 0.40-0.69 = moderate correlation, 0.70-0.89 = strong correlation, and > 0.90 = very strong correlation. However, it has also been recommended not to view the correlation coefficient from a simplistic lens of different categories and instead view the coefficient for what it is: an indication of the strength of the relationship from 0-1 (Schober et al., 2018). To better articulate the data, the simplistic categories outlined above will be used, with the recognition that these categories are, in fact, simplified categories that help contextualize the data. With ICC, there are no acceptable criteria, however in lieu of this it has been suggested to view ICC values < 0.50 as demonstrating

poor reliability, 0.50-0.75 as moderate reliability, 0.75-0.90 as good reliability, and >0.90 as excellent reliability (Portney & Watkins, 2009). Nevertheless, both methods were conducted to gain additional insight into the quality of the MMSB-OA.

3.3 Results

3.3.1 ESEM

The initial 50-item, 6-factor model demonstrated satisfactory scores on several measures of model fit while also failing to meet other criteria for good-fit: $\chi^2_{(940)} = 1{,}619.801$ $p < 0.001$; CFI = 0.890; TLI = 0.857; SRMR = 0.033; and RMSEA = 0.053 (90% confidence interval [CI] = 0.049, 0.058). Eleven items loaded above 0.32 on more than one factor (IM1, IM3, IM4, IM5, IM7, IG2, IG4, ID7, IJ4, IJ5, EX8,). All of the aforementioned items – except IM5, loaded on two unintended factors - loading on an intended and unintended factor. Four items loaded above 0.32 on only an unintended factor (IM2, IM6, IJ1, EX6). Three items did not load on any factor above 0.32 (ID6, IJ3, EX3). See Table 3.3 for factor loadings of the initial item pool.

3.3.2 Post-hoc modifications

Following the initial model, problematic items were removed one-by-one based on several criteria – see methods section for criteria. For a detailed breakdown of the process, and the rationale behind why specific items were removed see Table 3.4. The final model contained 24 items (4 items per subscale), with 26 items removed: EX6, EX3, IJ1, EX8, IM5, EX4, ID6, ID7, EX7, EX12, IG4, EX13, IM7, IM2, ID1, IJ7, IG7, AM1,EX11, IJ4, EX9, ID2, EX10, AM3, IG2, EX15. Results for the 24-item model indicated a better fit: $\chi^2_{(147)} = 201.029$, $p = 0.002$; CFI = 0.975; TLI = 0.953; SRMR = 0.023; and RMSEA = 0.038 (90% confidence interval [CI] = 0.024, 0.051). Three problematic items were retained (IG6, ID8, IJ5). Though removal or replacement with other items representing the same factor may have improved model fit, it was

determined that these items represented integral components of older adults' motives to limit SB, and therefore removal may compromise the content representation of the MMSB-OA. See table 3.5 for the factor loadings of each item in the final model.

3.3.3 Follow-up Confirmatory Factor Analysis

Factor loadings obtained from the CFA can be viewed in Table 3.5. The model fit scores obtained for the CFA were as follows: $\chi^2_{(237)} = 491.127$, $p < 0.001$; CFI = 0.882; TLI = 0.863; SRMR = 0.078; and RMSEA = 0.065 (90% confidence interval [CI] = 0.057, 0.073). CFA factor loadings can be viewed in Table 3.5. Briefly, the range of loadings scores for each factor were as follows: 0.71 - 0.73 for IM, 0.62 – 0.76 for IG, 0.58 – 0.79 for ID, 0.65 – 0.71 for IJ, 0.65 – 0.85 for EX, and 0.53 – 0.75 for AM.

3.3.4 Internal Consistency Reliability and Inter-factor Correlations

The inter-factor correlations and Cronbach alphas for each subscale can be viewed in Table 3.6. Briefly, it was observed that intrinsic motivation was positively correlated with integrated, identified, and introjected regulation ($p < 0.01$), but negatively correlated with external regulation ($p < 0.05$); integrated regulation was positively correlated with identified and introjected regulation ($p < 0.01$); identified regulation was positively correlated with introjected regulation ($p < 0.01$) and negatively correlated with amotivation ($p < 0.01$); introjected regulation was positively correlated with external regulation ($p < 0.01$), and; external regulation was positively correlated with amotivation ($p < 0.05$). Alpha values for all six of the subscales were ≥ 0.77 (range 0.77 – 0.85), indicating that the internal consistency for each subscale was adequate-to-good.

3.3.5 Criterion Validity

The outcomes for criterion validity can be viewed in Table 3.7. To summarize the trends, more self-determined motives (those representing intrinsic motivation, integrated regulation, and identified regulation) were generally found to be positively correlated with optimal levels of subjective wellbeing (positive affect and life satisfaction) and subjective health. Though in some instance, neither motives representing intrinsic motivation nor integrated regulation were significantly correlated with indices of subjective health; however, motives representing identified regulation were. As for negative affect, significant negative correlations were only observed between motives representing identified regulation and negative affect.

Looking at the less self-determined motives, those representing external regulation and amotivation were generally negatively associated with optimal levels of subjective wellbeing and subjective health. This was particularly prevalent for subjective health whereby motives representing external regulation and amotivation were consistently negatively associated with each of the indices. Motives representing introjected regulation generally correlated in the same direction as the other less self-determined motives, except for with positive affect whereby it correlated similarly to the more self-determined motives.

No significant correlations were observed between: (1) intrinsic motivation and negative affect, role limitations due to physical health, role limitations due to emotional problems, emotional wellbeing, social functioning, and bodily pain; (2) integrated regulation and negative affect, role limitations due to physical health, and role limitations due to emotional problems; (3) identified regulation and role limitations due to emotional problems; (4) introjected regulation and life satisfaction, physical functioning, vitality, bodily pain, and general health perceptions, and; (5) external regulation positive affect and life satisfaction. The amotivation factor was found to be significantly correlated with every variable of interest at the < 0.01 level.

Interestingly, with daily sedentary behaviour, significant correlations were only observed for intrinsic motivation (ρ = -0.13; p = 0.05: τ-b = -0.09; p = 0.05) and integrated regulation (ρ = -0.13; p = 0.05: τ-b = -0.10; p = 0.03).

3.3.6 Test-retest Reliability

Means and standard deviations of item and aggregate factor score at time 1 and time 2 can be found in Table 3.8 alongside mean difference and standard deviation from time 1 to time 2 and the results of the Pearson's *r* and ICC analyses. Results from the paired sample T-test demonstrated that there were no significant differences between scores obtained from survey 1 and survey 2 for any of the items or the aggregate measure. Speaking to the Pearson's *r* results, at the item-level, observed value ranges were 0.58 – 0.73 for the IM factor, 0.53 – 0.73 for the IG factor, 0.38 – 0.66 for the ID factor, 0.48 – 0.62 for the IJ factor, 0.64 – 0.78 for the EX factor, and 0.26 – 0.68 for the AM factor. At the aggregate level, all Pearson's *r* values exceeded 0.57. Turning the attention to the ICC results at the item-level, the observed value ranges were 0.58 – 0.73 for the IM factor, 0.54 – 0.71 for the IG factor, 0.39 – 0.66 for the ID factor, 0.49 – 0.62 for the IJ factor, 0.65 – 0.78 for the EX factor, and 0.27 – 0.67 for the AM factor. At the aggregate level all values once again exceeded 0.57.

3.4 Discussion

The purpose of this study was to evaluate the criterion validity, test-retest reliability alongside factorial validity, internal consistency reliability and inter-factor correlations of the revised MMSB-OA. Additionally, the second purpose was to refine the item pool to four representative items per factor. Beginning with factorial validity, the first iteration of the model did not demonstrate satisfactory model fit: $\chi^2_{(940)}$ = 1,619.801 p < 0.001; *CFI* = 0.890; *TLI* = 0.857; SRMR = 0.033; and RMSEA = 0.053 (90% confidence interval [CI] = 0.049, 0.058);

however, after removing 26 items, the model fit substantially improved: $\chi^2_{(147)} = 201.029$, $p = 0.002$; CFI = 0.975; TLI = 0.953; SRMR = 0.023; and RMSEA = 0.038 (90% confidence interval [CI] = 0.024, 0.051). Three problematic items were retained for the final model (IG6, ID8, IJ5), because the removal of these items was unwarranted upon reviewing both the data and the items as a whole – this will be discussed in depth in the general discussion section.

Reflecting on the observed factorial validity, it was previously stated that the intent was to have each item ideally achieve the threshold of excellent factor loading scores on the intended factor (≥ 0.71; Tabachnick & Fidell, 2013). Unfortunately, only 7/24 items loaded above 0.71 on the respective factor when utilizing the ESEM data analysis approach. However, data from the CFA demonstrated that 14/24 items loaded above 0.71 on the intended factor, with all but one item loading above 0.55 (the criteria for good; Tabachnick & Fidell, 2013). Speaking more to the CFA results, the elephant in the room cannot be ignored. That is, for the CFA of the final model, the model fit indices were: $\chi^2_{(237)} = 491.127$, $p < 0.001$; CFI = 0.882; TLI = 0.863; SRMR = 0.078; and RMSEA = 0.065 (90% confidence interval [CI] = 0.057, 0.073). Under most circumstances, this would be unacceptable. But, there are a few reasons why this is not as concerning as it may appear especially when contextualized with the results of the ESEM. The main rationale is that compared to ESEM, CFA measurement models constrain loadings of items to specific factors, with loadings on unintended factors set to zero (Asparouhov & Muthén, 2009). As a result, this constraint often is not a good fit for the data as it is incredibly unlikely that items will ever perfectly load on one factor without loading on any other (Asparouhov & Muthén, 2009). Essentially, for CFA to produce a well-fitting model without extensive model modifications, the items representing different latent variables being measured must have few if any crossloadings (Asparouhov & Muthén, 2009). If there are crossloadings present this may

lead to overestimated factor correlations and distorted structural relations (Asparouhov & Muthén, 2009). When constructing an instrument from a SDT perspective, having zero crossloadings is not realistic. It is widely accepted that an individual can endorse motives representing different motivations simultaneously (e.g., Collins & Pope, 2021; Howard et al., 2020), causing the different motivations to be highly correlated with one another when measured in this fashion. Consequently, if individuals are endorsing motives reflecting different motivations along the motivational continuum, to evaluate the data using a restrictive model that constrains loadings of items on specific factors is not going to produce the greatest results. Instead, an approach should be taken whereby items are specified to load onto the intended factors, but also allowed to freely load onto others. This approach better reflects the nature of motives from a perspective of SDT and may explain the difference in quality of data obtained from the more restrictive model type (CFA) compared to the less restrictive model type (ESEM).

Internal consistency reliability was lower in this study than in the first study for each of the factors except external regulation. On average, internal consistency reliability for each of the factors except external regulation dropped by 0.06-0.12. External regulation, on the other hand, increased by 0.21. A contributing factor to the increase in internal consistency reliability seen with the external regulation factor may have been reflected in the stronger factor loadings seen in the present study compared to in the previous study. In the previous study, when post-hoc model modifications were completed, four items remained for the external regulation factor with only three loading above 0.32 on the external regulation factor. For this study all four items loaded on the external regulation factor above 0.32, suggesting the items better represented the intended latent variable compared to previously. Regarding the other five factors, the decrease in internal consistency reliability score may be due to the reduced number of items per factor. Reducing the

number of items per factor has the potential to reduce the inter-item correlations and redundancy present for a particular factor, thereby leading to a reduction in the internal consistency value obtained (Tavakol & Dennick, 2011; Vaske et al., 2017). However, it should still be highlighted that the internal consistency scores obtained are still at the upper end of adequate, venturing into 'good' territory (Tavakol & Dennick, 2011; Vaske et al., 2017).

Similar to the first study, a simplex structure was observed in the data for the inter-factor correlations. While comparisons cannot be drawn between the data obtained from the previous study and the present study as different items were selected for the models, an interesting reoccurring finding was that identified regulation was the only factor negatively correlated with amotivation at $p < 0.01$. This is interesting because one would expect intrinsic motivation and integrated motivation, based on their location on the continuum, to be more negatively correlated with amotivation than identified regulation. When looking at previously published literature (e.g., Lonsdale et al., 2008; Pelletier et al., 2004; Pelletier et al., 2013), intrinsic motivation factor(s) tend to correlate more negatively with the amotivation factor than identified regulation (e.g., Lonsdale et al., 2008; Pelletier et al., 2004; Pelletier et al., 2013) ; however, while integrated regulation also typically correlates more negatively with amotivated factors than identified regulation (e.g., Lonsdale et al., 2008; Pelletier et al., 2004; Pelletier et al., 2013), there have been instances where identified regulation is more negatively correlated with amotivation than integrated regulation (e.g., Lonsdale et al., 2008), though this is not frequently replicated.

Before explaining the results for the criterion validity section, it is critical to once again highlight that the wording of some of the subscales may be misleading. Role limitations due to physical health, role limitations due to emotional problems, and bodily pain are all scored such that the higher the score reported, the less of that variable they possess. For these variables, think

of the labels including the prefacing words ‘absence of’ because in the MOS SF-36 those subscales are not measuring the presence of the variable, rather the absence of the variable. That is, if an individual scores high on bodily pain, their bodily pain is less than someone who scores low on that particular question. Moving forward with the discussion, each of the three previously mentioned subscales will be prefaced with “[absence of]” despite not appearing as such in the literature.

As anticipated, significant correlations in the expected direction were observed between the different motivations, subjective wellbeing, and subjective health. The more self-determined motivations were positively correlated with desirable ‘traits’ such as positive affect, life satisfaction, physical functioning, vitality, and general health perceptions. On the other hand, the less self-determined motivations (external regulation and amotivation) were significantly negatively correlated with desirable traits such as physical functioning, [absence of] role limitations due to physical health, [absence of] role limitations due to emotional problems, vitality, emotional wellbeing, social functioning, [absence of] bodily pain, and general health perceptions and significantly positively correlated with undesirable traits such as negative affect. Intrinsic motivation demonstrated lower correlation coefficients than integrated regulation and identified regulation which was not anticipated. In fact, intrinsic motivation was not significantly correlated with emotional wellbeing social functioning, or [absence of] bodily pain. Neither intrinsic motivation, nor integrated regulation were correlated significantly with negative affect, which mirrors the finding that external motivation was not significantly correlated with positive affect as anticipated. This finding was odd, but given that all the self-determined motivations were positively correlated with positive affect whereas external regulation and amotivation were positively correlated with negative affect, the results may be interpreted as more self-determined

motivations are correlated with presence positive affect but not as correlated with the absence of negative affect and less self-determined motivations are correlated with the presence of negative affect but not as correlated with the absence of positive affect. Unfortunately, as the correlations between motivations and affect using the PANAS have been under-investigated, more research is needed to better understand the relationships.

Interestingly, the introjected regulation variable correlated as hypothesized. In some instances, this factor operated similar to more self-determined motivations (e.g., positive affect), however, in other instances it correlated similar to the less self-determined motivations (e.g., negative affect, [absence of] role limitations due to physical health, [absence of] role limitations due to emotional problems, emotional wellbeing, and social functioning). Furthermore, introjected regulation did not correlate significantly with several other variables (e.g., life satisfaction, physical functioning, vitality, bodily pain, and general health perceptions). Looking specifically at the strength of the correlations, only very weak to weak correlations were observed per the recommended thresholds for Kendall's τ-b (Botsch, n.d.). In comparison, all other types of motivation achieved at least two moderate -strength correlations, with amotivation demonstrating correlation scores at Kendall's τ-b > 0.20 with eight other variables. This aligns with previous literature that suggests introjected regulation often report weak correlations that can align similarly with more self-determined motivations or less self-determined motivations depending on the particular variable (Teixeira et al., 2012).

One of the most interesting findings was with the measure for subjective health. Previous literature has reported that individuals endorsing more self-determined motivations scored greater on the MOS SF-36 compared to individuals endorsing less self-determined motivations (Ferrand et al., 2014). Though this was the case for several variables, many times no significant

correlations were observed between intrinsic motivation and integrated regulation and scores on the MOS SF-36; however, across every single variable, external regulation and amotivation demonstrate moderate-strong negative correlations (per the recommended thresholds for Kendall's τ-b). On the basis of this data, it may be that there is not so much a correlation between presence of subjective health and more self-determined motives, rather there is a correlation between absence of subjective health and less self-determined motives. This is merely a suggestion based on the empirical evidence collected during the present study. More research is needed on this topic before any conclusions can be reached.

