TESTING THE BIOPSYCHOSOCIAL MODEL OF PAIN AND AGING IN THE CANADIAN LONGITUDINAL STUDY ON AGING

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ABSTRACT

The biopsychosocial model of pain and aging was tested in 30,097 community-dwelling people, aged 45 to 85, using data from the Canadian Longitudinal Study on Aging. Baseline information on pain (presence, intensity, and impact), sociodemographic, cognitive, physical, and biopsychosocial measures was collected through an in-home interview, in-person assessment, and a telephone questionnaire. Significant correlates of pain presence were sex, education, ethnicity, income, marital status, Biophysical, Cognitive-motor, and Psychosocial factors. Significant correlates of pain intensity were education, ethnicity, income, Biophysical, Cognitive-motor, and Psychosocial factors. Significant correlates of pain impact were sex, ethnicity, income, language conversation, Biophysical, and Psychosocial factors. Other physical, treatment, comorbidity, and biospecimen measures differed within and between pain outcomes. Age was significant in bivariate analysis but not in multivariate analysis. These results support the biopsychosocial model of pain and aging for multiple pain outcomes, highlighting the variability of pain in older adults.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
α	Alpha
φ	Lambda
η^2	Partial eta squared
χ^2	Chi-square
ANOVA	Analysis of Variance
CAPI	Computer Assisted Personal Interviews
CATI	Computer Assisted Telephone Interview
CES-D10	Short form of the Center for Epidemiologic Studies Depression Scale
CI	Confidence Interval
CLSA	Canadian Longitudinal Study on Aging
cm	Centimetres
CONSORT	Consolidated Standards of Reporting Trials
COWAT	Controlled Oral Word Association Test
CRT	Choice Reaction Time
DCS	Data Collection Site
DXA	Dual energy X-ray Absorptiometry
EMM	Estimated Marginal Means
HDL	High-Density Lipoprotein
K10	Kessler Psychological Distress Scale
kg	Kilograms
LDL	Low-Density Lipoprotein
LSI	Life-Space Index
MANCOVA	Multivariate Analysis of Covariance
MAT	Mental Alternation Test
MCQ	Maintaining Contact Questionnaire
m	Metres
mL	Millilitres
MOBILIZE	Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly
MOS-SSS	Medical Outcomes Study Social Support Survey
MPMT	Miami Prospective Memory Test
NCC	National Coordinating Centre
NuAGE	Quebec Longitudinal Study on Nutrition and Aging
OR	Odds Ratio
PASE	Physical Activity Scale for the Elderly
PC-PTSD	Primary Care Post Traumatic Stress Disorder
PCA	Principal Component Analysis
PMT	Prospective Memory Task
PTSD	Post Traumatic Stress Disorder
RAVLT	Rey Auditory Verbal Learning Test
RDD	Random Digit Dialing
SD	Standard Deviation

SE	Standard Error
SPSS	Statistical Package for the Social Sciences
SWLS	Satisfaction with Life Scale
T	Transmission
TIPI	Ten-Item Personality Inventory
TUG	Timed-Up-and-Go
UK	United Kingdom
VIF	Variance Inflation Factor

CHAPTER ONE: INTRODUCTION

As the population ages, there will be an increase in the prevalence of pain (Gagliese, 2009; Gibson & Lussier, 2012; Zimmer & Zajacova, 2018). It has a large economic burden (Health Canada, 2019; Zimmer & Zajacova, 2018) and is negatively associated with quality of life (Gibson & Lussier, 2012). The gate control theory (Melzack & Wall, 1965) and its expansion (Melzack & Casey, 1968) have laid a strong foundation to understand pain as a biopsychosocial phenomenon, while lifespan developmental perspectives describe age-related changes across the biopsychosocial dimensions (Baltes, 1997; Dunn, 2010). Gagliese (2009) has identified an increase in the study of pain and aging, yet our understanding of the integration between pain and aging while simultaneously considering numerous biopsychosocial variables is limited. Gagliese et al. (2018) recently proposed the biopsychosocial model of pain and aging (Figure 1). The goal of this study was to integrate previous pain theories with lifespan developmental perspectives, providing a framework to understand pain across the adult lifespan as the dynamic interaction of multiple variables (e.g., sex, depression, social support). The model serves as a comprehensive framework of pain in older adults.

The present study is the first, to our knowledge, to test the biopsychosocial model of pain and aging using data from the baseline comprehensive cohort (n = 30,097) of the Canadian Longitudinal Study on Aging (CLSA) (Raina et al., 2009). The CLSA is a national, longitudinal study of the trajectories of healthy aging. Men and women between the ages of 45 and 85 years at baseline will be followed for 20 years or until death. Pain (presence, intensity, and impact), sociodemographic, cognitive, physical, and biopsychosocial information is gathered in three-year intervals through an in-home interview, in-person assessment at a Data Collection Site (DCS), and a Maintaining Contact Questionnaire (MCQ) administered over the phone. Using these data,

the present study simultaneously examined numerous variables in multivariate analysis for three pain outcomes (presence, intensity, and impact). Specifically, after a Principal Component Analysis (PCA) was conducted, separate regression models were created for each pain outcome, followed by a series of Multivariate Analysis of Covariance (MANCOVA) models and chi-square tests (χ^2) to identify additional significant variables for each outcome. Testing the biopsychosocial model of pain and aging in the CLSA provides a baseline model for longitudinal research as the participants age, thus improving our understanding of the variability of pain in older adults.

Pain

The population of Canadians aged 65 and over has been increasing since the early twentieth century and is projected to accelerate until 2030 as the Baby Boomer (i.e., people born between 1946 and 1964) population ages (Statistics Canada, 2019). Specifically, the population of Canadians aged 65 and over will increase from 17.2% in 2018 to 23.4% in 2030 (Statistics Canada, 2019). Additionally, the median age of the population increased by 16 years from 1921 (i.e., 23.9 years) to 2018 (i.e., 40.8 years) and is projected to further increase (Statistics Canada, 2019).

As the population ages, there will also be an increase in the prevalence of pain (Gagliese, 2009; Gibson & Lussier, 2012; Zimmer & Zajacova, 2018). Currently, 33% of Canadians aged 65 years and over live with chronic pain (Health Canada, 2019). The increase of pain in particular sites, however, is variable with age (Gagliese, 2009; Gibson & Lussier, 2012). For example, neuropathic pain may increase but musculoskeletal pain may decrease or plateau in later life (Gagliese, 2009). Additionally, headache and abdominal pain peak in mid life, while foot or joint pain increase in later life (Gibson & Lussier, 2012). The differences in pain types

and locations might be due to the non-uniform impact of age on underlying pathophysiological mechanisms (Gagliese & Farrell, 2005).

Unfortunately, pain is undertreated in the older population (Gagliese, 2009; Gibson & Lussier, 2012) although this is not universal (Gagliese & Melzack, 2003; Reid, Eccleston, & Pillemer, 2015). In general, pain is experienced differently for older compared to younger people due to physiological, psychological, and social changes with age (Savvas & Gibson, 2016). Among older people, there might be differences in pain management due to variations in the number and types of comorbidities, polypharmacy interactions, and cognitive impairment (Borsheski & Johnson, 2014).

Lack of knowledge about pain among both patients and health care providers and gaps in research that remain (e.g., identifying individual factors such as comorbidities when assessing pain treatments) might also contribute to inadequate pain management (Gagliese et al., 2012; Gibson & Lussier, 2012; Reid et al., 2011). Not only does pain affect the individuals experiencing it and their caregivers, but it also has a large economic burden due to increased health care utilization (Zimmer & Zajacova, 2018). For instance, the Chronic Pain Task Force estimates healthcare costs in Canada due to pain are between $56 to $60 billion per year (Health Canada, 2019), providing another reason to understand its effects in older people.

Biopsychosocial Model of Pain and Aging

The biopsychosocial model of pain is a comprehensive framework that proposes pain as the dynamic interaction between biological, psychological, and social variables, unique to each person (Gatchel, Bo Peng, Peters, Fuchs, & Turk, 2007; Gatchel, Howard, & Kishino, 2010). In the model, age is considered as one of many factors (Gatchel et al., 2007); however, age might

act as a proxy for biological, psychological, and social variables. As a result, the relationship between variables may differ across age groups and be obscured when age is not considered. For example, Turk et al. (1995) found that chronic pain and depression were not significantly related until the relationship was investigated separately in younger and older adults. In the younger group, the relationship remained insignificant, but it was significant in the older age group. The separation of the sample into age groups revealed associations between variables that were not otherwise captured, highlighting the role of age as a proxy for other variables. Consistent with this, Gagliese et al. (2008) found that younger adults with high pain scores self-administered more morphine than those with lower pain scores. In the older age group, however, morphine consumption slightly differed between higher and lower pain scores. Additionally, postoperative patient-controlled analgesia was associated with increased pain intensity in older adults but not in younger adults. Similar to the Turk et al. (1995) study, the consideration of age in Gagliese et al.'s (2008) study showed the variability in factors associated with pain.

A lifespan developmental perspective also aids in explaining age-related changes. Specifically, there are gains and losses in functioning throughout the lifespan (Baltes, 1997); however, as people age, the losses outweigh the gains (Baltes, 1997). When applying a lifespan developmental perspective to pain, Dunn (2010) proposes that risks (i.e., risks of developing pain or having it persist or worsen) may simultaneously accumulate over time in the biological (e.g., comorbidities), psychological (e.g., depression), and social (e.g., reduced social networks) domains. These risks may be determined by other modifying or mediating factors at the individual or environmental level and occur at various periods in development. For example, if an individual had an episode of back pain during childhood because of carrying a heavy load in their school bag, and another episode of pain in adulthood when working a strenuous manual

labour job, this accumulation of risk might contribute to the development of back pain in later life. If this pain is also combined with depression, the risk for acute pain developing into chronic pain might increase. The accumulation of risks across the biopsychosocial domains might also be associated with reduced ability to respond to other stressors and changes (a concept referred to as homeostenosis), thereby contributing to vulnerability to pain (Walco, Krane, Schmader, & Weiner, 2016).

Although pain and age are associated with various biopsychosocial factors across the lifespan, there is no guiding framework to account for their individual complexities and interrelationships. Previous theories have provided comprehensive foundations in explaining pain through the key role of the central nervous system (Melzack & Wall, 1965) and integration of sensory, cognitive, and motivational aspects (Melzack & Casey, 1968). Specifically, the gate control theory proposes that pain is the result of interactions between the modulating gate control system (substantia gelatinosa), central control trigger (afferent patterns in the dorsal column system), and the action system (transmission (T) cells; located in the spinal cord) (Melzack & Wall, 1965, 1996). The dynamic activation of small and large diameter fibers open and close the gate, respectively, which accordingly activate T cells. The gate control theory proposes that pain is created by the brain and influenced by psychological factors such as past experiences and attention. It emphasizes sensory feedback and the role of the central nervous system in pain.

In 1968, Melzack and Casey (1968) expanded the gate control theory by emphasizing the integration of sensory, motivational, cognitive determinants in pain. For example, while the sensory domain provides information about the noxious stimuli, the motivational domain provides fight or flight information, and the cognitive domain provides appraisals based on past experiences and anticipation of pain, amongst other factors.