Lastly, the correlations – or lack thereof – between SB and motivations were not anticipated. Briefly, SB was only correlated with intrinsic motivation and integrated regulation at the significant level, both of which demonstrated negative correlation ($\rho = 0.13$). Upon reflection, two factors may have caused bias in the data. Briefly, only two types of motivations – intrinsic motivation and integrated regulation – were observed to be associated with daily SB, and both were negatively correlated. Though these correlations were in the anticipated direction, the strength of the relationship and the absence of any other correlations highlights concern regarding these results. One potential explanation for this, and the least likely, is that a self-report measure was used to collect information about daily SB. Self-report measures are notorious for introducing bias into data, and the evidence identifies that with adults, self-report measures tend to underestimate daily SB by ~1.74 hours (Prince et al., 2020b). The reason why this explanation is less likely is that it is anticipated that this underestimation would occur across all participants. Thus, to suggest it explains the observed results would also be to suggest that individuals endorsing different motivations differentially misestimate their daily SB based in a consistent manner. This is a bold claim that requires empirical testing before it can be put forth. The

second, and perhaps more realistic explanation for the results is that all data was collected in a pandemic environment where movement behaviours – and autonomy over one's behaviours in general – have been restricted. With the COVID-19 pandemic, older adults in general have been less active (e.g., Lehtisalo et al., 2021 Shinohara et al., 2021; Yamada et al., 2020), potentially increasing daily SB overall. It is realistic to presume that the restrictions associated with the present pandemic has impacted all individuals regardless of personal motivations in that even if people were motivated to engage in less SB, the circumstances that they faced may not have been conducive to limiting SB. Support for this suggestion comes from the differences between the average reported SB in the present study compared to what is typically observed for older adults. In the present study, older adults reported engaging in an average of ~8 hours per day of SB. Previous literature has found that on average, using self-report surveys, older adults report ~5.3 hours engaged in SB (Harvey et al., 2015). Additionally, in the initial validation paper for the MOST, the survey was administered at three time points with the average reported SB coming back between 5.7 – 7.3 hours/day (Gardiner et al., 2011). Thus, it can be concluded that older adults in the present study reported substantially more time engaged in SB than what is typically expected from this demographic using this measure of SB pre-pandemic. Consequently, the data collected may not be an accurate reflection of difference in SB based on motivations. In order to be sure, SB data should be collected post-pandemic with objective measures to evaluate if there are any correlations between motivations and daily SB.

Lastly, the test-retest reliability scores were also investigated in the present study - demonstrating promising results. Though, reliability at the item level was not always satisfactory, the reliability scores at the aggregate level was encouraging. Specifically, considering the thresholds for Pearson's *r*, the aggregate scores for IM, IG, and EX from time 1

to time 2 all achieved ‘strong correlation’, whereas ID, IJ, and AM achieved ‘moderate correlation’. Inspection of the ICC scores, demonstrated that IG, ID, IJ, and AM all reported ‘moderate reliability’ whereas IM and EX achieved ‘good reliability’. The rationale for focusing on the aggregate score as opposed to the item-level scores is that some level of fluctuation is to be expected with the responses provided for each item over time; thus, investigating test-retest reliability is less about determining if the items remain stable over time, rather the stability of the latent variable from one period of time to another is more pertinent (Devilles, 2017). If the item scores fluctuate from one time period to another, but the aggregate score representing the latent variable remains consistent across two time periods, then it can be said that the instrument is demonstrates test-retest reliability in terms of evaluating the latent variable (Devilles, 2017).

3.5 Limitations and Future Directions

Though there were several limitations brought up throughout this discussion, only one limitation and subsequent future direction will be discussed in the present context, with the remaining left for the general discussion section. The main limitation of the present study was the low sample size. Sample size is incredibly important with scale development, with almost every form of validity and reliability sensitive to the number of cases available for analysis. A general rule of thumb for this form of data analysis is to have a minimum of 300 cases available (Tabachnick & Fidell, 2013). For the factorial validity analysis, only 253 cases were available whereas for the criterion validity only 243 cases were available. While some studies suggest that 150-200 participants may be adequate for this type of research if certain criteria are met (e.g., Worthington, & Whittaker, 2006), it is understood that the more cases one has, the better. With that in mind, the present study had an insufficient sample for what was being examined.

Consequently, though these analyses stand for the submission of the present thesis, more participants will be collected moving forward.

In sum, this study demonstrated strong factorial validity for the updated 24-item MMSB-OA – final item list in table 3.9 – when considering the data obtained through ESEM, acceptable internal consistency reliability, inter-factor correlations reflecting a simplex structure, correlations between subjective wellbeing, subjective health, and motivations indicative of acceptable criterion validity, and moderate-to-good test-retest reliability. In contrast, this study did not report the anticipated relationship between self-reported SB and motives to limit daily SB. Future research should be conducted with a larger sample size to maximize the rigor of the study.

Tables and Figures

Table 3.1. Gender, Race, Education, Residence, Employment, and Mobility Status of Participants

Variable	Total	Percent (%)
Gender		
Man	115	45.5
Woman	136	53.8
Prefer not to say	2	0.8
Race		
Asian	20	7.9
Black/African	11	4.3
Caucasian	191	75.5
Hispanic	25	9.9
Indigenous/Aboriginal	8	3.2
Other	2	0.8
Education		
No certificate, diploma, or degree	5	2.0
High school diploma	45	17.8
Apprenticeship or other trades certificate	30	11.9
College diploma	91	36.0
University Bachelor's	58	22.9
University graduate school	24	9.5
Residence		
Personal or family members home	204	80.6
Retirement home	35	13.8
Assisted living facility	8	3.2
Nursing home	5	2.0
Employment		
Contract, freelance, or temporary	19	7.5
Part time (<30 hours per week)	22	8.7
Full time (>30 hours per week)	13	5.1
Retired or unemployed	199	78.7
Mobility		
Unable to walk independently, but able to stand and transfer to a wheelchair independently	6	2.4
Able to walk independently with the assistance of an aid (walking stick or walker)	45	17.8
Able to walk independently without the assistance of an aid	202	79.8

Table 3.2. Age, Sedentary Behaviour, BMI, Subjective Wellbeing, and Subjective Health of Participants

Variable	*N*	Mean	Standard Dev.	Range
Age (years)	253	68.91	3.96	65-84
Sedentary behaviour (minutes)				
Weekly	231	3378.68	1777.50	480.00-7320.00
Daily	231	482.67	253.93	68.57-1045.72
BMI (kg/m^2)	227	25.0	5.36	14.40-41.80
Affect[a]				
Positive affect	243	31.34	6.96	10-50
Negative affect	243	18.21	7.31	10-43
Satisfaction with Life[b]	243	4.90	1.28	1.20-7
Subjective Health(%)				
Physical Functioning	243	65.74	25.20	0-100
Role Limitations due to Physical Health	243	61.63	38.32	0-100
Role Limitations due to Emotional Problems	243	69.55	36.56	0-100
Energy/Fatigue	243	61.97	16.73	10-100
Emotional Wellbeing	243	71.04	17.79	28-100
Social Functioning	243	73.21	23.95	12.50-100
Pain	243	68.55	19.45	10-100
General Health	243	69.84	18.44	16.67-100

Note.

[a] Potential scores ranged from 10-50.

[b] Potential scores ranged from 1-7

Table 3.3. Results of Exploratory Structural Equation Modelling for the full MMSB-OA

	IM	IG	ID	IJ	EX	AM
IM1	0.38	0.28	0.32	-0.16	-0.10	-0.10
IM2	0.04	0.41	0.29	-0.12	-0.08	-0.05
IM3	0.42	0.42	0.15	-0.03	-0.05	0.01
IM4	0.36	0.27	0.32	-0.13	0.07	-0.20
IM5	0.17	0.35	0.39	0.08	-0.12	0.04
IM6	0.06	0.46	0.27	0.04	0.01	-0.12
IM7	0.40	0.24	-0.16	0.15	0.15	0.35
IG1	0.21	0.53	-0.12	0.16	-0.04	0.13
IG2	0.15	0.39	0.26	0.02	0.33	-0.21
IG3	0.05	0.61	0.00	0.15	-0.13	0.23
IG4	0.49	0.58	0.01	-0.14	-0.03	-0.02
IG5	-0.05	0.67	-0.08	0.34	-0.05	-0.09
IG6	-0.04	0.71	0.14	-0.05	0.03	-0.02
IG7	0.14	0.54	0.04	-0.03	0.21	-0.17
ID1	0.27	-0.03	0.55	0.16	-0.06	0.03
ID2	0.08	0.06	0.50	0.16	-0.05	0.05
ID3	-0.01	0.18	0.49	0.29	0.03	-0.14
ID4	0.10	0.23	0.47	0.18	-0.08	0.01
ID5	0.09	0.03	0.53	0.14	-0.14	-0.03
ID6	0.25	0.09	0.21	0.30	0.18	-0.04
ID7	-0.17	0.10	0.33	0.34	0.14	0.12
ID8	0.17	0.04	0.56	0.06	0.19	-0.13
IJ1	-0.01	-0.03	0.49	0.23	-0.01	-0.13
IJ2	-0.09	0.10	0.15	0.56	0.15	-0.02
IJ3	-0.11	0.13	0.06	0.05	0.02	0.12
IJ4	-0.06	-0.10	0.04	0.65	0.61	0.16
IJ5	-0.10	-0.02	0.57	0.37	0.03	-0.14
IJ6	-0.09	0.19	0.11	0.55	0.10	0.13
IJ7	0.27	0.11	0.07	0.39	0.06	0.03

EX1	0.04	0.06	0.03	0.17	0.69	-0.02
EX2	-0.14	-0.11	0.02	0.05	0.67	0.14
EX3	0.01	0.07	0.17	0.23	0.23	0.07
EX4	0.31	0.00	-0.05	0.26	0.65	-0.18
EX5	-0.27	0.12	-0.04	-0.06	0.66	0.23
EX6	0.32	-0.12	0.18	0.23	0.29	0.04
EX7	-0.18	0.04	-0.15	0.19	0.58	0.15
EX8	0.46	-0.06	0.09	0.18	0.51	-0.05
EX9	0.15	-0.08	0.09	-0.13	0.75	0.03
EX10	0.01	-0.01	0.04	-0.22	0.79	0.11
EX11	-0.16	0.03	-0.02	-0.20	0.78	0.14
EX12	-0.26	0.10	-0.03	-0.14	0.58	0.02
EX13	0.02	0.05	-0.04	0.24	0.86	-0.16
EX14	-0.04	-0.07	0.13	-0.10	0.80	0.09
EX15	0.08	0.08	-0.22	0.05	0.84	-0.04
AM1	-0.02	-0.14	0.17	0.05	0.05	0.71
AM2	0.27	0.05	-0.03	0.02	-0.03	0.59
AM3	-0.09	0.06	0.09	-0.01	-0.05	0.73
AM4	0.06	0.10	-0.17	0.00	0.16	0.59
AM5	0.06	-0.03	-0.01	0.07	0.11	0.64
AM6	0.01	-0.06	0.15	-0.07	0.27	0.60

Note. Factor loadings ≥ 0.32 on intended factors are highlighted in green. Factor loadings ≥ 0.32 on unintended factors or items crossloading higher on unintended factors than intended factors are highlighted in red. Items crossloading weaker on unintended factors ≥ 0.32 compared to loading on intended factors are highlighted in yellow. Largest factor loadings for each item are bolded.

Table 3.4. Summary of Fit Indices for each Model Iteration

Model	Scaled χ^2	d.f.	CFI	TLI	SRMR	RMSEA	90% CI for RMSEA	IM FL_{range}	IG FL_{range}	ID FL_{range}	IJ FL_{range}	EX FL_{range}	AM FL_{range}
Initial (50 items)	1619.801	940	0.890	0.857	0.033	0.053	0.049; 0.058	0.04; 0.42	0.39; 0.71	0.21; 0.56	0.05; 0.65	0.23; 0.86	0.59; 0.73
49-items • **Removed EX6**	1562.105	897	0.891	0.857	0.033	0.054	0.050; 0.059	0.04; 0.44	0.36; 0.73	0.21; 0.57	0.07; 0.66	0.23; 0.87	0.59; 0.73
Removed Item: EX6; Rationale: Did not strongly load on EX factor and instead loaded above 0.32 on IM factor. Item was removed in previous study due to the presence of a double negative in addition to low factor loading onto the EX factor.													
48-items • **Removed EX6, EX3**	1482.952	855	0.895	0.862	0.032	0.054	0.049; 0.058	0.03; 0.44	0.36; 0.72	0.21; 0.57	0.08; 0.65	0.48; 0.87	0.59; 0.73
Removed Item: EX3; Rationale: Item did not load above 0.32 on EX factor. In the previous data set, this item did not load above 0.32 on any factor. With the addition of EX items in the present study, this item was removed early due to low factor loadings in both data sets.													
47-items • **Removed EX6, EX3, IJ1**	1400.069	814	0.900	0.867	0.032	0.053	0.049; 0.058	0.03; 0.45	0.37; 0.75	0.26; 0.58	0.08; 0.64	0.48; 0.87	0.57; 0.74
Removed Item: IJ1; Rationale: Item did not load above 0.32 on intended factor but loaded at 0.49 on ID factor. In the previous study, IJ1 also loading more strongly on the ID factor than the IJ factor. Therefore, with the problem occurring twice, this item was removed.													
46-items • **Removed EX6, EX3, IJ1, EX8**	1348.243	774	0.899	0.865	0.032	0.054	0.049; 0.059	0.06; 0.47	0.34; 0.72	0.26; 0.58	0.11; 0.65	0.54; 0.88	0.56; 0.76
Removed Item: EX8; Rationale: Item crossloaded on IM factor at 0.45. Removal of item did not lead to improvements in model fit indices; however, removal of item did improve factor loading scores and reduced crossloading of several IM items. EX8 was a unique item that is not similar to other items in this instrument and was designed specifically for this demographic. 'Looking younger' was discussed often in the original focus groups, which is why the item was created. However, the specificity may have been what contributed to its poor performance. 'Looking younger' was discussed often in the original focus groups, which is why the item was created.													

45-items													
• **Removed EX6, EX3, IJ1, EX8, IM5**	1268.891	735	0.903	0.869	0.032	0.054	0.049; 0.059	0.01; 0.48	0.36; 0.74	0.27; 0.62	0.10; 0.65	0.55; 0.88	0.58; 0.74
Removed Item: IM5; Rationale: Item crossloaded above 0.32 on both the IG factor and the ID factor while also failing to load above 0.32 on the IM factor. Conceptually, IM5 is similar to other IM items (e.g., IM6), however, the language used for IM5 could be considered ambiguous and jargon laden. That is, the word 'stimulating' could be interpreted in several different ways, whereas the word 'pleasure' – as used with IM6 – is easy to understand and grasp.													
44-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4**	1184.409	697	0.908	0.875	0.031	0.053	0.047; 0.058	0.03; 0.47	0.35; 0.74	0.28; 0.60	0.15; 0.67	0.52; 0.89	0.53; 0.82
Removed item: EX4; Rationale: Item loading on IM factor and IG factor was approaching 0.32. EX4 was removed in the previous study for poor-factor loading as well.													
43-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6**	1130.365	660	0.909	0.875	0.031	0.053	0.048; 0.058	0.03; 0.47	0.35; 0.74	0.36; 0.59	0.15; 0.68	0.52; 0.88	0.53; 0.82
Removed item: ID6; Rationale: Item loading did not achieve 0.32 on intended factor. ID6 was removed in the previous study as well due to poor item loading. Though social benefits have previously been extensively highlighted by older adults as motives to limit SB, the phrasing of ID6 is questionable upon further investigations. This is because it implies that the only way to stay engaged in the community is to reduce daily SB. This is obviously misleading, and thus the item was removed.													
42-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7**	1050.963	624	0.915	0.882	0.031	0.052	0.047; 0.057	0.05; 0.46	0.37; 0.75	0.37; 0.68	0.12; 0.69	0.53; 0.87	0.54; 0.79
Removed item: IM7; Rationale: In the previous phase, item was removed for being conceptually different from other IM items (framed as 'avoidance-orientated' instead of 'approach orientated') which may cause problems for interpretation. Though this item was performing well, there was a concern that it was impacting the overall factor structure because of its inherent difference. Upon removal of the item an increase was observed in item loading for all of the other IM items confirming the idea that IM7 may have been dominating the factor preventing other items from loading onto it.													
41-items													
• **Removed EX6, EX3, IJ1, EX8,**	960.436	589	0.924	0.894	0.030	0.050	0.044; 0.056	0.04; 0.45	0.37; 0.76	0.41; 0.64	0.12; 0.70	0.53; 0.87	0.52; 0.81

IM5, EX4, ID6, IM7, ID7													
Removed item: ID7; Rationale: ID7 failed to load above 0.32 on the intended factor.													
40-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5**	887.934	555	0.929	0.900	0.030	0.049	0.043; 0.055	-0.01; 0.43	0.35; 0.76	0.43; 0.77	0.11; 0.67	0.53; 0.87	0.52; 0.80
Removed item: IJ5; Rationale: Item loading was 0.30 on intended factor, but 0.61 on the ID factor. In the previous study, this item also loaded on the IM factor at 0.29, ID at 0.29 and IJ at 0.46. With that in mind, this item is the only item that gets at the ego-enhancement side of introjected regulation; thus, it may be returned later in the model to ensure full representativeness of the latent variable 'introjected regulation'.													
39-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, IM1**	831.908	522	0.932	0.903	0.030	0.048	0.042; 0.055	-0.08; 0.35	0.37; 0.73	0.49; 0.71	0.12; 0.68	0.53; 0.87	0.52; 0.81
Removed item: IM1; Rationale: Item loading was 0.31 on intended factor, but 0.42 on the ID factor. IM1 was the first item removed in the previous study due to its ambiguous wording and poor item loading on the ID factor. Though the item was not removed initially as the factor loading on IM was greater than on ID, once IJ5 was removed IM1 more closely aligned with the ID factor. Thus, the item was removed.													
38-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, IM1, EX7**	767.351	490	0.936	0.909	0.029	0.047	0.041; 0.054	-0.07; 0.36	0.37; 0.71	0.49; 0.69	0.14; 0.68	0.52; 0.86	0.51; 0.81
Removed item: EX7; Rationale: Item was removed to reduce number of items representing the EX factor. At this points the EX factor had twice as many items as any other factor with redundancy between various items. This over-representation of the factor is problematic as it has the potential to dominate the overall model and skew the factor loadings for other items in unintended directions. All EX items that were redundant with other items were systematically removed from the model one by one and it was observed that removing EX7 lead to the greatest model fit. EX7 was redundant with other EX items, therefore removing it did not impact the overall representativeness of the factor.													
37-items													
• **Removed EX6, EX3, IJ1, EX8,**	680.629	459	0.945	0.921	0.029	0.044	0.037; 0.050	-0.09; 0.34	0.39; 0.70	0.54; 0.69	0.13; 0.68	0.50; 0.80	0.52; 0.81

IM5, EX4, ID6, IM7, ID7, IJ5, IM1, EX7, EX12													
Removed item: EX12; Rationale: Similar to the rationale for EX7, there were too many items representing the EX factor. After systematic removal of each EX item, it was observed that removing EX12 lead to the best model fit. As EX12 was redundant with other EX items, removing it did not impact the overall representativeness of the factor.													
36-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, IM1, EX7, EX12, IG4**	646.828	429	0.943	0.917	0.029	0.045	0.038; 0.052	-0.02; 0.42	0.39; 0.68	0.49; 0.67	0.12; 0.68	0.50; 0.81	0.53; 0.80
Removed item: IG4; Rationale: On the surface data-level, removing IG4 did not lead to a better fitting model; however, up until this point the IM factor has been struggling. As IG4 was crossloading on the IM factor above 0.32, it was removed in an attempts to improve the IM item loadings. Removing IG4 improved all IM item loadings by between 0.07 – 0.10, and reduced crossloadings onto the IG factor by between 0.02 and 0.08. Though this may not seem like a substantial improvement, it did this for all remaining IM items, suggesting that IG4 was pulling the IM items to the IG factor.													
35-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7 ID7, IJ5, IM1, EX7, EX12, IG4, EX13**	601.004	400	0.946	0.920	0.029	0.045	0.037; 0.052	-0.02; 0.42	0.39; 0.68	0.49; 0.68	0.14; 0.69	0.63; 0.81	0.52; 0.80
Removed item: EX13; Rationale: Same rationale for removing EX7 and EX12													
34-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, IM1, EX7, EX12, IG4, EX13, AM6**	545.823	372	0.952	0.927	0.029	0.043	0.035; 0.051	0.01; 0.42	0.39; 0.68	0.46; 0.67	0.14; 0.70	0.64; 0.82	0.52; 0.83

Removed item: AM6; Rationale: Item was lowest loading AM item and crossloaded onto the EX factor. Though the loadings were not problematic, it was the poorest performing AM item.													
34-items • **Bring back: IM1** • **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, EX7, EX12, IG4, EX13, AM6, IM2**	546.882	372	0.952	0.928	0.029	0.043	0.035; 0.051	0.09; 0.50	0.38; 0.73	0.40; 0.70	0.12; 0.73	0.65; 0.82	0.54; 0.82
Removed item: IM2; Rational: IM2 did not load above 0.32 on any model iteration and, instead, was crossloading above 0.32 on the IG factor. IM2 was therefore removed and IM1 was returned in its place. While IM1 was originally removed for poor performance both in this study and in the previous phase, returning IM1 improved loading scores for the other IM items. Additionally, IM1 was a more representative item to return compared to the other previously removed IM items such as IM5 and IM7, therefore it was returned in favour of the other IM items.													
33-items • **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, EX7, EX12, IG4, EX13, AM6, IM2, ID1**	522.152	345	0.950	0.923	0.028	0.045	0.037; 0.053	0.15; 0.60	0.35; 0.66	0.26; 0.64	0.13; 0.73	0.65; 0.83	0.50; 0.84
Removed item: ID1; Rationale: Item was beginning to crossload onto IM and IJ factor. Concerns were that it was impacting the already problematic IM factor. Upon removing it, two of the IM items which were crossloading on the ID factor above 0.32 were no longer deemed problematic. Further, removing ID1 improved all the IM item loadings scores between 0.06 – 0.10.													
32-items • **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7**	484.054	319	0.951	0.924	0.027	0.045	0.037; 0.053	0.28; 0.58	0.26; 0.89	0.40; 0.58	0.13; 0.75	0.65; 0.82	0.51; 0.82

Removed item: IJ7; Rationale: Item was crossloading onto the IM factor. Other items better represented the idea that IJ7 was attempting to get at (e.g., IJ3)													
31-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG2**	458.364	294	0.949	0.919	0.027	0.047	0.039; 0.055	0.31; 0.60	0.37; 0.88	0.41; 0.59	0.13; 0.74	0.65; 0.83	0.52; 0.84
Removed item: IG2; Rationale: Item did not load onto any factor in particular. Factor loadings in the previous model for this item were: 0.33 on IM factor, 0.26 on IG factor (intended factor), 0.22 on ID factor, and 0.29 on EX factor. Though IG2 was an exemplary item in terms of representing older adults' motives to limit SB from the perspective of SDT, its failure to load specifically on any one factor retaining it could detrimentally influence the model fit indices, thus retaining the item was not in the best interest of the model.													
30-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG2, IG7**	389.709	270	0.961	0.937	0.026	0.042	0.032; 0.051	0.38; 0.68	0.35; 0.84	0.30; 0.49	0.11; 0.78	0.67; 0.82	0.49; 0.84
Removed item: IG7; Rationale: Item crossloaded on the IM factor above 0.32 on several previous model iterations, while also loading stronger on the IM factor than the IG factor.													
29-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG2, IG7, EX5**	349.057	247	0.965	0.942	0.025	0.040	0.030; 0.050	0.38; 0.68	0.33; 0.84	0.32; 0.52	0.13; 0.75	0.67; 0.82	0.47; 0.84

Removed item: EX5; Rationale; EX5 was removed as it was the lowest loading EX item and more EX needed to be removed in order to balance out the model.													
29-items • **Items which were switched: AM6 for AM1** • **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG2, IG7, EX5 AM1**	319.333	247	0.975	0.958	0.024	0.034	0.022; 0.044	0.36; 0.67	0.35; 0.84	0.31; 0.62	0.13; 0.75	0.68; 0.80	0.58; 0.75
Removed item: EX5, AM1; Rationale; AM1 was removed and AM6 was returned in its place as AM1 seemed to dominate the factor, causing all other items to load at ~0.50 while it loaded above 0.83. Returning AM6 to the model balanced the factor loadings- other AM items loaded more evenly and at greater levels than with AM1.													
28-items • **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, IJ5, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG2, IG7, EX5 AM1, EX11**	289.113	225	0.975	0.959	0.024	0.034	0.021; 0.044	0.39; 0.69	0.32; 0.84	0.31; 0.71	0.14; 0.71	0.67; 0.79	0.61; 0.75
Removed item: EX11; Rationale: The EX factor still contained seven items whereas with all other factors contained only 4-5 items. EX11 was removed as it was deemed, following systematic removal of all EX items, that removing it led to the best model fit. Item was also redundant with other EX items, thus removing it did not negatively impact the overall representation of the factor.													
28-items • **Items which were switched: IJ5 for IJ4**	282.367	225	0.978	0.963	0.024	0.032	0.018; 0.043	0.40; 0.72	0.30; 0.81	0.33; 0.56	0.35; 0.77	0.68; 0.81	0.58; 0.74

• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG2, IG7, EX5, AM1, EX11, IJ4**													
Removed item: IJ4; Rationale; IJ4 did not load above 0.32. IJ5, though still crossloading, loaded on intended factor above 0.35. Though the term 'obligated' arises frequently in SDT surveys to represent introjected regulation, it was more important to have an item that included at the ego-enhancement aspect of introjected regulations such as IJ5.													
28-items													
• **Items which were switched: IG2 for IG6**													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG7, EX5 AM1, EX11, IJ4, IG6**	276.139	225	0.981	0.968	0.023	0.030	0.015; 0.041	0.38; 0.69	0.17; 0.83	0.33; 0.57	0.35; 0.76	0.66; 0.81	0.58; 0.74
Removed item: IG6; Rationale: Item loaded more strongly on the IM factor (0.34) than on the IG factor (0.30).													
27-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG7, EX5 AM1, EX11, IJ4, IG6, EX9**	250.202	204	0.982	0.969	0.023	0.032	0.014; 0.042	0.39; 0.70	0.17; 0.83	0.32; 0.57	0.35; 0.76	0.67; 0.81	0.58; 0.73

Removed item: EX9; Rationale: Removal of this item over any other EX item led to a better model fit. Item was redundant with other items (e.g., EX14, EX1, EX2).													
26-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG7, EX5 AM1, EX11, IJ4, IG6, EX9, ID2**	216.023	184	0.987	0.977	0.022	0.26	0.000; 0.040	0.36; 0.69	0.16; 0.82	0.38; 0.54	0.39; 0.82	0.69; 0.80	0.61; 0.72
Removed item: ID2; Rationale: Item crossloaded stronger on IM factor than intended factor, as well, item crossloaded at 0.30 on IJ factor while only loading at 0.32 on intended factor (ID). ID2 was another item that was included because it specifically targeted ideas discussed previously by the older adult demographic (maintaining independence). It was retained in previous iterations due to its previously discussed importance amongst older adults However, the data demonstrated that it was not a good fit for the data with substantial crossloading on multiple factors that could not be overlooked.													
25-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG7, EX5 AM1, EX11, IJ4, IG6, EX9, ID2, EX10**	190.707 (*p = 0.08)*	165	0.989	0.979	0.021	0.025	0.000; 0.039	0.37; 0.70	0.15; 0.82	0.38; 0.54	0.40; 0.82	0.67; 0.81	0.61; 0.73
Removed item: EX10; Rationale: EX factor needed to be refined by one more item. As EX10 was redundant with other EX items, removing it did not impact the representativeness of the factor.													
24-items													
• **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, EX7, EX12, IG4,**	165.615 *(p = 0.14)*	147	0.992	0.984	0.020	0.022	0.000; 0.038	0.38; 0.71	0.14; 0.83	0.38; 0.58	0.39; 0.82	0.67; 0.81	0.59; 0.72

EX13, AM6, IM2, ID1, IJ7, IG7, EX5 AM1, EX11, IJ4, IG6, EX9, ID2, EX10, AM3													
Removed item: AM3; Rationale: An AM item needed to be removed from the model. AM3 was chosen due to its lack of specificity. All other AM item begin with 'I don't try to limit my sitting time because…'; however, AM3 is only 'I don't try'. Though an ambiguous reason – or lack thereof – may be beneficial to allow people to project their own rationale into the item, the item does not add anything, nor give assistance in determining why an individual might not choose to limit daily SB.													
24-items • **Items which were switched: IG6 for IG2** • **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, EX7, EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG7, EX5, AM1, EX11, IJ4, EX9, ID2, EX10, AM3, IG2**	174.803 *(p=0.06)*	147	0.987	0.976	0.020	0.027	0.000; 0.042	0.40; 0.72	0.25; 0.80	0.39; 0.57	0.39; 0.83	0.68; 0.81	0.57; 0.71
Removed item: IG2; Rationale: Similar to the previous removal of IG2 the jargon of 'core-values' adds to the reading complexity and may facilitate potential misunderstandings. What are 'core-values', and how do they relate to participating in SB? The jargon coupled with poor factor loadings (loading on intended factor at 0.14, but on an unintended factor (IM) at 0.47), strengthens the rationale to replace this item with the less jargon heavy IG6. Furthermore, though the wording is different, IG2 and IG6 essentially get at the same concept.													
24-items • **Items which were switched: EX5 for EX15** • **Removed EX6, EX3, IJ1, EX8, IM5, EX4, ID6, IM7, ID7, EX7,**	197.938 *(p= 0.003)*	147	0.976	0.956	0.023	0.037	0.022; 0.050	0.35; 0.69	0.30; 0.78	0.34; 0.56	0.40; 0.91	0.64; 0.87	0.57; 0.58

	EX12, IG4, EX13, AM6, IM2, ID1, IJ7, IG7, AM1, EX11, IJ4, EX9, ID2, EX10, AM3, IG2, EX15
	Removed item: EX15; Rationale: Though EX1, EX2, EX14 and EX15 were unproblematic and represented the strongest factor in term of internal consistency reliability, the items were too similar. All items were just re-wordings of 'I engage in this behaviour as a result of externally applied positive reinforcement (e.g., praise, encouragement, external pressure, suggestions). Though this represents external regulation, it does not encapsulate it. EX15 was therefore replaced with EX5 because it addresses the idea of engaging in a behaviour to prevent receiving a negative reaction (e.g., punishment).

Note: FLrange indicates the loading range for items representing the specific factor.
IM = intrinsic motivation, IG = integrated regulation, ID = Identified regulation, IJ = introjected regulation, EX = external regulation , AM = amotivation

Table 3.5. Results of the Exploratory Structural Equation Modelling and Confirmatory Factor Analysis for the 24-item Final Model

	IM	IG	ID	IJ	EX	AM	CFA
IM1	0.69	0.01	0.11	-0.03	-0.14	0.01	0.71
IM3	0.50	0.31	0.09	-0.05	-0.02	-0.01	0.71
IM4	0.69	0.01	0.15	-0.04	0.07	-0.11	0.72
IM6	0.35	0.29	0.19	0.06	0.01	-0.09	0.73
IG1	-0.01	0.78	0.04	-0.14	0.10	0.01	0.62
IG3	0.05	0.72	-0.02	0.03	-0.05	0.10	0.68
IG5	0.07	0.51	0.07	0.27	-0.06	-0.05	0.76
IG6	0.39	0.30	0.01	0.15	-0.01	0.03	0.69
ID3	0.02	0.18	0.56	0.24	0.05	-0.11	0.79
ID4	0.27	0.16	0.43	0.12	-0.04	0.05	0.75
ID5	0.24	-0.01	0.37	0.15	-0.10	0.01	0.58
ID8	0.34	0.00	0.34	0.15	0.17	-0.09	0.67
IJ2	-0.08	0.10	0.15	0.51	0.14	-0.04	0.71
IJ3	-0.18	0.11	0.03	0.70	-0.02	0.08	0.69
IJ5	-0.04	-0.08	0.60	0.40	-0.02	-0.08	0.65
IJ6	0.06	-0.03	-0.21	0.91	0.03	0.06	0.70
EX1	0.07	0.10	0.01	0.15	0.64	-0.01	0.65
EX2	-0.19	0.03	0.05	-0.02	0.77	-0.01	0.79
EX5	-0.02	0.05	-0.22	0.07	0.68	0.14	0.76
EX14	0.12	-0.13	0.13	-0.08	0.87	0.08	0.85
AM2	0.02	0.07	0.13	0.00	-0.19	0.75	0.53
AM4	0.03	0.01	-0.10	0.03	0.01	0.75	0.75
AM5	-0.16	0.11	0.14	-0.07	0.17	0.57	0.69
AM6	0.07	-0.13	-0.01	0.10	0.22	0.58	0.72

Note. Factor loadings ≥ 0.32 on intended factors are highlighted in green. Factor loadings ≥ 0.32 on unintended factors or items crossloading higher on unintended factors than intended factors are highlighted in red. Items crossloading weaker on unintended factors ≥ 0.32 compared to loading on intended factors are highlighted in yellow. Largest factor loadings for each item are bolded.