With these models as the foundation, Gagliese et al. (2018) proposed the biopsychosocial model of pain and aging (Figure 1). The upper half of Figure 1 depicts pain across the adult lifespan as the interaction of dynamic biological, psychological, and social factors, some of which include sex, comorbidities, and depression. The lower half of Figure 1 depicts pain report and treatment as being influenced by patient/person factors such as physical impairment and observer/caregiver factors such as pain beliefs (Melzack & Katz, 2013; Prkachin & Craig, 1995; Prkachin, Solomon, & Ross, 2007; Rosenthal, 2008; Spector & Orrell, 2010).

For the purposes of this study, the upper half of the model was tested, for pain presence, intensity, and impact. The sociodemographic factors included in the study are age, sex, education, religion, ethnicity, income, marital status, and language conversation. The cognitive factors are executive function, memory, and psychomotor speed. The physical factors are life-space, falls, and physical function and activity. The biological factors are comorbidities, medication and other treatment use, white blood cell count, albumin, and total cholesterol. The psychological factors are depression, anxiety, distress, and personality. The social factors are social support and participation. These factors were selected based on previous research and are described in detail in the next sections.

For the purposes of the present study, the factors are categorized according to the Canadian Longitudinal Study on Aging (CLSA) to ensure consistency between the present study and the CLSA. It is important to note, however, that the factors work together rather than within isolated domains (Gagliese et al., 2018; Melzack & Casey, 1968).

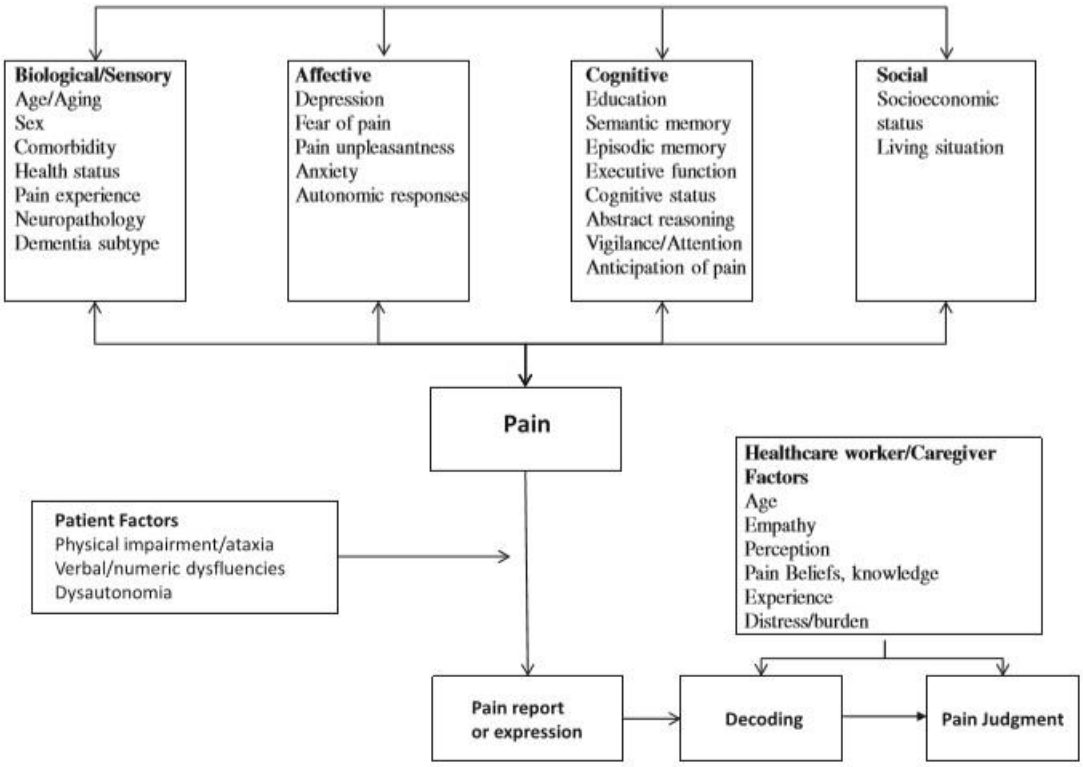

Figure 1. Biopsychosocial model of pain and aging (Gagliese et al., 2018).

CLSA

To understand pain in older people while accounting for numerous biopsychosocial variables across the lifespan, Gagliese (2009) identified a need for studies with large sample sizes and strong statistical power. The CLSA serves such a purpose as it is a national, prospective cohort study that follows 51,338 community-dwelling middle-aged and older adults (aged 45 to 85 years at baseline) for 20 years or until death (Raina et al., 2009). Assessments occur every 3 years and, for the comprehensive cohort, involve an in-home visit, a Data Collection Site (DCS) visit, and a Maintaining Contact Questionnaire (MCQ) (Raina, Wolfson, & Kirkland, 2008). At the in-home visit, CLSA-trained interviewers obtained informed consent from participants and administered a questionnaire which included sociodemographic, cognitive, physical, and

psychological information. In the DCS visit, participants underwent a physical assessment, neuropsychological testing, and completed a questionnaire about disease and social factors. In the MCQ, a limited amount of additional data were collected and contact information of participants was updated. Our objectives are compatible with the overall goal of the CLSA which is to identify ways to help the population live long and well, and to understand the various trajectories of healthy aging (Raina et al., 2009).

Pain and Aging

Cognitive Dimension

In the present study, cognitive function refers to neuropsychological test performance on domains of executive function (i.e., processing speed, prospective memory, attention, inhibition, mental control, and verbal fluency), memory (i.e., learning and retention), and psychomotor speed (Raina et al., 2008).

With age, there is a decrease in global cognitive performance (Murman, 2015). Among specific cognitive domains, there are decreases in processing speed, complex attentional tasks (i.e., the ability to focus on information while ignoring irrelevant information and to simultaneously focus on tasks), delayed memory recall, and prospective memory (Murman, 2015).

Cognitive function is also related to pain. For instance, people with pain allocate their attention differently with a bias towards pain (Oosterman, Derksen, Van Wijck, Kessels, & Veldhuijzen, 2012), which is mediated by multiple factors such as pain intensity and emotional arousal (Eccleston & Crombez, 1999). Eccleston and Crombez (1999) developed the cognitive-affective model to understand the interruptive nature of pain. In this model, attention is

understood as a cognitive resource that can be allotted to different tasks but might be interrupted by more demanding tasks (e.g., self-protection from pain). A higher intensity of chronic pain, then, can interrupt attention more than lower intensities while novel pain also disrupts attention. When the intensity of pain is reduced, attention is shifted back to the original task but in cases of chronic pain, the attention fluctuates between the pain and other tasks, emphasizing the complex relationship between pain and this aspect of cognition.

Pain is associated with other aspects of cognition as well. Among middle-aged patients with chronic pain (Pulles & Oosterman, 2011) and fibromyalgia (Verdejo-García, López-Torrecillas, Calandre, Delgado-Rodríguez, & Bechara, 2009), higher pain intensities were associated with lower cognitive performance. Specifically, higher pain intensities were found to be associated with slower mental processing speed but not immediate and delayed memory or phonological fluency (Pulles & Oosterman, 2011). The nonuniform changes are also seen in larger population-based studies. In the Paquid study, older people with moderate or severe chronic pain, showed poorer global cognition than those with none or mild chronic pain; however, when analysing specific measures of cognition, results showed a steeper decline of processing speed in older adults with pain compared to those with none or mild pain after accounting for depression, comorbidities, and opioids (Rouch et al., 2021). In another sample from the Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly (MOBILIZE) study, older people who reported severe pain or high pain impact performed poorly on measures of executive function and memory when compared to those with less or no pain (Van Der Leeuw et al., 2016). After adjusting for attention, however, the associations were reduced (Van Der Leeuw et al., 2016). This might be due to the attentional demands of pain taking precedence over other tasks (Oosterman et al., 2012).

Age differences in the relationship between cognition and pain are unclear. When compared to pain-free controls, people with chronic pain performed poorly on memory tasks (i.e., measures of visual episodic, working, semantic, and verbal episodic memory); however, when including the interaction between chronic pain and age in the analysis, there was no significant contribution to poor performance on any memory task (Oosterman, Derksen, Van Wijck, Veldhuijzen, & Kessels, 2011). The authors suggest that the discrepant finding could be due to the small sample size and few participants over the age of 75 years. Another study examining the interactions between age, pain, and cognition found that pain was associated with poorer performance on executive function and episodic memory tasks in younger people, but this relationship was either absent or reversed (i.e., less pain associated with lower cognition) in older people (Oosterman, Gibson, Pulles, & Veldhuijzen, 2013). The authors suggest that with increasing age, poor cognition might be explained by factors other than pain, such as structural changes in the brain.

Since cognitive decline is nonuniform across cognitive domains, measuring specific cognitive domains might lead to more sophisticated insights compared to global measures of cognition. Johnson, Lui, and Yaffe (2007), for instance, found that poor performance on a specific measure of executive function was a stronger correlate of functional decline when compared to a global measure of cognition in older women. The CLSA offers numerous valid and reliable measures of specific aspects of cognition that span the domains of executive function, memory, and psychomotor speed that were tested within the current study.

Physical Dimension

Life-space is an index of a person's physical and social mobility, and general health, as they move through their physical environments, ranging from their home to outside their geographic area (P. S. Baker, Bodner, & Allman, 2003; Byles, Leigh, Vo, Forder, & Curryer, 2015). It also tracks an individual's ability to live independently by indexing transportation assistance to reach the different life-space levels (P. S. Baker et al., 2003). It is gaining increasing attention in geriatric research (Béland et al., 2018) and is helpful in understanding health outcomes compared to more traditional measures of functional status (Boyle, Buchman, Barnes, James, & Bennett, 2010). Importantly, life-space is associated with multiple demographic, medical, environmental, and biopsychosocial factors to understand mobility in the real world (Boyle et al., 2010; James, Boyle, Buchman, Barnes, & Bennett, 2011; Mackey et al., 2014, 2016).

Previous studies have consistently shown that life-space decreases with age (Buss, Wolf-Oostermann, & Strupeit, 2017; J. Johnson, Rodriguez, & Al Snih, 2020; Suzuki, Kitaike, & Ikezaki, 2014). Studies of life-space that consider pain, however, are scarce. In one study examining pain in relation to life-space in older adults, bothersome pain was found to be associated with decreased life-space scores along with walking difficulties and depressive symptoms, after accounting for age, sex, and disease severity (Rantakokko, Iwarsson, Slaug, & Nilsson, 2019). However, pain presence, intensity, and impact were not all simultaneously included in the study and the population was restricted to Parkinson's disease patients. In another study of older adults with orthopaedic diseases, life-space scores did not differ between those with and without pain; however, this study only examined the relationship between pain and life-space using bivariate testing (i.e., t-test) (Suzuki et al., 2014). Since life-space is associated with

numerous variables, the inclusion of it in multivariate analysis might have led to more insightful findings.

Given the possible important role that life-space plays in mobility and aging, and the gaps in our knowledge regarding its relationship to pain, it was important to include this variable in the present study.