Table 3.6. Exploratory Structural Equation Modelling Latent Factor Correlations and Internal Consistencies

Factors	IM	IG	ID	IJ	EX	AM
IM	(0.81)					
IG	0.46**	(0.79)				
ID	0.44**	0.37**	(0.79)			
IJ	0.34**	0.49**	0.43**	(0.78)		
EX	-0.13*	-0.03	0.03	0.25**	(0.85)	
AM	-0.18	0.08	-0.30**	0.06	0.53**	(0.77)

Note. Internal consistencies are on the diagonal. *$p < 0.05$, **$p < 0.01$

Table 3.7. Confirmatory Factor Analysis Latent Factor Correlations and Internal Consistencies

Factors	IM	IG	ID	IJ	EX	AM
IM	(0.81)					
IG	0.76**	(0.79)				
ID	0.86**	0.75**	(0.79)			
IJ	0.44**	0.64**	0.76**	(0.78)		
EX	-0.18*	-0.03	0.02	0.30**	(0.85)	
AM	-0.26**	0.06	-0.20*	0.13	0.67**	(0.77)

Note. Internal consistencies are on the diagonal. *$p < 0.05$, **$p < 0.01$

Table 3.8. Correlations between MMSB-OA with Subjective Wellbeing, Subjective Health, and Daily SB

Variable	Spearman's ρ	*p-value*	Kendall's τ-b	*p-value*
Subjective Wellbeing				
Positive Affect				
IM	0.34	$p < 0.01$	0.25	$p < 0.01$
IG	0.46	$p < 0.01$	0.34	$p < 0.01$
ID	0.52	$p < 0.01$	0.39	$p < 0.01$
IJ	0.25	$p < 0.01$	0.18	$p < 0.01$
EX	-0.05	$p = 0.44$	-0.03	$p = 0.47$
AM	-0.25	$p < 0.01$	-0.18	$p < 0.01$
Negative Affect				
IM	-0.01	$p = 0.86$	-0.01	$p = 0.82$
IG	-0.08	$p = 0.23$	-0.05	$p = 0.27$
ID	-0.19	$p < 0.01$	-0.14	$p < 0.01$
IJ	0.17	$p < 0.01$	0.13	$p < 0.01$
EX	0.33	$p < 0.01$	0.24	$p < 0.01$
AM	0.44	$p < 0.01$	0.32	$p < 0.01$
Life Satisfaction				
IM	0.28	$p < 0.01$	0.20	$p < 0.01$
IG	0.28	$p < 0.01$	0.21	$p < 0.01$
ID	0.27	$p < 0.01$	0.20	$p < 0.01$
IJ	0.03	$p = 0.62$	0.02	$p = 0.59$
EX	-0.12	$p = 0.07$	-0.08	$p = 0.08$
AM	-0.27	$p < 0.01$	-0.19	$p < 0.01$
Subjective Health				
Physical Functioning				
IM	0.21	$p < 0.01$	0.16	$p < 0.01$
IG	0.35	$p < 0.01$	0.25	$p < 0.01$
ID	0.32	$p < 0.01$	0.24	$p < 0.01$
IJ	0.04	$p = 0.54$	0.03	$p = 0.52$
EX	-0.29	$p < 0.01$	-0.20	$p < 0.01$
AM	-0.39	$p < 0.01$	-0.28	$p < 0.01$
Role Limitations due to Physical Health				
IM	-0.03	$p = 0.68$	-0.02	$p = 0.69$
IG	0.08	$p = 0.24$	0.06	$p = 0.23$
ID	0.13	$p = 0.05$	0.09	$p = 0.06$
IJ	-0.15	$p = 0.02$	-0.11	$p = 0.03$
EX	-0.35	$p < 0.01$	-0.27	$p < 0.01$
AM	-0.34	$p < 0.01$	-0.26	$p < 0.01$
Role Limitations due to Emotional Problems				
IM	-0.08	$p = 0.23$	-0.07	$p = 0.23$
IG	0.05	$p = 0.43$	0.04	$p = 0.42$

ID	0.11	$p = 0.10$	0.08	$p = 0.11$
IJ	-0.22	$p < 0.01$	-0.17	$p < 0.01$
EX	-0.35	$p < 0.01$	-0.28	$p < 0.01$
AM	-0.35	$p < 0.01$	-0.28	$p < 0.01$
Vitality				
IM	0.24	$p < 0.01$	0.18	$p < 0.01$
IG	0.27	$p < 0.01$	0.19	$p < 0.01$
ID	0.28	$p < 0.01$	0.21	$p < 0.01$
IJ	0.02	$p = 0.76$	0.01	$p = 0.79$
EX	-0.13	$p = 0.05$	-0.10	$p = 0.04$
AM	-0.28	$p < 0.01$	-0.20	$p < 0.01$
Emotional Wellbeing				
IM	0.10	$p = 0.11$	0.07	$p = 0.11$
IG	0.19	$p < 0.01$	0.13	$p < 0.01$
ID	0.28	$p < 0.01$	0.20	$p < 0.01$
IJ	-0.15	$p = 0.02$	-0.11	$p = 0.01$
EX	-0.33	$p < 0.01$	-0.25	$p < 0.01$
AM	-0.48	$p < 0.01$	-0.35	$p < 0.01$
Social Functioning				
IM	0.10	$p = 0.13$	0.07	$p = 0.13$
IG	0.15	$p = 0.02$	0.11	$p = 0.03$
ID	0.23	$p < 0.01$	0.18	$p < 0.01$
IJ	-0.15	$p = 0.02$	-0.12	$p = 0.02$
EX	-0.34	$p < 0.01$	-0.26	$p < 0.01$
AM	-0.46	$p < 0.01$	-0.35	$p < 0.01$
Bodily Pain				
IM	0.04	$p = 0.50$	0.03	$p = 0.51$
IG	0.13	$p = 0.04$	0.10	$p = 0.03$
ID	0.12	$p = 0.05$	0.09	$p = 0.05$
IJ	-0.12	$p = 0.06$	-0.09	$p = 0.06$
EX	-0.20	$p < 0.01$	-0.15	$p < 0.01$
AM	-0.21	$p < 0.01$	-0.15	$p < 0.01$
General Health Perceptions				
IM	0.21	$p < 0.01$	0.15	$p < 0.01$
IG	0.14	$p = 0.03$	0.10	$p = 0.03$
ID	0.26	$p < 0.01$	0.19	$p < 0.01$
IJ	-0.11	$p = 0.10$	-0.08	$p = 0.10$
EX	-0.26	$p < 0.01$	-0.18	$p < 0.01$
AM	-0.38	$p < 0.01$	-0.28	$p < 0.01$
Daily Sedentary Behaviour				
IM	-0.13	$p = 0.05$	-0.09	$p = 0.05$
IG	-0.13	$p = 0.05$	-0.10	$p = 0.03$
ID	0.06	$p = 0.43$	0.04	$p = 0.43$
IJ	-0.03	$p = 0.60$	-0.03	$p = 0.59$
EX	-0.13	$p = 0.06$	-0.09	$p = 0.06$
AM	-0.08	$p = 0.21$	-0.06	$p = 0.19$

Table 3.9. One-week Test-Retest Reliability for the MMSB-OA

Item	Mean (*SD)*	Time 1 (*SD*)	Time 2 (*SD)*	Diff. Time 2-Time 1	*p-value* (2-tailed)	Pearson's *r*[a]	*p-value*	ICC (95% CIs)[a]
IM1	3.94 (1.09)	3.88 (1.14)	4.00 (1.06)	0.13 (0.97)	0.42	0.62	<0.01	0.62 (0.38; 0.78)
IM3	3.63 (1.08)	3.63 (1.19)	3.63 (0.98)	0.00 (1.01)	1.00	0.58	<0.01	0.58 (0.33; 0.75)
IM4	3.60 (1.14)	3.55 (1.26)	3.65 (1.03)	0.10 (1.03)	0.54	0.61	<0.01	0.60 (0.36; 0.77)
IM6	3.49 (1.07)	3.50 (1.15)	3.48 (0.99)	-0.03 (0.80)	0.84	0.73	<0.01	0.73 (0.54; 0.85)
IG1	3.14 (1.23)	3.03 (1.29)	3.25 (1.17)	0.23 (0.92)	0.13	0.73	<0.01	0.71 (0.52; 0.84)
IG3	2.90 (1.25)	2.85 (1.35)	2.95 (1.15)	0.10 (1.22)	0.61	0.54	<0.01	0.54 (0.28; 0.73)
IG5	3.01 (1.23)	2.95 (1.34)	3.08 (1.12)	0.13 (1.09)	0.47	0.62	<0.01	0.61 (0.38; 0.77)
IG6	3.28 (1.14)	3.25 (1.19)	3.30 (1.09)	0.05 (1.11)	0.78	0.53	<0.01	0.54 (0.28; 0.73)
ID3	3.18 (1.24)	3.10 (1.26)	3.25 (1.24)	0.15 (1.030	0.36	0.66	<0.01	0.66 (0.45; 0.81)
ID4	3.50 (1.16)	3.43 (1.20)	3.58 (1.13)	0.15 (1.29)	0.47	0.38	~0.01	0.39 (0.09; 0.62)
ID5	3.14 (1.17)	3.13 (1.16)	3.15 (1.19)	0.03 (1.27)	0.90	0.41	<0.01	0.42 (0.14; 0.65)
ID8	3.83 (1.18)	3.83 (1.13)	3.83 (1.24)	0.00 (1.11)	1.00	0.56	<0.01	0.57 (0.32; 0.75)
IJ2	2.59 (1.10)	2.53 (1.15)	2.65 (1.05)	0.13 (0.99)	0.43	0.60	<0.01	0.60 (0.36; 0.77)
IJ3	2.75 (1.13)	2.85 (1.17)	2.65 (1.10)	-0.20 (1.09)	0.25	0.54	<0.01	0.53 (0.27; 0.72)
IJ5	3.44 (1.09)	3.38 (1.15)	3.50 (1.04)	0.13 (1.11)	0.48	0.48	<0.01	0.49 (0.21; 0.69)
IJ6	2.59 (1.15)	2.53 (1.18)	2.65 (1.14)	0.13 (1.02)	0.44	0.62	<0.01	0.62 (0.39; 0.78)
EX1	2.09 (1.14)	2.13 (1.26)	2.05 (1.01)	-0.08 (0.94)	0.62	0.68	<0.01	0.67 (0.45; 0.85)
EX2	1.78 (1.01)	1.83 (1.06)	1.73 (0.96)	-0.10 (0.78)	0.42	0.71	<0.01	0.71 (0.51; 0.83)
EX5	1.64 (1.08)	1.65 (1.10)	1.63 (1.08)	-0.03 (0.92)	0.86	0.64	<0.01	0.65 (0.43; 0.80)

EX14	1.94 (1.17)	1.93 (1.25)	1.95 (1.11)	0.03 (0.80)	0.84	0.78	<0.01	0.78 (0.62; 0.87)
AM2	2.55 (1.32)	2.53 (1.30)	2.58 (1.36)	0.05 (1.15)	0.79	0.62	<0.01	0.63 (0.40; 0.79)
AM4	2.20 (1.16)	2.30 (1.14)	2.10 (1.19)	-0.20 (0.94)	0.19	0.68	<0.01	0.67 (0.46; 0.81)
AM5	2.13 (1.19)	2.05 (1.11)	2.20 (1.29)	0.15 (1.46)	0.52	0.26	0.10	0.27 (-0.04; 0.53)
AM6	1.86 (1.05)	1.88 (0.97)	1.85 (1.14)	-0.03 (0.89)	0.86	0.66	<0.01	0.65 (0.43; 0.80)
IM	3.64 (0.90)	3.64 (0.97)	3.64 (0.84)	0.01 (0.56)	0.94	0.82	<0.01	0.81 (0.68; 0.90)
IG	3.04 (0.98)	2.99 (1.04)	3.08 (0.92)	0.09 (0.73)	0.45	0.73	<0.01	0.73 (0.54; 0.85)
ID	3.41 (0.96)	3.34 (0.97)	3.48 (0.95)	0.14 (0.89)	0.33	0.57	<0.01	0.57 (0.32; 0.75)
IJ	2.91 (0.86)	2.91 (0.89)	2.90 (0.84)	-0.01 (0.69)	0.91	0.68	<0.01	0.69 (0.49; 0.82)
EX	1.89 (0.92)	1.93 (0.98)	1.86 (0.87)	-0.06 (0.48)	0.41	0.87	<0.01	0.87 (0.77; 0.93)
AM	2.15 (0.91)	2.11 (0.86)	2.18 (0.97)	0.07 (0.76)	0.57	0.66	<0.01	0.66 (0.45; 0.81)

Note: Possible subscale scores: 1-5

[a] Alpha value set to 0.05

Table 3.10. Final Item list for the MMSB-OA

SDT Category	Item Label	Item Description
Intrinsic Motivation	IM1	So that I can do the activities I love.
	IM3	Because I enjoy trying activities that get me moving.
	IM4	In order to do activities that I am interested in.
	IM6	Because I get pleasure from moving.
Integrated Regulation	IG1	Because I am not the type of person that sits a lot.
	IG3	Because I have never been one to sit much.
	IG5	Because that's who I've been all my life.
	IG6	Because it's consistent with who I am as a person.
Identified Regulation	ID3	Because it's personally important to me.
	ID4	So that I can feel my best.
	ID5	To increase the number of quality years I have left.
	ID8	For health reasons.
Introjected Regulation	IJ2	Because I would feel bad about myself if I didn't.
	IJ3	Because I feel guilty if I sit on my butt for too long.
	IJ5	Because I feel better about myself when I do.
	IJ6	Because I get upset with myself if I sit too much.
External Regulation	EX1	Because people whose opinions I value tell me to.
	EX2	Because important people in my life pressure me to.
	EX5	Because others will be upset with me if I don't.
	EX14	Because others encourage me to.
Amotivation	AM2	I don't limit my sitting time because I don't want to.
	AM4	I don't limit my sitting time because I don't care how much I sit.
	AM5	I don't limit my sitting time because I don't see how sitting less could benefit me.
	AM6	I don't limit my sitting time because it is not worth the effort.

Chapter 4: General Discussion

4.1 Introduction and Brief Summary

Current trends predict that by 2050, 30% of the population in many North American, European, and Asian countries will be 65 years or older (World Health Organization, 2015), with the proportion of people worldwide older than 65 expected to be 15.9% – up from 9.3% in 2020 (World Health Organization, 2021). With this knowledge, it is imperative to address any and every potential threat to the successful aging process. One such threat is prolonged SB. The evidence suggests that older adults represent the most sedentary age demographic worldwide (Harvey et al., 2015), which is problematic given that excessive accumulation of sedentary time is correlated with numerous detrimental health consequences including cardiovascular disease, diabetes, cancer, reduced mobility, functional limitations, and all-cause mortality (Copeland, 2017; Saunders et al., 2020) amongst adult and older adult populations. Interventions have been conducted in the past to try and mitigate older adults' sedentary behaviour (e.g., Aunger et al., 2018; Aunger at al., 2020; Crombie et al., 2021; Fitzsimons et al., 2013; Gardner et al., 2011; Rosenberg et al., 2015; Voss et al., 2020b); however, no intervention has been successful in accomplishing meaningful long-term reductions in sedentary time. One explanation for this is the lack of emphasis on the psychological elements, such as motives, that may contribute to overall SB and SB reduction. Past interventions have focused predominately on elements of goal setting and providing information (Aunger et al., 2018). While these two components are proven to assist with behaviour change in the physical activity and SB contexts (Aunger et al., 2018; McEwan et al., 2016), this intervention approach has proven to be insufficient. Thus, incorporating motives as an intervention component may be beneficial as it could isolate modifiable mechanisms implicated with the behaviour, allowing for the development of specific

and tailored strategies to encourage long-term behaviour change (e.g., Teixeira et al., 2020). To do this, an instrument must be developed rooted in a theoretical framework that can evaluate older adults' motives to limit SB. This is because use of previous instruments of such nature have been demonstrated to assist the development of successful interventions for altering daily SB amongst other demographics (e.g., MLSQ, Lubans et al., 2016).

The purpose of the present study was to evaluate the psychometric properties of an item pool developed to assess older adults' motives from the theoretical perspective of SDT as well as refine the number of items to a comprehensive and representative list for each of the six regulatory styles outlined by the theory (intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation; Deci & Ryan, 1985). This program of research included two studies with several overlapping and distinct purposes and hypotheses. The overall purpose of the first study was to ascertain the factorial validity, inter-factor correlations, and internal consistency reliability of the MMSB-OA. An additional purpose was to further refine the number of items. The purpose of the second study was to examine factorial validity, inter-factor correlations, and internal consistency reliability of a revised MMSB-OA and evaluate the criterion validity and test-retest reliability of the revised MMSB-OA. Similarly, the secondary purpose was to refine item pool size to four representative items per factor. The following discussion will be broken down based on the different psychometric properties analyzed and how it relates to previous literature.