Falls. In the present study, falls refers to whether a fall and resultant injury occurred over a 12-month period and if any health care was sought (Raina et al., 2008). Falls are a major health concern in the older population (Kitayuguchi et al., 2017) and pain is a risk factor for single and multiple falls (Altintas & Aslan, 2019; Cederbom & Arkkukangas, 2019; Crowe et al., 2017; Kitayuguchi et al., 2017; Munch et al., 2015; Welsh, Mallen, Ogollah, Wilkie, & McBeth, 2019). For instance, a review paper found that 51% of older adults with pain but only 26% of those without pain reported at least one fall in a 12-month period (Stubbs, Binnekade, et al., 2014). More recently, studies found a higher risk of falls among older women (Marshall et al., 2016) and men (Marshall et al., 2017) with back pain compared to those with no pain. Among older men, “any pain” (i.e., of moderate or great pain impact) was the strongest risk factor for falls when compared to hip or knee joint pain, even after controlling for factors such as physical function, medical conditions, and medications (Munch et al., 2015). Finally, increased pain intensity is also associated with increased risk of falls in older people (Altintas & Aslan, 2019; Awale et al., 2017; Kitayuguchi et al., 2017).

Various factors such as local joint pathology (e.g., arthritis), neuromuscular effects of pain, and pain impact on cognitive domains such as executive function might contribute to an increased risk of falls in older adults (Stubbs, Binnekade, et al., 2014). In particular, the risk of

falls in older adults is higher when examining multiple biopsychosocial risk factors (i.e., physical and cognitive impairment, depression, physical inactivity, chronic conditions, and medications) together, rather than looking at the risk factors separately (Ek et al., 2018). This supports a biopsychosocial approach to be used when studying falls in older adults with pain; however, falls have not yet been examined within the biopsychosocial model of pain and aging. The present study addressed this gap by testing the role of falls within the model.

Physical function and activity. Physical function is the ability to conduct daily tasks and leisure activities without difficulty (Caspersen, Powell, & Christenson, 1985) and has become a common outcome measure in geriatric research (Reuben et al., 2004). Low performance on a physical function test battery has been associated with multiple variables such as increased age, depressive symptoms, and medication use (Chalé-Rush et al., 2010).

Physical activity is bodily movement that results in energy expenditure (Caspersen et al., 1985). In older adults, physical activity can slow cognitive decline (Bherer, Erickson, & Liu-Ambrose, 2013; Penedo & Dahn, 2005) by modulating brain structures (e.g., forming new synapses, increasing cerebral blood flow) (Maldonato et al., 2018). It may indirectly enhance cognition by improving health conditions (e.g., stress, heart disease) (Bherer et al., 2013), executive function (Colcombe & Kramer, 2003), and psychomotor speed (Karssemeijer et al., 2019). Higher levels of physical activity have been associated with improved quality of life (Geneen et al., 2017) and mental health (Penedo & Dahn, 2005), fewer comorbidities (Ryan et al., 2018), and less functional decline (Scudds & Østbye, 2001), while low levels of physical activity have been associated with poor physical and mental health (Resnick et al., 2018).

In older people, there is a decline in physical function and activity with age (Alcock, O'Brien, & Vanicek, 2015; Mcphee et al., 2016). In addition to its relationship with age, increased levels of physical activity are associated with reduced pain (Geneen et al., 2017; O'Reilly, Muir, & Doherty, 1999; Scudds & Østbye, 2001). Physical activity is associated with increased self-efficacy (Scudds & Østbye, 2001) and can contribute in other ways to pain management (Horgas, 2017). For example, aerobic activity aids in weight loss, which reduces pressure on the joints and strength training supports bone and cartilage, which reduces stiffness (Geneen et al., 2017). Pain is related to physical function as it is associated with mobility problems and sedentary behaviour (Vancampfort, Stubbs, & Koyanagi, 2017).

While physical function and activity are different constructs, they are related to each other (Chalé-Rush et al., 2010; Edholm, Nilsson, & Kadi, 2019). For instance, older adults who perform <150 minutes of physical activity per week performed worse on a physical function test of gait speed compared to those with ≥150 minutes of physical activity per week (Chalé-Rush et al., 2010). Additionally, in middle-aged women with rheumatoid arthritis, a small to moderate association between physical function and activity was found, suggesting that those with increased physical function might also be more physically active (Piva, Almeida, & Wasko, 2010). Studies with larger sample sizes, and consistent measures across time are needed to further understand physical function and activity in the older population (Geneen et al., 2017).

Performance-based and self-reported measures were used to assess physical function and activity in the current study. The former objectively assesses a person's ability to complete a task whereas the latter assesses a person's perception of their own ability to perform a task (Brach, Vanswearingen, Newman, & Kriska, 2002; Piva et al., 2010). It has been found that performance-based measures are more likely to identify functional limitations when compared to

self-reported measures in older adults (Brach et al., 2002). However, performance-based and self-reported measures are often complementary and together more comprehensively report on a variable of interest (Brach et al., 2002; Reuben, Valle, Hays, & Siu, 1995). While physical function and activity may have many beneficial effects, no studies have yet examined both in the biopsychosocial model of pain and aging while using a large sample size with multiple measures. This study addressed this gap and expands our current knowledge on the effects of physical function and activity in middle-aged and older adults.

Biological Dimension

Sex refers to biological attributes such as physiological (e.g., chromosomes) and physical (e.g., reproductive anatomy) features, and is expressed as a man or woman (Canadian Institutes of Health Research, 2020). Gender is a socially constructed behaviour, role, and expression that is not confined to a binary identity and can change with time (Canadian Institutes of Health Research, 2020). The present study examined biological sex since it is collected by the CLSA and more frequently used in studies of pain (Dance, 2019; Raina et al., 2008; Sorge & Totsch, 2017).