4.2 Factorial Validity

As discussed in the introductory chapter, two elements comprise factorial validity: factor loading scores and model fit indices. For factor loadings, the general rule of thumb is that loadings above 0.71 are considered "excellent", above 0.63 "very good", above 0.55 "good", and

above 0.45 “fair” (Tabachnick & Fidell, 2013); however, it is acknowledged that factor loadings should be above 0.32 to be retained in the overall model interpretation. Additionally, it is recommended to mitigate any cross-loadings and ensure that items only load on intended factor above 0.32, and not load onto any other factor at or above that level (Tabachnick & Fidell, 2013). In the present thesis, particularly in the second study, several items were retained in the model that violated these accepted rules of thumb. These items were IG6, ID8, and IJ5. IG6 loaded more strongly on an unintended factor (intrinsic motivation = 0.39) than it did on the intended factor (integrated regulation = 0.30), ID8 loaded equally strong on its intended factor (identified regulation = 0.34) as it did on an unintended factor (intrinsic motivation = 0.34), and IJ5 loaded both on an unintended factor and intended factor above 0.32, but loaded more strongly on the unintended factor (identified regulation = 0.60) than the intended factor (introjected regulation = 0.40). Although the data is important to consider when engaging in the item removal process, it is also important to consider the way the items relate to the theory. Removal of IG6 did not lead to a better fitting model, nor did replacing it with a previously removed integrated item. Furthermore, IG6 better represented integrated regulation for the older adult demographic than previously removed items (e.g., IG4) as it focused more on motives to limit SB as opposed to motives to increase MVPA. Speaking to ID8, though simplistic, ID8 was retained as ‘health reasons’ could mean a variety of different things not encapsulated by the other identified items. Removing it would eliminate the only item which could catch the people who endorse identified motives, but not identify with the specificity of the other identified items. Lastly, the retention of IJ5 was a simple decision. Introjected regulation is the process of engaging in a particular behaviour as a result of internal pressure (Deci & Ryan 2000). This internal pressure could either be negative (e.g., feelings of guilt/obligation) or positive (ego-

enhancement; Deci & Ryan 2000). All other introjected items were focused on more negative internal pressures (e.g., guilt, upset), whereas IJ5 focused more on the positive internal pressures (ego-enhancement). Thus, to ensure the regulatory style was accurately represented by the items included, IJ5 was retained despite the poor factor loadings.

Though many problematic items from a data-driven perspective were retained, several problematic items from a data-driven perspective were removed despite strong theoretical support for item retention. With item removal there must be a balance between data-driven reasons and theory-based reasons. However, when one is overwhelming it overshadows any other reason. This was the case for ID2: 'because I want to maintain my independence'. Independence was emphasized across the board in the focus groups conducted for the first phase of the study (Collins & Pope, 2021), and although this perfectly represents identified regulation as it encapsulates the idea of engaging in a particular behaviour for personally valued outcomes, from a data-driven perspective, several problems arose with the item. When looking at the data, particularly the model prior to the item's removal, ID2 loaded on intrinsic motivation (0.34), identified regulation (0.32) and introjected regulation (0.30). Even going back further with model iterations, ID2 loaded more strongly on intrinsic motivation than identified regulation, with introjected regulation within 0.02 – 0.03 points of identified regulation. IJ4 'because I feel obligated to' was also in a similar position as the word 'obligated' is linked to introjected regulation and appears in many other instruments rooted in SDT (e.g., BRSQ; Lonsdale et al., 2008**)**. However, within the data collected for the present study, IJ4 loaded more strongly on the external regulation factor (0.57) and did not load on the introjected regulation factor (0.14). It is unclear why this occurred, though one could speculate that the term 'obligation' may have been interpreted as an external pressure and therefore caused the item to load more in line with items

emphasizing pressure from others (e.g., EX2 ‘Because important people in my life pressure me to’, EX9 ‘ Because people in my life want me too’, and EX10 ‘Other people close to me insist that I do’) as opposed to the introjected items which clearly emphasized internal pressure (e.g., IJ2 ‘I would feel bad about myself if I didn’t’, IJ3 ‘I feel guilty if I sit on my butt for too long’, and IJ6 ‘I get upset with myself if I sit too much’).

As mentioned in the previous chapter, with the final model iteration from study 2, per the ESEM, few items loaded at an excellent level on the intended factor. In comparison, the factor loadings in the CFA does improve upon that point with 14/24 items achieving excellent factor loadings, and the following loadings observed: intrinsic motivation = 0.71 - 0.73, integrated regulation = 0.62 – 0.76, identified regulation = 0.58 – 0.79, introjected regulation = 0.65 – 0.71, external regulation = 0.65 – 0.85, and amotivation = 0.53 – 0.75. A worthwhile consideration is to reflect on the factor loadings from previous six-factor motivation instruments rooted in SDT. For the REBS – an SDT-based instrument designed to examine how an individual’s eating behaviour are regulated – the following factor loadings were observed in a CFA for the final model iteration: (1) intrinsic motivation = 0.59 – 0.74; (2) integrated regulation = 0.64 – 0.84; (3) identified regulation = 0.45 – 0.62; (4) introjected regulation = 0.66 – 0.73; (5) external regulation = 0.59 – 0.80, and; (6) amotivation = 0.60 – 0.73 (Pelletier et al., 2004). Looking at the SMS-II – an instrument designed to examine motives for sport participation – the following factor loadings were observed in a CFA for the final model iteration across two studies: (1) intrinsic motivation, study 1 = 0.80 – 0.86, study 2 = 0.77 – 0.85; (2) integrated regulation, study 1 = 0.73 – 0.78, study 2 = 0.68 – 0.79; (3) identified regulation, study 1 = 0.78 – 0.91, study 2 = 0.63 – 0.90; (4) introjected regulation, study 1 = 0.59 – 0.68, study 2 = 0.47 – 0.71; (5) external regulation, study 1 = 0.57 – 0.94, study 2 = 0.59 – 0.76, and; (6) amotivation, study 1 = 0.74 –

0.76, study 2 = 0.77 – 0.95 (Pelletier et al., 2013). Lastly, the BRSQ – another instrument which serves to evaluate motives to engage in sports – observed across two studies the following factor loadings: (1) intrinsic motivation, study 1 = 0.81 – 0.94, study 2 = 0.63 – 0.85; (2) integrated regulation, study 1 = 0.63 – 0.79, study 2 = 0.59 – 0.77; (3) identified regulation, study 1 = 0.67 – 0.79, study 2 = 0.53 – 0.82; (4) introjected regulation, study 1 = 0.72 – 0.90, study 2 = 0.78 – 0.88; (5) external regulation, study 1 = 0.86 – 0.89, study 2 = 0.82 -0.85, and; (6) amotivation, study 1 = 0.78 – 0.88, study 2 = 0.76 – 0.90 (Lonsdale et al., 2008). Taken together and relating it to the data collected from study 2, the factor loadings observed for the MMSB-OA are comparable to previous instruments of a similar design despite many of the items not achieving an 'excellent' rating. While some of the upper limits reached by certain items from certain scales exceeded that of the MMSB-OA, many of the lower limits were substantially below that observed from the MMSB-OA. Unfortunately, a large proportion of the SDT instruments available in the literature utilize superordinate factors that group intrinsic motivation, integrated regulation and identified regulation into one, introjected regulation and external motivation into another, and leave amotivation as its own category (e.g., MLSQ; Lubans et al, 2013). Therefore, although there are many other SDT instruments that would be more relevant to compare the factor loadings of the MMSB-OA (e.g., the MLSQ; Lubans et al., 2013; BREQ-2: Marland & Tobin 2004), the structure of those instruments does not serve as adequate comparison points. Another limitation of this comparison is the varying item pool size. Both the BRSQ and the REBS contain four items per factor, whereas the SMS-II only has three items per factor (Lonsdale et al., 2008; Pelletier et al., 2004; Pelletier et al., 2013). Less items may have an impact on the overall factor structure and the extent to which items load (Devilles, 2017). Given

that six-factor instruments rooted in SDT are uncommon, the SMS-II acts as a necessary comparison point.

The other aspect of factorial validity is model fit indices. In comparison to the generally accepted rules of thumb (e.g., Hu & Bentler 1999), the obtained model fit statistics for the final 24-item model from the ESEM conducted in study 2 were satisfactory. Comparing the obtained CFA model fit statistics for the final model to the general thresholds results in a less than ideal final model fit. Similarly, when comparing the CFA model fit statistics to those observed in previous surveys, it becomes apparent that the MMSB-OA is not as strong as some of the previously established instruments in other contexts. Once again starting with the REBS, the final model test statistics were $\chi^2_{(234)} = 531.97$, $p < 0.001$; CFI = 0.92; and RMSEA = 0.06 (Pelletier et al., 2004). For the BRSQ, the model test statistics were: $\chi^2_{(237)} = 385.44$, $p < 0.01$; CFI = 0.99; TLI = 0.99; and RMSEA = 0.04 (90% confidence interval [CI] = 0.03, 0.05) for one study and $\chi^2_{(237)} = 601.44$, $p < 0.01$; CFI = 0.97; TLI = 0.97; and RMSEA = 0.07 (90% confidence interval [CI] = 0.06, 0.08; Lonsdale et al., 2008). As a reminder the CFA from the MMSB-OA result in the following test statistics: $\chi^2_{(237)} = 491.127$, $p < 0.001$; CFI = 0.882; TLI = 0.863; SRMR = 0.078; and RMSEA = 0.065 (90% confidence interval [CI] = 0.057, 0.073). Contrasting the MMSB-OA to the REBS, the MMSB-OA resulted in a better chi-square test-statistic, however the REBS had a stronger CFI value and RMSEA value. When compared to the BRSQ, the MMSB-OA pales in comparison, with a substantially higher chi-square value and RMSEA value and a substantially lower CFI and TLI value. It would be interesting to see and compare the model test-statics obtained through ESEM for the BRSQ and REBS to the MMSB-OA because when dealing with an instrument rooted in SDT, ESEM offers advantages that CFA does not (e.g., less constrained model). However, since no such data exists, only CFA data can

be compared. There are several reasons that may have caused the MMSB-OA to not achieve the same model fit as the BRSQ and the REBS. The first and most obvious reason is that the sample size of the MMSB-OA was less than ideal (Tabachnick & Fidell, 2013). Several model fit indices are sensitive to sample size (e.g., chi-square, TLI, SRMR), thus having a sample less than 300 participants can result in misidentified model fit statistics (Kline, 2015; Schermelleh-Engel et al., 2003). Another explanation is number of trials. For the BRSQ development, three trials were conducted to evaluate the psychometric properties of the instrument including the factorial validity (Lonsdale et al., 2008). More trials allow for more alterations to be made to ensure an optimal model fit. A third explanation is the behaviour being investigated. Sedentary behaviour is an under-explored area of interest in the context of SDT, with limited studies focussing on the older adult population (Collins & Pope, 2021). Eating behaviours and sport participation comparatively have received extensive focus in the SDT literature (Ryan & Deci 2017). Consequently, the REBS and BRSQ had more to draw from in the development phase than the MMSB-OA. An additional consideration is both the REBS and BRSQ measure motives for participating in a particular behaviour (i.e., approach behaviour) whereas the MMSB-OA measures motives for avoiding a particular behaviour (i.e., avoidance behaviour). Though it is unclear how this difference may impact the model structures and the subsequent comparisons, it is important to highlight that the type of behaviour being measured in the MMSB-OA is diametrically opposed to that being measured with the REBS and BRSQ.

The SMS-II was not included in the main comparison for a number of reasons including the smaller item pool and small sample size (N = 206; Pelletier et al., 2013). Briefly, less items reduces the degrees of freedom which in turn can artificially deflate the chi-square value and inflate the TLI value (Kline, 2015; Schermelleh-Engel et al., 2003). Essentially, the structure of

the instrument artificially biases it towards better model fit indices. With that mentioned, the model fit indices obtained for the SMS-II from a CFA was: $\chi^2_{(120)} = 231.88$, $p < 0.001$; CFI = 0.94; TLI = 0.92; and RMSEA = 0.05 (90% confidence interval [CI] = 0.04, 0.06). Although the sample size for the MMSB-OA was also below 300, comparing the two instruments is unfair because the relative contributions the item pool size on model fit indices cannot be determined. As evident by the SMS-II data, the degrees of freedom are substantially less than for the MMSB-OA, artificially deflating the chi-square value and inflating the TLI value. Therefore, while the data for the SMS-II looks relatively attractive especially in comparison to the MMSB-OA, these types of comparisons are unproductive if the item pools are also different in size despite similarly low sample sizes. Reflecting back to the model test statistics from the REBS and BRSQ, it would be interesting to compare the data once an additional sample is collected for the MMSB-OA to see if modifications arise.

4.3 Internal Consistency Reliability

For both study 1 and study 2, the internal consistency reliability scores were satisfactory. In study, 1 the range for the scores was 0.64 – 0.91, with five out of the six factors exceeding 0.83, and in study 2 the range for the scores was 0.77 – 0.85. Unsurprisingly, the data from study 2 was in line with what has been observed with previously developed instruments. For the: (1) REBS, internal consistency reliability scores ranged from 0.77 – 0.90 (Pelletier et al., 2004); (2) SMS-II, scores ranged from 0.70 – 0.88 (Pelletier et al., 2013), and (3) BRSQ, scores ranged from 0.82 – 0.93 in one study and 0.76 – 0.91 in another study (Lonsdale et al., 2008). Even the data from study 1 for the MMSB-OA aligns with previously obtained data if one overlooks the abnormally low score for the external regulation factor. This is promising as the general rule of thumb is to consider internal consistency scores 0.65 - 0.80 as adequate and scores between 0.8 -

0.95 good to excellent (Tavakol & Dennick, 2011; Vaske et al., 2017). While this means many of the internal consistency scores obtained for the MMSB-OA can only be considered adequate, the fact that the MMSB-OA data is in line with previously established instruments strengthens the quality of the MMSB-OA as an instrument rooted in SDT to evaluate older adults' SB.

4.4 Inter-factor Correlations

One of the main points that has been stressed throughout this thesis is ensuring a simplex structure is observed in the inter-factor correlation. To refresh, a simplex structure or pattern refers to an observable correlation amongst motivation types presenting closely together along the motivational continuum per SDT (Ryan & Connell, 1989). The closer the motivations are, the more highly correlated they should be, whereas the further away the motivations are on the continuum the lower the correlations or more negative the correlations should be (Ryan & Connell, 1989). This occurs because motivation is suggested to exists along a continuum with a single unifying dimension that varies in the degree of strength. It should be stressed that the existence of a single unifying dimension does not preclude the existence of different categories that serve as distinct observable entities, instead it is to highlight that in spite of these distinct observable entities there still exist some level of correlation between categories. If no correlations are observed between categories, then motivation does not have a singly unifying dimension, but if perfect to near-perfect correlations are observed between categories regardless of relative distance on the motivation continuum then the categories are unnecessary. Therefore, observing a simplex structure is critical to the SDT as it demonstrates that motivation exists along a continuum with a single unifying factor, but there are also six distinct observable categories that may have different antecedents and outcomes as per the theory. All motivation-

based instruments rooted in SDT should therefore demonstrate a simplex structure, otherwise what is being measured may not necessarily be in agreement with the SDT.

In both study 1 and study 2, a simplex structure was observed in the data. When looking at other six-factor instruments, a simplex structure has been consistently observed (e.g., BRSQ, REBS, SMS-II). As detailing the findings from those studies would be tedious and space-consuming, the simplex structure of the six factor instruments will not be presented here; however, to highlight the trends in all the studies, generally the more self-determined factors – intrinsic motivation, integrated regulation, identified regulation – are positively correlated with one another but negatively correlated with the less self-determined factors – introjected regulation, external regulation, amotivation – with the strength of those correlations depending on the distance between the factors (and vice versa for the less-self determined factors) (Lonsdale et al., 2008; Pelletier et al., 2004; Pelletier et al., 2013). For example, there is typically a strong negative correlation between intrinsic motivation and amotivation, however the correlation is weaker when looking at identified regulation and amotivation. Though at times, integrated and identified regulation are found to be positively correlated with introjected and external regulation due to the proximity on the continuum, the strength of these correlations – especially between integrated and introjected/external regulation – can be weak to non-significant (e.g., Pelletier et al., 2004; Pelletier et al., 2013).

4.5 Criterion Validity

Establishing the criterion validity – particularly concurrent validity – was a critical and unique contribution of study 2. While it is important that an instrument demonstrates strong factorial validity and internal constancy as these psychometric properties give an indication of whether the hypothesized model for the data fits with the observed data, these psychometric

properties only scratch the surface of determining whether the instrument truly measures the latent variable that it is hypothesized to. To ascertain the effectiveness of an instrument at measuring a latent variable that is otherwise unobservable, criterion validity must be investigated (DeVellis, 2017; DeVon, 2007; Drost et al., 2011). Though the definition has been mentioned elsewhere, briefly, all latent variables are correlated in some fashion to other variables. As many latent variables are unobservable, the only way to ensure an instrument is effectively operating as intended is to have individuals complete the instrument under development with other previous established instruments that have been proven to estimate a correlated variable (i.e., a nomonological network; Cronbach & Meehl, 1955). If the expected correlations are achieved, then it can be suggested that the instrument is measuring desired latent variable; however, if the expected correlations are not achieved then, regardless of the findings surrounding factorial validity and internal consistency reliability, further studies must be conducted to better refine the instrument (DeVellis, 2017; DeVon, 2007; Drost et al., 2011). For the MMSB-OA, three overarching variables were evaluated based on previous literature: subjective wellbeing, subjective health, and daily SB. The findings for both subjective wellbeing and subjective health were as anticipated; however, the same cannot be said with daily SB.