In general, pain is more prevalent in women than men (Bartley & Fillingim, 2013; Scudds & Østbye, 2001; Zimmer & Zajacova, 2018), and women may have a greater risk for chronic pain conditions compared to men (Bartley & Fillingim, 2013; Fillingim, King, Ribeiro-dasilva, Rahim-Williams, & Riley III, 2009; Mogil, 2012). However, sex differences may not be uniform across the different types and intensities of pain. For instance, there may be a greater risk of neuropathic pain, higher prevalence of back pain and migraines (Fillingim et al., 2009), and higher reports of clinical (Mogil, 2012) and musculoskeletal pain in women compared to men,

but little differences between the sexes in cancer pain (Fillingim et al., 2009). Fillingim et al. (2009) also concluded that women were more sensitive than men to experimentally-applied pressure and electrical painful stimuli, but no sex differences were found with ischemic stimuli.

When investigating pain intensity that may be limiting (i.e., difficulty in performing usual activities), Zimmer and Zajacova (2018) found that older women reported severe or limiting pain more frequently compared to older men, but mild or moderate nonlimiting pain was reported almost equally between the sexes. Another study investigating postoperative pain in younger and older adults found women had higher pain intensities compared to men, regardless of age group (Gagliese et al., 2008).

Sex, on its own, cannot account for variability in pain (Defrin, Eli, & Pud, 2011). Instead, sex differences in pain are associated with a range of biological, psychological, and social factors (Bartley & Fillingim, 2013; Fillingim et al., 2009). When considering pain mechanisms, for example, differences in sex hormones might contribute to pain since estrogen and testosterone influence pain sensitivity (Dance, 2019). Additionally, sex differences in pain might be diminished following the hormonal changes associated with menopause (Dance, 2019). When considering phenotype, women may have lower tolerance of pain than men, resulting in an increased report of pain syndromes (Mogil, 2012). When considering psychosocial and systemic factors, women may seek health care more frequently than men, and thus, report pain more often than men (Mogil, 2012). In an interesting study of university students by Fowler et al. (2011), men who were primed with feminine cues before responding to a cold pressor task reported less pain compared to men not primed with a feminine cue. The authors suggest that the former group might have felt that a feminine cue made them appear less masculine and so, to combat that, they

underreported pain. These studies demonstrate the different pathways in which pain and sex are associated with each other.

Taken together, there is evidence of a relationship between sex and pain; however, the relationships between sex, age, and pain are less clear. The CLSA offers an opportunity to further understand sex in middle-aged and older adults through the examination of an equally distributed sample of men and women.

Comorbidities and medications. Comorbidity is defined as the co-occurrence of multiple chronic conditions with the condition under investigation (Gulbech Ording & Toft Sørensen, 2013; Valderas, Starfield, Sibbald, Salisbury, & Roland, 2009), which in this case, is pain (Siddall & Cousins, 2004). It is an important measure of health in studies of aging (Blyth et al., 2008) and pain (Leong, Farrell, Helme, & Gibson, 2007). Polypharmacy is the intake of five or more medications (Gnjidic et al., 2012). With age, there are alterations in drug distribution, absorption, metabolism, and clearance, which could lead to adverse drug reactions (Frazier, 2005; Nawai, Leveille, Shmerling, van der Leeuw, & Bean, 2017; Savvas & Gibson, 2016; Yang et al., 2019). There may also be cognitive impairments with age, which can increase the risk of medication errors (Frazier, 2005) making it important to understand. Both comorbidities and polypharmacy can complicate pain management in older adults (Paladini, Fusco, Coaccioli, Skaper, & Varrassi, 2015; Savvas & Gibson, 2016) and lead to higher health costs due to increased health care utilization (Garin et al., 2016).

As the population ages, there will be an increase in the prevalence of chronic conditions (Gulbech Ording & Toft Sørensen, 2013; Held et al., 2016; Patel et al., 2017), possibly due to an accumulation of risks over the lifespan (Dunn, 2010). 31% of adults over 65 years have two or

more chronic conditions (Roberts, Rao, Bennett, Loukine, & Hayaraman, 2015). In addition to comorbidities, at least 40% of older adults take more than five prescribed medications (Savvas & Gibson, 2016), and older adults over the age of 40 are ten times more likely to take four or more medications daily compared to those aged 20 to 39 (A. W. Taylor et al., 2010). In older men, the prevalence of multiple conditions and polypharmacy are high across five age groups (ranging from 70 years of age to over 90), with the prevalence of polypharmacy further increasing in older age groups (Noguchi et al., 2016).

When studying pain in older adults, it is important to examine both individual conditions (e.g., arthritis and osteoporosis) and an accumulated comorbidity count (de Luca, Parkinson, Haldeman, Byles, & Blyth, 2017; Dominick, Blyth, & Nicholas, 2012a). When examining the latter, it has been found that two or more comorbid conditions are associated with a 1.6 increase in odds of reporting pain in older adults (Dominick et al., 2012a). In a sample of older women with or without spinal pain, individual comorbid conditions (e.g., diabetes, cardiovascular conditions) and an overall increasing comorbidity count were both associated with spinal pain compared to no spinal pain (de Luca et al., 2017). Specifically, one to four comorbidities were associated with increased odds of spinal pain, with two or more comorbidities having higher odds than only one comorbidity for spinal pain. An increase in comorbidities is also associated with increased pain intensity. Specifically, older adults with four or more comorbidities reported more intense pain compared to those with zero to three comorbidities (Leong et al., 2007).