4.5.1 Subjective wellbeing

Subjective wellbeing for this thesis was broken down into three categories: positive affect, negative affect, and satisfaction with life. Positive and negative affect were measured using the PANAS (Watson et al., 1988), whereas satisfaction with life was measured using the SWLS (Pavot & Diener, 2008). These two instruments have previously demonstrated strong psychometric properties and are generally used most frequently when investigating affect and life satisfaction (e.g., Crawford & Henry, 2004; Merz et al., 2013; Pavot & Diener, 2008; Von

Humboldt et al., 2017; Watson et al., 1988). One limitation, however, is that the extent of these instrument's use with older adults and/or within the context of SDT is fairly limited, making assumptions about the performance and correlation of these instruments with the MMSB-OA challenging given the lack of previously established literature. Nevertheless, it was hypothesized that more self-determined motives – representing intrinsic motivation, integrated regulation, and identified regulation – would be positively correlated with positive affect and life satisfaction and negatively correlated with negative affect. On the flip side, it was hypothesized that less self-determined motives – representing external regulation and amotivation – would be negatively correlated with positive affect and life satisfaction, and positively correlated with negative affect. It was unknown how introjected regulation would interact as previous literature is unclear. The findings aligned closely with these hypothesized results, save for a few instances.

Speaking to the more self-determine motives, all were positively correlated with positive affect and life satisfaction, but only those representing identified regulation were negatively correlated with negative affect. Unfortunately, in studies with older adults' looking at the correlations between motivation and positive and negative affect, superordinate categories of motivation (autonomous, controlled, and amotivation) have been used (Tang et al., 2020). Therefore, direct comparisons cannot be used. However, with that in mind, the findings from studies with older adults suggest that autonomous motivation is correlated with positive affect ($r = 0.24$, $p < 0.05$) and negatively correlated with negative affect ($r = -0.29$, $p < 0.05$; Tang et al., 2020). Thus, although the findings for the MMSB-OA were consistent with past research when considering the relationship between autonomous motives and positive affect, only motives representing identified regulation were consistent with past research in terms of the relationship for negative affect. Looking toward life satisfaction, despite not having any previous data for

motives representing integrated regulation, the meta-analytic results correlating motivation and life satisfaction in later life reported intrinsic motivation was positively correlated with life satisfaction (number of studies (k) = 3, n = 223, r = 0.29, $p < 0.001$) as well as identified regulation (k = 3, n = 223, r = 0.19, $p < 0.01$; Tang et al., 2020). The results obtained for the correlation between intrinsic motivation and life satisfaction from the present study were similar to that of the meta-analysis (r = 0.28, $p < 0.01$), yet stronger for identified regulation (r = 0.27, $p < 0.01$). One reasoning for the observed difference may be that the studies included in the meta-analysis utilized the Elderly Motivation Scale which does not specify a factor for identified regulation, and instead has a factor called "self-determined extrinsic motivation" that the authors of the meta-analysis reclassified as identified regulation (Tang et al., 2020; Vallerand & O'Connor, 1991). Regardless, the correlations between subjective wellbeing and the more self-determined motives were as anticipated.

The same conclusion cannot be drawn for the less self-determined motives representing external regulation and amotivation. Briefly, motives representing external regulation were positively correlated with negative affect and motives representing amotivation were found to be negatively correlated with positive affect and life satisfaction, but positively correlated with negative affect. The lack of correlations between external regulation and subjective wellbeing was unsurprising as no evidence could be found in the literature to indicate the existence of significant correlations between these variables amongst older adults' (Tang et al., 2020); however, this could be a result of a lack of empirical focus as in the present study a significant positive correlation was observed between negative affect and motives representing external regulation (r = 0.33, $p < 0.01$) that previously had not be reported in the literature for older adults in generalized contexts. It should be noted that in some studies, significant correlations have

been observed between external regulation and life satisfaction with older adults (e.g., r = -0.28, p < 0.05; Vallerand et al., 1995), however these results have not been consistently replicated for older adults (Tang et al, 2020). As for amotivation, the finding for life satisfaction were inconsistent in strength but consistent in direction with what has previously been observed as in the meta-analysis by Tang and colleagues (2020; r = -0.11, p = 0.30) compared to the significant negative correlation reported in the present thesis (r = -0.27, p < 0.01). Though the study by Vallerand and colleagues (1995) should again be highlighted for observing a significant negative correlation between amotivation and life satisfaction (r = -0.24, p < 0.05). Once again due to the lack of empirical evidence, a comparison to previous studies could not be made in examining positive and negative affect correlations with motives representing amotivation for older adults. However, examination of the literature outside the older adult context demonstrated that the associations with subjective wellbeing were as anticipated (see chapter 1.3.2.1 for a breakdown of those study findings).

Based on previous literature, it was unclear how motives representing introjected regulation would correlate with indices of subjective wellbeing. Past literature with older adults has not specifically measured introjected regulation outside of controlled motivation (Tang et al., 2020), however, it is well known that introjected regulation does not always act in a similar fashion as external regulation and amotivation (e.g., Teixeira et al., 2012). Therefore, with no previous literature centered on older adults, and the acknowledgement that introjected regulation can align with either more self-determined motives or less self-determined motives, anticipated correlations were not proposed. Interestingly, introjected motives were positively correlated with positive affect (r = 0.25, p < 0.01) and negative affect (r = 0.17, p < 0.01), which is not something that one would expect given that the intercorrelation identified in the initial validation

study between the positive affect and negative affect factor for the PANAS was -0.17 (Watson et al., 1988). In other words, it was interesting that motives representing introjected regulation were positively correlated with two factors that, based on the conceptual definitions, should be negatively correlated with one another. Motives representing introjected regulation were also found to be unrelated to life satisfaction. While there is no precedence for motives representing introjected regulation to be correlated with life satisfaction amongst older adults, observing an almost zero correlation despite evidence identifying life satisfaction as measured with the SWLS being positively correlated with positive affect (correlation coefficient = 0.36 – 0.55) and negatively correlated with negative affect (correlation coefficient = -0.40 – -0.57: Pavot & Diener, 2008) is interesting. Although one may speculate that it may be that because motives representing introjected regulation were positively correlated with positive and negative affect that no significant correlations were observed. Specifically, because motives representing introjected regulation were positively associated with both positive and negative affect, any correlations for life satisfaction at the individual level were cancelled out when looking at the aggregate level. While this is merely speculative that the correlations between introjected regulation and life satisfaction are highly individualized, it may be one explanation for the observed data rather than assuming that introjected regulation has no relation to life satisfaction.

4.5.2 Subjective health

For subjective health, eight variables of interest were measured using the MOS SF-36. These variables were: 1) physical functioning, (2) [absence of] role limitation due to physical health, (3) [absence of] bodily pain, (4) general mental health, (5) [absence of] role limitation due to emotional problems, (6) social functioning, (7) vitality, and (8) general health perceptions (Ware & Sherbourne, 1992). Investigations into the relationship between subjective health and

motivation per SDT are limited amongst older adults, however, the data that is available suggests significant difference between those endorsing more self-determined motives and those endorsing less self-determined motives in areas such as [absence of] role limitations due to physical health ($p = 0.01$, $\eta_p^2 = 0.06$), [absence of] bodily pain ($p = 0.01$, $\eta_p^2 = 0.07$), social functioning *(*$p = 0.001$, $\eta_p^2 = 0.11$), and [absence of] role limitations due to emotional problems ($p = 0.006$, $\eta_p^2 = 0.08$; Ferrand et al., 2014), with those endorsing more self-determined motives scoring greater on those aspects. Within the present study, differences between groups were not investigated. Albeit the present study demonstrated that motives representing different regulatory styles differed in the manner they were associated with indices of subjective health. In particular, external regulation and amotivation were consistently negatively correlated with all the elements of subjective health, whereas intrinsic motivation, integrated regulation, identified regulation, and introjected regulation were inconsistently correlated throughout. During the previous discussion, it was suggested that this may be due to the present context in which more self-determined motives are not correlated with the presence of subjective health, rather, the presence of less self-determined motives is associated with an absence of subjective health. Meaning, higher levels of subjective health might not necessarily be observed as an individual's motives transition to reflect more optimal forms of motivation, but lower levels might be observed in individuals as their motives reflect less optimal forms of motivation.

This observation is interesting because it frames the task of transitioning motives as a way to maintain current levels and prevent reductions in subjective health instead of a way to improve levels of subjective health – although causation cannot be established from the data collected. While no concrete explanation for this finding can be provided due to the limited evidence available in the literature, one potential suggestion is that the nature of the behaviour

being measured may play a role. That is, the MMSB-OA is measuring motives to avoid a particular behaviour, rather than motives to engage in a behaviour. Following this line of thought, those that endorse more optimal motives for avoiding SB may be more consistent in the amount they avoid the behaviour (e.g., more self-determined motives). With less engagement in the behaviour, the individuals experience less of the detriments associated with engaging in prolonged SB (e.g., stiffness) as opposed to those who endorse motives less conducive to consistent maintenance of lower SB levels (e.g., amotivation and external regulation). Those who avoid the behaviour less – that is, participate in more prolonged SB – may experience more of the detrimental consequences which in turn impacts their subjective health. In other words, those with more optimal motives may not be experiencing any positive outcomes as a result of limiting daily SB, however, unlike those endorsing less optimal outcomes, they may instead be avoiding the detrimental consequences associated with prolonged SB that could impact subjective health.

4.5.3 Daily SB

Unfortunately, the correlations observed between self-report daily SB and motives to limit SB do not support the explanation proposed in the previous section. Specifically, the evidence does not paint a clear picture of how motives to limit SB are related to actual SB levels. Motives representing intrinsic motivation and integrated regulation were negatively correlated with daily SB, as anticipated; however, the strength of the correlation was weak (r = -0.13, p = 0.05). Further, motives representing external regulation also demonstrated a similar correlation (r = -0.13), although the correlation was not significant (p = 0.06). No other category of motives correlated significantly with daily SB. Two explanations were provided in the previous section for why this might have occurred: (1) the self-report data introduced bias into the results, and/or (2) the pandemic environment restricted movement behaviours to such an extent that motives to

limit SB were irrelevant to actual SB. Though self-report data could potentially introduce bias as discussed previously, the bias introduced is generally consistent across participants. That is, irrespective of other factors, when using self-report measures, adults consistently underestimate daily SB by ~1.74 hours (Prince et al., 2020b). Additionally, in the initial validation of the MOST, correlations between the instrument and accelerometer derived SB data was $\rho = 0.30$ (Gardiner et al., 2011), meaning that there is some level of agreement between the MOST and objectively measured SB. Therefore, while it is not outside the realm of possibility that the self-report data is biased and thus inaccurately reflecting the true levels of SB amongst participants, it is unproductive to assume that observed correlations between SB and motives – or lack thereof – is only attributable to the self-report measure. It would be beneficial to conduct a follow up study with both objective and self-report measures to see: (1) if there are any observable correlations between motives to limit SB and daily SB from an objective perspective, and (2) if, depending on motives, there are observable differences between SB as reported by objective and subjective measures.

To expand on point two, although it is unlikely that motives to limit daily SB could differentially impact how accurate an individual is when reporting their daily SB measure using a self-report measure, based on the present data it would be something of value to investigate. Previous evidence in SDT suggests that correlations should have been observed between motives and the behaviour under investigation (e.g., Ryan & Deci, 2017). Bringing it to a more relevant context, in the development of the MLSQ, screen-time in adolescents was negatively correlated with autonomous ($r = -0.31$, $p < 0.001$) and controlled motives ($r = -0.19$, $p < 0.001$) but positively correlated with amotivation ($r = 0.23$, $p < 0.001$; Lubans et al., 2013). Considering past literature, the factorial validity, internal consistency reliability, inter-factor correlation, and

other aspects of criterion validity for the MMSB-OA, a non-significant correlation between daily SB and motives to limit SB is undeniably unexpected. Given the unexpected nature of the results, every avenue should be investigated to unearth the root cause. One such avenue, as alluded to, is to investigate whether there is a difference in the accuracy of a self-report measure depending on the motives an individual endorses. No previous investigations of this nature have been conducted; however, an investigation into this may prove beneficial.

The second explanation for this finding as discussed in the previous chapter is that the pandemic played a role. There is already evidence to suggest that older adults' physical activity levels and overall wellbeing have been reduced during the COVID-19 pandemic (e.g., Lehtisalo et al., 2021 Shinohara et al., 2021; Yamada et al., 2020). Looking more specifically at the motives older adults have reported in previous research (e.g., Collins & Pope, 2021) and it is apparent that in a pandemic environment, engaging in SB reducing behaviour is not feasible with the restrictions implemented. For example, older adults have reported that attending physical activity classes at local senior activity centres motivated them to reduce SB because the classes were 'fun' or offered a social element not found elsewhere (Collins & Pope, 2021). Remove access to the classes and those older adults no longer have a place nor driving reason to limit their SB. This is not to say that the older adults are no longer motivated to limit daily SB, rather their ability to act on the motives have been restricted severely. Although this is mere speculation, it is not a stretch to assume that many older adults have been engaging in levels of sedentary behaviour uncharacteristic of their pre-pandemic levels despite retaining previous motives to limit daily SB.

A third explanation for the observation is that motives to limit daily SB may not be correlated to participation in daily SB. Extensive literature suggests that motives should be

correlated to behaviour (e.g., Ryan & Deci, 2017), but in the present study where a psychometrically sound SB measure was utilized, these correlations were not observed. Although two overarching reasons have been provided it is also important to recognize that these reasons have not been tested and are instead mere proposed explanations. It is plausible, based solely on the data collected in the present study using a self-report measure that older adults motives are not correlated with motives. Regardless of the reason, the fact remains that the correlations observed between daily SB and motives to limit SB in the present study do not lend support to the suggestion that motives are important elements to reducing older adults' daily SB. This is not to say that future research will not find significant correlations, as past evidence in other contexts suggest should exist.

4.6 Test-Retest Reliability

The final psychometric property to discuss is test-retest reliability. As mentioned, at the aggregate item level and using a 1-week interval, both Pearson's *r* and the ICC scores for the MMSB-OA were satisfactory: (1) intrinsic motivation (*r)* = 0.82, ICC = 0.81; (2) integrated regulation (*r)* = 0.73, ICC = 0.73; (3) identified regulation (*r)* = 0.57, ICC = 0.57; (4) introjected regulation (*r)* = 0.68, ICC = 0.69; (5) external regulation (*r)* = 0.87, ICC = 0.87, and; (6) amotivation (*r)* = 0.66, ICC = 0.66 . Though test-retest reliability as a psychometric property is considered weak due to the various external threats (Devilles 2017), for the purposes of the present study ascertaining temporal stability was necessary. Investigating previously developed instruments rooted in SDT and it is apparent that the MMSB-OA performed comparatively. For the initial development of the BRSQ, the ICC scores of the different aggregate factors after a 1-week interval were as follows: (1) intrinsic motivation = 0.73; (2) integrated regulation = 0.90; (3) identified regulation = 0.88; (4) introjected regulation = 0.87; (5) external regulation = 0.79,

and (6) amotivation = 0.83 (Lonsdale et al., 2008). Unfortunately, neither the REBS nor SMS-II included an assessment of one-week test-retest reliability in the initial development nor have any follow-up studies filled those gaps with western samples. In a Chinese athletic sample, however, the SMS-II was found to demonstrate the following ICC scores following a one-week interval: (1) intrinsic motivation = 0.80; (2) integrated regulation = 0.82; (3) identified regulation = 0.79; (4) introjected regulation = 0.70; (5) external regulation = 0.73; and (6) amotivation = 0.89 (Li, et al., 2018).

Looking past six-factor instruments - as the number of factors is not completely relevant in the discussion of test-retest reliability – an evaluation with the MLSQ observed the following ICC score for the three-factor structure: autonomous motivation = 0.82, $p = 0.148$; controlled motivation = 0.70, $p = 0.138$, and amotivation = 0.67, $p = 0.792$ (Lubans et al., 2013). Taken together, the evidence suggests that the MMSB-OA performs similarly to other SDT scales, albeit the lower ends of the MMSB-OA might be somewhat lower than desired. Unfortunately, many of the instruments that are rooted in SDT that would serve as beneficial comparisons (e.g., BREQ – an instrument designed to evaluate behaviour regulation for exercise; Markland & Tobin 2004) have not been evaluated for test-retest reliability or have not been investigated in a western/English speaking context. Thus, despite the fact that the MMSB-OA currently appears to demonstrate adequate test-retest reliability, more comparison points would be beneficial.

4.7 Limitations

Unfortunately, there were a number of limitations to the present thesis that must be addressed. Two which have consistently been discussed throughout the extent of this document have been the COVID-19 pandemic and the small sample size of study 2. Though the implications of the small sample size and some of the causes have already been stated in

previous sections, it is important to highlight the interrelatedness between the sample that was obtained and the pandemic itself. As mentioned previously, all of the thesis work was conducted during the pandemic. One of the main advisory messages broadcasted during the pandemic was to avoid large social gatherings and avoid going out unnecessarily. Accordingly, many businesses and locations suspended daily operations. When conducting research with older adults, in-person recruitment and data collections is preferred. A reason for this preference is older adults' generally do not have a large presence in the digital space, and the presence they do have diminishes with age with negative correlation between computer usage and age (r = -0.27, p < 0.01; Calhoun & Lee, 2019). With less in-person recruitment opportunities, and a lower presence of older adults in the online space, recruiting a representative sample becomes challenging. This challenge is further compounded by the fact that older adults who do occupy space in the digital world are generally more educated (correlation between education and computer use in older adults r = 0.29. p < 00.1; Calhoun & Lee, 2019). Consequently, it is unsurprising that the sample which was obtained for study 1 and 2 were relatively young (study 1 M_{age} = 71.9 years; study 2 M_{age} = 68.9 respectively) considering the average age of older adults in Canada over the age of 65 is ~74.5 years (Statistics Canada, 2021). Furthermore, it is unsurprising that the sample for study 2 was well educated with 68.4% possessing some form of post-secondary education compared to only 54% at the national level (no data available specific to older adults 65 years or older; Statistics Canada, 2017).

Ultimately, though causation cannot be established, it can be speculated that the pandemic contributed to a less representative older adult sample based on the data; however, this is not the only way the pandemic may have impacted the results. As mentioned with the pandemic, people were advised to limit social contact and avoid going out unnecessarily. Though

these advisories were necessary to help protect public health, the messages also served to further isolate older adults, increasing levels of loneliness and other negative psychological and health outcomes (e.g., Lehtisalo et al., 2021; Simard & Volicer, 2020). Given that subjective wellbeing and subjective health were outcome measures for this study, it is highly likely that if the study occurred outside a pandemic environment the data collected for these outcome measures would be different. This is not to say similar correlations between the MMSB-OA and the outcomes measures would not be observed, as these correlations are backed up by literature (e.g., Tang et al., 2020), however, the strength of certain correlations may be different if assessed outside a pandemic. This is similar to how the pandemic may have limited older adults' opportunities to limit SB as discussed in the previous chapter for why the SB data may have been different than anticipated.

Aside from sample and environmental limitations, the method to which data was screened and cleaned in study 2 was unconventional. Unfortunately, as a consequence of using online recruitment methods, questionable data was collected and mixed in with legitimate data. Though removal of the questionable data was systematic, as outlined in Chapter 3, legitimate data may have also been removed with the questionable data, and/or questionable data may have been retained in the sample. This is problematic as by eliminating cases which did not meet certain criteria (e.g., response length), the data is being biases towards the researchers expected completion time. Though even the primary investigator involved with constructing the survey was unable to fully read the survey and answer all the questions in under 12 minutes, it cannot be ruled out that there were a handful of older adults who were able to that ended up having their data eliminated from the study.

The final limitation worthy of discussion is the range of self-report SB gathered in the second study. Briefly, participants reported sitting between 68.57 and 1045.72 minutes/day, or, between 1 and 17.4 hours/day with an average of 482 minutes/day or 8 hours/day (*SD* = 253.93 minutes/day, or 4.23 hours/day). Though the problems with self-report SB data have been highlighted elsewhere (i.e., underestimation of overall time), the data obtained in study 2 was unexpectedly varied. Surprisingly, no univariate outliers were present in the data (standardized scores (Z) was between -1.6 and 2.4), though it should be noted that the data was non-normally distributed – skewed towards the lower-end. This is a limitation because although self-report data is usually biased, there is no literature on a standardized method to appropriately address irregularities in the data. One study previously truncated the results for daily SB to no more 960 minutes/day, operating under the assumption that an otherwise healthy and ambulatory individual would be mobile for at least 8 hours a day (Bennie et al., 2013); however, there is no evidence that was provided to support this assumption. Further, operating under this assumption also instills the idea that sleeping should be grouped with SB as, if an individual was sedentary for 960 minutes a day and mobile for an additional 480 minutes, no time has been factored in for sleeping. It is incredibly unlikely that the range of data obtained for SB for study 2 was accurate, and though this is to be expected with self-report data, research should be conducted on the use of appropriate methods to truncate self-report time so that the data from these measures are more realistic.

4.8 Future Directions and Practical Implications

Several of the future directions for this study have been previously mentioned throughout, however, to reiterate, it is first and foremost a priority to achieve a larger sample for the data analysis conducted in study 2. Secondly, to strengthen the results obtained, it would be

beneficial to conduct an assessment of the MMSB-OA psychometric properties in a post-pandemic environment with an emphasis on obtaining a more representative sample of older adults through varied in-person recruitment strategies. Specifically, in the present study the sample was relatively young, well-educated, predominately white, and resided mostly in a community dwelling setting. This is not representative of the entire older adult demographic in Canada, and therefore more emphasis should be placed on obtaining a sample with a greater mean age, a more representative educational background, greater racial diversity, and a better mix of place of residence (e.g., assisted living). Third, objective measures for SB should be incorporated to better ascertain if any correlations exist between daily SB and motives to limit SB. One of the rationales for the development of the MMSB-OA is that understanding older adults' motives could better assist in facilitating greater SB reduction. With the present data, however, the evidence does not support a correlation between motives to limit SB and daily SB. Though there are many reasons why this could be, it is critical that objective assessments be conducted to identify if the data collected in study 2 is truly reflective of the relationship between motives and daily SB, or if there were confounding factors that contributed to the observed relationships. The fourth area that should be explored with future research is the other psychometric properties of the MMSB-OA. Neither predictive, convergent, nor divergent validity was explored in the present study. Though the evidence collected in the present thesis constructs a strong argument for the validity and reliability of the MMSB-OA, exploring other psychometric properties will serve to enhance the understanding of the utility of the MMSB-OA.

An additional future direction not mentioned previously but alluded to throughout is that there are no instruments to evaluate SB from an SDT perspective amongst any age demographic. The MMSB-OA will fill the gap for older adults, but it does nothing to address children, young

adults, nor adults. Therefore, future research should be conducted to replicate the MMSB-OA with other age groups and contexts (e.g., occupational SB).

Despite the presence of several limitations, the value of the present research must not be understated. Through the two studies conducted for this thesis, as well as the several studies leading up to it, an instrument demonstrating comparably strong psychometric properties was developed to evaluate older adults' motives to limit daily SB. Not only was this the first instrument rooted in a theoretical framework of this nature to be developed, but it was the first instrument ever developed to measure older adults' motives to limit daily SB. This is a crucial step as now researchers and program designers can better quantify older adults' motives for this particular behaviour, gaining insight that would otherwise not be available.

Research into older adults' motives to limit daily SB has been ongoing for the last decade (e.g., Chastin et al., 2014; Collins & Pope 2021; Compernolle et al., 2019; Dontje et al., 2018; Greenwood-Hickman et al., 2016; Matson et al., 2018; McEwan et al., 2017; McGowan et al., 2020; Tam-Seto et al., 2016; Voss et al., 2020a). Although it could be considered relatively new, briefly reading through the published literature one could already see that the knowledge is starting to saturate, with novel findings becoming few and far between. Trends of what older adults' find motivating have been established, and these trends seem to be consistent regardless of demographic factors such as gender or place of residence. Albeit, the practical applications of such knowledge is limited. Essentially, it is known what motivates older adults, but the relative importance and antecedents of different motives, and the ways to which the motives can be capitalized on for program design and implemented is ultimately unexplored. Many previous interventions have focused on providing information about SB and opportunities to reduce SB to older adults with the hope that successful behaviour change will be achieved (e.g., Aunger et al.,

2018). Though this method can prove efficacious, it neither capitalizes on the psychological side of SB reduction nor has demonstrated long-term success. Substantial literature exists in other fields that an individual's motives from an SDT perspective are correlated with their engagement in particular behaviour, with motives representing specific motivation types being more conducive to optimal participatory, behavioural, and psychological outcomes (Ryan & Deci, 2017). Moreover, there is literature to suggest that transitioning people's motives to reflect more optimal forms of motivation is possible, but inappropriately applied strategies could have detrimental effects (Ryan & Deci, 2017). Therefore, applying strategies without direction or understanding could have unanticipated consequences. In the context of older adults' motives to limit SB, the MMSB-OA can act as this direction. Although the MMSB-OA must undergo further psychometric testing, based on the data obtained in this thesis, there is the potential that having older adults complete the MMSB-OA provides insight into the degree of internalization of their motivation. Once further psychometric testing is conducted on the MMSB-OA, incorporating it into an intervention design could allow for strategies to be specifically tailored to an individual's needs, thereby transitioning them to endorsing more optimal motives that may be conducive to beneficial participatory, behavioural, and psychological outcomes.

4.9 Conclusion

The present thesis demonstrated the development and psychometric assessment of an instrument designed to evaluate older adults' motives to limit daily SB from the theoretical perspective of SDT. An instrument of this nature is critical as it opens the doors to more evidence-based strategies to facilitate long-term reduction in daily SB, allowing for some mitigation of one potential threat to the successful aging process (e.g., Copeland, 2017; Saunders et al., 2020). The MMSB-OA demonstrated satisfactory factorial validity, internal consistency

reliability, inter-factor correlations, one-week test-retest reliability, and correlations with variables within the constructed nomonological network, albeit, it failed to correlate in a meaningful way with daily SB. Although this is problematic as it undermines the entire purpose of constructing an instrument to evaluate older adults' motives to limit daily SB, future investigations with objective measures in a post-pandemic environment may uncover correlations not identified in the present study. Overall, despite the notion that the MMSB-OA as a tool to enhance SB reduction interventions in older adults is not supported by the empirical evidence collected in the present study, the creation of the MMSB-OA effectively addresses the lack of instrument to better quantify older adults' motives to limit SB. Additionally, this presents a unique case in that if the findings that no correlation exists between motives to limit SB and engagement in SB are supported by future evidence, then this may be one of the few behaviours whereby motives from an SDT perspective are unrelated to engagement in the actual behaviour. Though unlikely, the other psychometric properties demonstrate that the MMSB-OA reliably measures the latent variables of intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation and amotivation. As it is not that the MMSB-OA that demonstrates poor reliability or validity, if the observed relationships between motives and SB are supported by future research using objective measures, the only conclusion that can be drawn is that motives are unrelated to participation in SB.

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Appendix A
Study 1 Survey Package

Informed consent

You have been invited to participate in a study titled "Reasons for Limiting Sitting Time from the Perspective of Older Adults" carried out by Liam Collins and Dr. Paige Pope of the Department of Kinesiology and Physical Education at the University of Lethbridge. The objective of this study is to assess older adults (≥65 years) motives toward daily sitting time reduction using a recently developed scale. Information gathered during this survey will be used to understand the extent and patterns of motives that older adults endorse with regards to reducing daily sedentary time. Individuals who agree to participate in this study will be asked to complete a brief demographics questionnaire, a quality of life questionnaire, a questionnaire about average daily sitting time, and finally a questionnaire related to motivation to limit daily sitting time. The total expected time that this survey should take is approximately 30-45 minutes. To be eligible to participate you must be over the age of 65 and be able to transition between standing and sitting positions independently without the aid of anyone or anything else. Individuals who consent to participate in this study and provide contact information on a separate form, will be entered into a prize draw for one of four $25 VISA cards. Odds of winning a visa card is approximately 1 in 95. Providing contact information is not mandatory for participants, however, it is necessary to be entered into the draw.

There are no anticipated risks from participating in this study. There is a slight chance that some questions may make participants feel uncomfortable, however participants are not required to answer questions that they do not want to answer, and they may withdraw at any point with no consequences. Participants may not experience personal benefit from participating in this study but may gain insight into their own motives for reducing daily sitting time. Participation is voluntary and confidential. Participants' responses will not be identified with personal information; however, as with any online survey, neither anonymity nor confidentiality can be completely guaranteed. The survey is being hosted on Qualtrics and their privacy policy can be accessed at https://www.qualtrics.com/privacy-statement/. All responses to this survey will be kept on a password-protected computer, in a locked office, with restricted access, and will be deleted 5 years after data collection has been completed.

Participants have the right to withdraw from the survey at any time during the survey without penalty by simply closing the browser that the survey has been opened in. Once the survey has been submitted, there will be no way to withdraw your response because there is no way to link you to your survey.

If you have questions about this study, please contact Liam Collins of the University of Lethbridge, at liam.collins@uleth.ca, or at 403-332-5207, or Dr. Paige Pope of the University of Lethbridge at paige.pope@uleth.ca, or 403-332-4435.

If you have questions about your rights as a participant in this research please contact the Office of Research Ethics, University of Lethbridge (Phone: 403-329-2747 or email research.services@uleth.ca).

Do you consent to participate in this study?

- o Yes
- o No

Are you 65 years or older?

- o Yes

- No

Do you wish to receive a summary of research findings?
- Yes
- No

If you answered “yes” please provide a valid email address below

Do you wish to be entered into the draw for one of the $25 VISA gift cards?
- Yes
- No

Demographics Questionnaire

What is your gender?
- Man
- Woman
- Other
- Prefer not to disclose

What is your age?

What is your current residence status?
- My personal home or a family member’s home
- Retirement home
- Assisted living facility
- Nursing home

What is your current employment status
- Full-time (30 hours or more per week)
- Part-time
- Contract, freelance, or temporary
- Unemployed/retired

What is your current mobility status?
- I can walk independently WITHOUT the assistance of an aid (wheelchair, walking stick, walker)
- I can walk independently WITH the assistance of an aid (walking stick, walker)
- I cannot walk independently, but I can stand and transfer myself to my wheelchair independently
- I cannot walk independently, nor can I stand and transfer myself to my wheelchair independently

Motives for Managing Sedentary Behaviour – Older adults (MMSB-OA)

Reasons for Limiting Your Sitting Time

In this section, please think about the reasons you choose to limit your sitting time in general, considering sitting time as anything you do while seated or reclined and awake. Please read each statement and respond to the bolded question using the response scale provided.

Why do you limit your sitting time?

	0 Not at all true for me	1 Slightly true for me	2 Moderately true for me	3 Very true for me	4 Completely true for me
1. Because people whose opinions I value tell me to					
2. To be at my best mentally					
3. Because I know I shouldn't sit a lot					
4. Because I would feel bad about myself if I didn't					
5. So that I can do the activities I love					
6. Because important people in my life pressure me to					
7. Because I'm not the type of person that sits a lot					
8. Because I want to maintain my independence					
9. Because it's personally important to me					
10. Because others need me to do things that require me to not sit					

11. So that I can feel my best

12. Because activities in which I don't sit are fun

13. Because I don't want others to see me as if I'm old

14. Because it's in line with my core values

15. To increase the number of quality years I have left

16. So that I stay engaged in the community

17. I don't limit my sitting time because I don't see why I should

18. I don't limit my sitting time because I don't see why I should

19. Because I enjoy trying activities that get me moving

20. Because I have never been one to sit much

21. Because I feel guilty if I sit on my butt for too long

22. Because I feel obligated to

23. I don't try to

24. Because I feel better about myself when I do

25. Because other will be upset with me if I don't

26. Because I get with myself if I sit too much

27. I don't limit my sitting time because I don't care how much I sit

28. In order to do activities I'm interested in

29. Because I'm and active person by nature

30. Because that's who I've been all my life

31. Because I don't want others to treat me like I can't do things for myself

32. I don't limit my sitting time because I don't see how sitting less could benefit me

33. Because it's consistent with who I am as a person

34. Because being more active is stimulating for me

35. For social reasons

36. Because it fits with my personality

37. Because I don't want to feel lazy

38. I don't limit my sitting time because

it’s not worth the effort 39. Because I get pleasure from moving 40. Because I don’t enjoy sitting 41. For health reasons	

Appendix B

Study 2 Survey Package 1

Informed Consent

You have been invited to participate in a study entitled "Motives for Managing Sedentary Behaviour – Older Adults" carried out by Liam Collins and Dr. Paige Pope of the Department of Kinesiology and Physical Education at the University of Lethbridge. The objective of this study is to understand older adults' (≥65 years) motives towards limiting daily sitting time using a recently developed questionnaire: the Motives for Managing Sedentary Behaviour – Older Adults (MMSB-OA) Instrument. As the MMSB-OA is still in the initial phase of development, the data collected during this study will be used to evaluate if the MMSB-OA accurately and reliably measures motives to limit daily sitting time and the relationship between those motives and other important factors. This study will involve two surveys: the first survey, which is the one you will be filling out today if you consent to participate, will contain a demographics questionnaire, the MMSB-OA, a self-report daily sitting time questionnaire, a questionnaire about positive and negative affect, a satisfaction with life questionnaire, and finally a quality of life questionnaire. The second survey, which will be sent out one week after completion of the first survey, will only contain the MMSB-OA. It is anticipated that the first survey will take between 30-40 minutes, whereas the second survey will take approximately 10-15 minutes. To be eligible to participate individuals must be over the age of 65 and be able to transition between standing and sitting positions independently without the assistance of an aid (e.g., walking stick, walker, etc.). In order to participate in survey 2, participants must provide a valid email address at the end of the survey 1. Emails will only be used to contact you about participation in the second survey. Individuals who consent to participate in this study have two opportunities to be entered into a draw for a $25 VISA gift card: once for this survey, and once for the second survey. For every 100 draw entries in this study, one draw will take place, putting the odds of winning a gift card at approximately 1 in 100. In order to enter, an email must be provided so that the winners can be contacted with the results of the draw. All email addresses collected for the purposes of sending the second survey will be deleted following the completion of the second survey and replaced with an identifying code that cannot be traced back to any individual participant. All email address collected for the purpose of entering the draw will be deleted immediately following the notification of the draw winners.