While medications are used to treat conditions, they may also exacerbate other conditions (Vincent, Whipple, McAllister, Aleman, & St Sauver, 2015). Conversely, when assessing adverse outcomes associated with medications (Gnjidic et al., 2012), it is important to consider comorbidities as it may predispose an individual to polypharmacy (Ferrari, Baraldi, Licata, &

Rustichelli, 2018). The current study tested individual comorbidities, comorbidity count, and medications using data from the CLSA.

White blood cells, albumin, and cholesterol. White blood cells are an important part of the body's defense system against invaders (Longe & Gale, 2006) and are indicators of inflammation (Ahmadi-Abhari, Luben, Wareham, & Khaw, 2013; Akintoye, Oniyide, & Owoyele, 2018). They are associated with infection, trauma, shock, and injury (Zahorec, 2001). Specifically, an increased white blood cell count is an indicator of conditions with potentially painful symptoms, such as cancer, allergies, autoimmune and inflammatory diseases, and infections (Longe & Gale, 2006; U.S. National Library of Medicine, 2020b). A decreased white blood cell count is an indicator of liver, spleen, or immune system diseases, cancer (U.S. National Library of Medicine, 2020b), poor health, and stress (Bozkurt, Arac, & Cigdem, 2019).

Albumin is a transport protein that maintains fluid pressure in the blood vessels, binds drugs, and transports hormones (Campion, DeLabry, & Glynn, 1988; Longe & Gale, 2006). It helps to prevent fluid leakage from the bloodstream into tissues (U.S. National Library of Medicine, 2020a). Decreased albumin levels might indicate kidney or liver dysfunction (U.S. National Library of Medicine, 2020a) and the presence of long-term inflammation (Visser et al., 2005). Low albumin levels might also be indicators of inflammatory bowel disease, thyroid disease, or infection (U.S. National Library of Medicine, 2020a), all of which have potentially painful symptoms according to diagnostic criteria (Longe & Gale, 2006).

Cholesterol is a lipid that aids in repairing cell membranes, manufacturing vitamin D, and creating hormones (Longe & Gale, 2006); it includes high-density lipoprotein (HDL), which prevents fat buildup, and low-density lipoprotein (LDL), which holds most of the cholesterol in

the body (Longe & Gale, 2006). When examining the presence of low back pain in middle-aged adults, cholesterol (i.e., low HDL and a high LDL/HDL ratio) was associated with back pain compared to no back pain (Yoshimoto et al., 2018). Similarly, a recent systematic review showed that people with tendon pain had lower HDL and higher LDL and total cholesterol compared to people without pain (Tilley, Cook, Docking, & Gaida, 2015).

White blood cells, albumin, and cholesterol all act as indicators of health and are related to pain. The CLSA collected biospecimen data, including white blood cell count, albumin, and total cholesterol (Raina et al., 2008), which were investigated in the current study.

Psychological Dimension

Depression, anxiety, and distress. Depression is an emotional state which affects how a person feels, thinks, and acts (American Psychiatric Association, 2020). It is associated with persistent feelings of sadness, disinterest, and it can interfere with previously valued and pleasurable activities, leading to emotional (e.g., feelings of worthlessness) and physical (e.g., fatigue) problems (American Psychiatric Association, 2020), which may be triggered by a combination of dynamic environmental, biological, and psychosocial factors (Watson, 2018). Anxiety is an emotional state that involves feelings of tension, worry, and physical symptoms such as increased heart rate (American Psychological Association, n.d.; Longe & Gale, 2006). It might be short-term or persistent as an individual thinks about previous events and/or anticipates future events (American Psychological Association, n.d.; Longe & Gale, 2006). Psychological distress includes mental and physical symptoms associated with mood changes that might be early signs of mood disorders such as anxiety disorder or major depressive disorder (American Psychological Association, 2020a). Stress is a response to physiological or psychological

stressors, influencing how individuals feel and behave (American Psychological Association, 2020b).

The relationship between age and depression is unclear with reports that the prevalence of depression increases (Akram & Malik, 2019; Solhaug, Romuld, Romild, & Stordal, 2012; Zis et al., 2017) or decrease with age (Orhurhu et al., 2019) or that that the relationship between age and depression is curvilinear (Kessler, Foster, Webster, & House, 1992). Specifically, in Kessler et al.'s (1992) study, depressive symptoms were found to be high at a young age, low in middle-age, and high in older age. Similarly, another study found a higher increase in depression in those aged 76 years and older when compared to those between 45 to 74 years (Solhaug et al., 2012). The highest longitudinal increase in depression was found in those aged 75 to 79 years (aged 86 to 90 years at follow up), supporting an increase in depression between the ages of 80 to 90 years (Solhaug et al., 2012). Contrary to the above studies of the oldest age groups showing the highest rates of depression, Orhurhu et al. (2019) found that adults between the ages of 45 to 64 years had the highest rate of depression compared to the 65 to 84 years and over 84 years age groups.