There are no anticipated risks from participating in this study. There is a slight chance that some questions may make participants feel uncomfortable, however participants are not required to answer questions that they do not want to answer. Participants may withdraw from the study at any time up until the submission of survey 2 with no consequences. After submitting survey 2, all personal identifiers will be removed from the data and it will be impossible to identify specific responses to allow for removal of data. In order to withdraw from the study while completing a survey, simply close the browser that the survey was opened in. If you would like to withdraw your data after submitting survey 1, please contact Liam Collins at the email provided below. It is not anticipated that participants will experience any personal benefit from participating in this study but some of the questions may improve insight into daily sitting time which could impact daily activity patterns. Participation is voluntary and confidential. As it is necessary for participants to provide a valid email address, and that email address will be used to connect survey response 1 and 2, complete anonymity cannot be guaranteed as email addresses may contain

personal identifiers. The researchers involved with this study will take every step to protect participant anonymity and confidentiality; however, as with any online survey, neither anonymity nor confidentiality can be completely guaranteed. The survey is being hosted on Qualtrics and their privacy policy can be accessed at https://www.qualtrics.com/privacy-statement/. All responses to this survey will be kept on a password-protected computer, in a locked office, with restricted access, and will be deleted 5 years after data collection has been completed. Data collected from these surveys will be used to help aid us in understanding older adults motives to limit daily sitting time. Data collected will be presented as part of a master's thesis/defense, at an academic conference, and/or in an academic journal. Data will be presented in an aggregate form and participants will never be identified individually in any publication/presentation of the data.

If you have questions about this study, or would like to obtain feedback about the study results, please contact Liam Collins of the University of Lethbridge, at liam.collins@uleth.ca, or at 403-332-5207, or Dr. Paige Pope of the University of Lethbridge at paige.pope@uleth.ca, or 403-332-4435.

If you have questions about your rights as a participant in this research please contact the Office of Research Ethics, University of Lethbridge (Phone: 403-329-2747 or email research.services@uleth.ca).

Do you consent to participate in this study?
- Yes
- No

Are you 65 years or older?
- Yes
- No

Do you wish to be entered into the draw for one of the $25 VISA gift cards?
- Yes
- No

If you answered "yes" please provide a valid email address below

Demographics Questionnaire

What is your gender?
- Man
- Woman
- Non-binary/ third gender
- Prefer not to disclose
- Option not listed here

What is your age?

What is your height (in cm)?

What is your weight (in kg)?

Which of the following do you identify as? (select all that apply)
- Asian
- Black/African
- Caucasian
- Hispanic
- Indigenous/Aboriginal
- Other (please specify)

Highest level of education attained?
- No certificate, diploma, or degree
- High school diploma
- Apprenticeship or other trades certificate
- College diploma
- University bachelor's
- University graduate school

What is your current residence status?
- My personal home or a family member's home
- Retirement home
- Assisted living facility
- Nursing home

What is your current employment status?
- Full-time (30 hours or more per week)
- Part time
- Contract, freelance, or temporary
- Unemployed/retired

What is your current mobility status?
- I can walk independently WITHOUT the assistance of an aid (wheelchair, walking stick, walker)
- I can walk independently WITH the assistance of an aid (walking stick, walker)
- I cannot walk independently, but I can stand and transfer myself to my wheelchair independently
- I cannot walk independently, nor can I stand and transfer myself to my wheelchair independently.

Motives to Manage Sedentary Behaviour – Older adults (MMSB-OA)

There are many reasons as to why someone may choose or not choose to limit their daily sedentary behaviour. For this section, **please think about the reasons you choose, or don't choose, to limit you sitting time in general,** considering sitting time as anything you do while seated or reclined and awake. Please read and **respond to each statement** following the bolded question using the response scale provided.

Why do you limit your sitting time?

	Not at all true for me	Slightly true for me	Moderately true for me	Very true for me	Completely true for me
1. To increase the number of quality years I have left					
2. Because I don't want to feel lazy					
3. Because I would feel bad about myself if I didn't					
4. To be at my best mentally					
5. I don't limit my sitting time because I don't see why I should					
6. I don't try					
7. To satisfy others					
8. Because I have never been one to sit much					
9. Because I enjoy trying activities that get me moving					
10. So that I can feel my best					
11. For social reasons					
12. Because people whose opinions I value tell me to					
13. Because that's who I've been all my life					
14. Because I don't want others to treat me like I can't do things for myself					
15. Because others need me to do things that require me to not sit					

16. Because important people in my life pressure me to					
17.Because I feel guilty if I sit on my butt for too long					
18.Because I feel better about myself when I do					
19.So that I stay engaged in the community					
20. Because I am not the type of person that sits a lot					
21. Because I get upset with myself if I sit too much					
22. Because it's personally important to me					
23. I don't limit my sitting time because I don't see how sitting less could benefit me					
24. To help me look younger					
25. Because being more active is stimulating for me					
26. Because I may be rewarded if I do					
27. Because I don't want others to see me as if I'm old					
28. Because I will be praised for doing it					
29. Because it fits with my personality					
30. In order to do activities that I am interested in					
31. Because I know I shouldn't sit a lot					
32. Other people close to me insist that I do					
33. Because other people say I should					
34. Because activities in which I don't sit are fun					
35. Because it's consistent with who I am as a person					

36. Because I don’t enjoy sitting					
37. I don’t limit my sitting time because I don’t want to					
38. Because others encourage me to					
39. Because it’s in line with my core values					
40. Because I am an active person by nature					
41. Because people in my life want me to					
42. People around me nag me to do it					
43. I don’t limit my sitting time because I don’t care how much I sit					
44. Because others will be upset with me if I don’t					
45. Because I want to maintain my independence					
46. So that I can do the activities I love					
47. I don’t limit my sitting time because it is not worth the effort					
48. Because I feel obligated to					
49. Because I get pleasure from moving					
50. For health reasons					

Measure of Older Adults Sedentary Time (MOST)

For this section, you are going to be asked about activities you did over the ***last week whilst sitting or lying down.*** Don't count the time you spend in bed

For each of the activities only count the time when this was your main activity. For example if you are watching television and doing a crossword, count it as television time or crossword time but not as both.

During the last week, how much time in total did you spend ***sitting or lying down*** *and……*

SEDENTARY ITEM	**TIME**	
1. Watching television or videos/DVDs	_____ hours	_____ minutes
2. Using the computer/Internet	_____ hours	_____ minutes
3. Reading	_____ hours	_____ minutes
4. Socializing with friends or family	_____ hours	_____ minutes
5. Driving or riding in a car, or time on public transport	_____ hours	_____ minutes
6. Doing hobbies, e.g. craft, crosswords	_____ hours	_____ minutes
7. Doing any other activities (e.g., eating)	_____ hours	_____ minutes

Positive and Negative Affect Schedule (PANAS)

This section consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you generally feel this way, that is, how you feel on the average.

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Interested					
Distressed					
Excited					
Upset					
Strong					
Guilty					
Scared					
Hostile					
Enthusiastic					
Proud					
Irritable					
Alert					
Ashamed					
Inspired					
Nervous					
Determined					
Attentive					
Jittery					
Active					
Afraid					

Satisfaction With Life Scale (SWLS)

Below are five statements with which you may agree or disagree. Using the 1-7 scale below, indicate your agreement with each item. Please be open and honest in your response.

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
In most ways my life is close to my ideal							
The conditions of my life are excellent							
I am satisfied with my life							
So far I have gotten the important things I want in life							
If I could live my life over, I would change almost nothing							

Medical Outcomes Survey Short Form 36-items (MOS SF-36)

1. In general would you say your health is:
    1. Excellent
    2. Very good
    3. Good
    4. Fair
    5. Poor
2. **Compared to one year ago,** how would you rate your health in general **now**?
    1. Much better now than one year ago
    2. Somewhat better now than one year ago
    3. About the same
    4. Somewhat worse now than one year ago
    5. Much worse now than one year ago

The following items are about activities you might do during a typical day. Does **your health now limit you** in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all
3.) **Vigorous activities,** such as running, lifting heavy objects, participating in strenuous sports			
4.) **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf			
5.) Lifting or carrying groceries			
6.) Climbing **several** flights of stairs			
7.) Climbing **one** flight of stairs			
8.) Bending, kneeling, or stooping			
9.) Walking **more than a mile**			
10.) Walking **several blocks**			
11.) Walking **one block**			
12.) Bathing or dressing yourself			

During the **past 4 weeks,** have you had any of the following problems with your work or other regular daily activities **as a result of your physical health?**

	Yes	No
13.) Cut down the amount of time you spent on work or other activities		
14.) Accomplished less than you would like		
15.) Were limited in the kind of work or other activities		
16.) Had difficulty performing the work or other activities (for example, it took extra effort)		

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a results of any emotional problems** (such as feeling depressed or anxious)?

	Yes	No
17.) Cut down the amount of time you spent on work or other activities		
18.) Accomplished less than you would like		
19.) Didn't do work or other activities as carefully as usual		

20. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?
    1. Not at all
    2. Slightly
    3. Moderately
    4. Quite a bit
    5. Extremely

21. How much **bodily** pain have you had during the **past 4 weeks?**
    1. None
    2. Very mild
    3. Mild
    4. Moderate
    5. Severe
    6. Very severe

22. During the **past 4 weeks,** how much did pain interfere with your normal work (including both work outside the home and housework)?

1. Not at all
2. A little bit
3. Moderately
4. Quite a bit
5. Extremely

These questions are about how you feel and how things have been with you **during the past 4 weeks.** For each question, please give the one answer that comes closest to the way you have been feeling

How much of the time during the **past 4 weeks…**

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
23.) Did you feel full of pep						
24.) Have you been a very nervous person?						
25.) Have you felt so down in the dumps that nothing could cheer you up?						
26.) Have you felt calm and peaceful						
27.) Did you have a lot of energy						
28.) Have you felt downhearted and blue						
29.) Did you feel worn out?						
30.) Have you been a happy person?						
31.) Did you feel tired?						

32. During the **past 4 weeks**, how much of the time has **your physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?
    1. All of the time
    2. Most of the time
    3. Some of the time
    4. A little of the time
    5. None of the time

How TRUE or FALSE is **each** of the following statements for you

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false
33.) I seem to get sick a little easier than other people					
34.) I am as healthy as anybody I know					
35.) I expect my health to get worse					
36.) My health is excellent					

Appendix C

Study 2 Survey Package 2

Informed Consent

You have been invited to participate in a study entitled "Motives for Managing Sedentary Behaviour – Older Adults" carried out by Liam Collins and Dr. Paige Pope of the Department of Kinesiology and Physical Education at the University of Lethbridge. The objective of this study is to understand older adults (≥65 years) motives towards limiting daily sitting time using a recently developed questionnaire: the Motives for Managing Sedentary Behaviour – Older Adults (MMSB-OA) Instrument. As the MMSB-OA is still in the initial phase of development, the data collected during this study will be used to evaluate if the MMSB-OA accurately and reliably measures motives to limit daily sitting time and the relationship between those motives and other important factors. This study will involve two surveys. You already completed the first survey last week, so today you will be completing the second survey which will only consist of the MMSB-OA. It is anticipated that this survey will only take between 10-15 minutes. All participants will be provided with a second opportunity to enter into the draw for a $25 VISA gift card. For every 100 draw entries in this study, one draw will take place, putting the odds of winning a gift card at approximately 1 in 100. In order to enter, an email must be provided so that the winners can be contacted with the results of the draw. All email address collected for the purpose of entering the draw will be deleted immediately following the notification of the draw winners.

There are no anticipated risks from participating in this study. There is a slight chance that some questions may make participants feel uncomfortable, however participants are not required to answer questions that they do not want to answer. Participants may withdraw from the study at any time up until the submission of survey 2 with no consequences. After submitting survey 2, all personal identifiers will be removed from the data and it will be impossible to identify specific responses to allow for removal of data. In order to withdraw from the study while completing a survey, simply close the browser that the survey was opened in. If you would like to withdraw your data after submitting survey 1 but before submitting survey 2, please contact Liam Collins at the email provided below. It is not anticipated that participants will experience any personal benefit from participating in this study but some of the questions may improve insight into daily sitting time which could impact daily activity patterns. Participation is voluntary and confidential. As it is necessary for participants to provide a valid email address, and that email address will be used to connect survey response 1 and 2, complete anonymity cannot be guaranteed as email addresses may contain personal identifiers. The researchers involved with this study will take every step to protect participant anonymity and confidentiality; however, as with any online survey, neither anonymity nor confidentiality can be completely guaranteed. The survey is being hosted on Qualtrics and their privacy policy can be accessed at https://www.qualtrics.com/privacy-statement/. All responses to this survey will be kept on a password-protected computer, in a locked office, with restricted access, and will be deleted 5 years after data collection has been completed. Data collected will be presented as part of a master's thesis/defense, at an academic conference, and/or in an academic journal. Data will be presented in an aggregate form and participants will never be identified individually in any publication/presentation of the data.

If you have questions about this study, or would like to obtain feedback about the study results, please

contact Liam Collins of the University of Lethbridge, at liam.collins@uleth.ca, or at 403-332-5207, or Dr. Paige Pope of the University of Lethbridge at paige.pope@uleth.ca, or 403-332-4435.

If you have questions about your rights as a participant in this research please contact the Office of Research Ethics, University of Lethbridge (Phone: 403-329-2747 or email research.services@uleth.ca).

Do you consent to participate in this study?

- Yes
- No

Do you wish to be entered into the draw for one of the $25 VISA gift cards?

- Yes
- No

Motives to Manage Sedentary Behaviour – Older adults (MMSB-OA)

There are many reasons as to why someone may choose or not choose to limit their daily sedentary behaviour. For this section, **please think about the reasons you choose, or don't choose, to limit you sitting time in general,** considering sitting time as anything you do while seated or reclined and awake. Please read and **respond to each statement** following the bolded question using the response scale provided.

Why do you limit your sitting time?

	Not at all true for me	Slightly true for me	Moderately true for me	Very true for me	Completely true for me
1. To increase the number of quality years I have left					
2. Because I don't want to feel lazy					
3. Because I would feel bad about myself if I didn't					
4. To be at my best mentally					
5. I don't limit my sitting time because I don't see why I should					
6. I don't try					
7. To satisfy others					
8. Because I have never been one to sit much					
9. Because I enjoy trying activities that get me moving					
10. So that I can feel my best					
11. For social reasons					
12. Because people whose opinions I value tell me to					
13. Because that's who I've been all my life					
14. Because I don't want others to treat me like I can't do things for myself					
15. Because others need me to do things that require me to not sit					

16. Because important people in my life pressure me to					
17.Because I feel guilty if I sit on my butt for too long					
18.Because I feel better about myself when I do					
19.So that I stay engaged in the community					
20. Because I am not the type of person that sits a lot					
21. Because I get upset with myself if I sit too much					
22. Because it's personally important to me					
23. I don't limit my sitting time because I don't see how sitting less could benefit me					
24. To help me look younger					
25. Because being more active is stimulating for me					
26. Because I may be rewarded if I do					
27. Because I don't want others to see me as if I'm old					
28. Because I will be praised for doing it					
29. Because it fits with my personality					
30. In order to do activities that I am interested in					
31. Because I know I shouldn't sit a lot					
32. Other people close to me insist that I do					
33. Because other people say I should					
34. Because activities in which I don't sit are fun					
35. Because it's consistent with who I am as a person					

36. Because I don’t enjoy sitting					
37. I don’t limit my sitting time because I don’t want to					
38. Because others encourage me to					
39. Because it’s in line with my core values					
40. Because I am an active person by nature					
41. Because people in my life want me to					
42. People around me nag me to do it					
43. I don’t limit my sitting time because I don’t care how much I sit					
44. Because others will be upset with me if I don’t					
45. Because I want to maintain my independence					
46. So that I can do the activities I love					
47. I don’t limit my sitting time because it is not worth the effort					
48. Because I feel obligated to					
49. Because I get pleasure from moving					
50. For health reasons					