Pain is associated with depression, anxiety, and distress (Akram & Malik, 2019; Creamer et al., 1999; Elbinoune et al., 2016; McWilliams, Cox, & Enns, 2003; Melzack & Katz, 2013; Riggs et al., 2018) across various pain types. Out of 271 older adults with neuropathic pain, 75% self-reported symptoms of anxiety and 84% self-reported symptoms of stress (Akram & Malik, 2019). Out of 80 older adults with neck pain, 68% self-reported symptoms of anxiety and 56% self-reported symptoms of depression (Elbinoune et al., 2016). Further, in older adults with chronic low back pain, comorbid anxiety and depression were associated with increased pain compared to those with only anxiety or depression or neither (Oliveira, Mendonça, Sampaio,

Dias De Castro-Lopes, & De Azevedo, 2018). In middle-aged and older adults with heel pain, there was a higher level of depression, anxiety, and stress compared to those without pain (Cotchett, Munteanu, & Landorf, 2016). In the latter study, depression, anxiety, and stress were each associated with pain even after controlling for age, sex, education, and body mass index. Specifically, for every 1-point increase in depression, anxiety, and stress, the chance of having heel pain increased by 1.3, 1.3, and 1.2 times, respectively. In older adults with chronic musculoskeletal pain, improvements in depression and anxiety predicted subsequent reductions in pain intensity and impact, with improvements in depression having the biggest effect (Scott, Kroenke, Wu, & Yu, 2016). Taken together, these studies suggest that people with pain often report symptoms of depression, anxiety, and/or stress, highlighting the importance of including these variables when studying pain.

Depressive symptoms are common in people with medical conditions, including older adults with cancer pain (Fitzgerald et al., 2015; C. Lo et al., 2010) and knee pain (Han, Lee, Kang, & Chang, 2016). In the latter study, depression was associated with a 2.6 times higher prevalence of severe pain even after controlling for sociodemographic factors (Han et al., 2016). Higher depression scores were also related to more physical suffering, including pain, compared to those with lower depression scores in people with advanced cancer (Fitzgerald et al., 2015). This association persisted even after controlling for age and disease-related factors (i.e., treatment status). When comparing younger and older age groups, a systematic review concluded that depression was prevalent in advanced cancer patients with pain regardless of age (Gagliese, Gauthier, & Rodin, 2007). In another study of cancer pain and depression, results showed a steeper increase in depressive symptoms for younger people compared to older people over a 6-

month interval, which might be attributed to difficulties in coping with cancer and pain (Green & Hart-Johnson, 2010).

Taken together, depression, anxiety, and distress are all related to pain, but these relationships are less clear when considering age. The CLSA has well-validated and reliable measures of these psychological measures for use in the older population, which were tested in this study.

Personality traits are patterns of thinking, feeling, and behaving that can be expressed within social and personal contexts (Raina et al., 2008; Tolea et al., 2012). The Big Five personality domains (i.e., neuroticism, extraversion, openness, agreeableness, and conscientiousness) are comprehensive descriptions of personality (McCrae & John, 1992) and are important psychosocial determinants of health in older people (Chiao & Hsiao, 2017). Neuroticism is the tendency to feel worried, nervous, and stressed (Sutin, Stephan, Luchetti, & Terracciano, 2019; Wranker, Rennemark, Elmstahl, & Berglund, 2015); low neuroticism is also called emotional stability (McCrae & John, 1992). People high in extraversion have a social, outgoing, and active demeanour (McCrae & John, 1992; Sutin et al., 2019; Wranker et al., 2015). Openness refers to a creative, imaginative, and intellectually curious mindset with a need for experience and variety (McCrae & John, 1992; Sutin et al., 2019; Wranker et al., 2015). People high in agreeableness tend to be altruistic, nurturing, cooperative, trusting, and selfless towards others (McCrae & John, 1992; Sutin et al., 2019; Wranker et al., 2015). Conscientiousness refers to being organized, disciplined, and in control of one's impulses (McCrae & John, 1992; Sutin et al., 2019; Wranker et al., 2015).

Specht et al. (2011) examined age-related differences in mean scores of the Big Five personality traits across a 4-year interval and found that emotional stability and agreeableness

were more prevalent in older ages, while extraversion, openness, and conscientiousness were less prevalent. Social experiences, including normal transitions in life such as starting a first job, life changes such as childbirth, and individual experiences such as the death of a loved one might contribute to differences in personality characteristics over time, but more studies that investigate various factors over the lifespan alongside personality are warranted to support this (Specht et al., 2011).

Personality traits also play an important role in understanding pain in older adults (Bucourt et al., 2017). When investigating pain in people living in the community, Sutin et al. (2019) found that high neuroticism and low extraversion and conscientiousness predicted the presence of persistent pain up to 10 years after a personality assessment. However, the authors suggested that attrition during the 10-year period might have contributed to the underestimation of associations between the traits and pain since participants with traits most associated with pain were likely to withdraw from the study. In another study of middle-aged adults with chronic widespread or regional pain compared to acute pain controls, Chang et al. (2017) found that high neuroticism was associated with chronic widespread pain but no personality traits were associated with chronic regional pain compared to the controls. Another study showed that high neuroticism and low conscientiousness were associated with increased chronic pain, but emotional stability was related to decreased pain in middle-aged women (Bucourt et al., 2017). Taken together, the association between personality, pain, and age are variable. To further elucidate the relationships between them, this study tested personality traits within the biopsychosocial model of pain and aging.

Social Dimension

Social participation and support. For the purposes of the present study, social participation refers to the frequency of participation in activities such as family, friends, church, sports, educational, cultural, or physical activities. Social support refers to the perception of emotional and instrumental support, guidance, feedback, and companionship (Raina et al., 2008).

Unfortunately, the social dimension of pain has received little attention (Craig, 2009; Gagliese et al., 2018). Nonetheless, some studies highlight the importance of social participation and support in older adults since they are positively associated with health (Douglas, Georgiou, & Westbrook, 2017; Hand, Law, McColl, Hanna, & Elliott, 2014). Social participation might lead to more perceived social support in older people since they trust that other community members will provide help if required. Older adults who perceived greater social support are also more satisfied with participation because of increased companionship (Hand et al., 2014). With age, however, there might be decreases in social participation because of mortality of family and friends (Savvas & Gibson, 2016).

When considering the relationships between the social dimension and pain, there is evidence that social isolation longitudinally predicts higher pain-related interference (Karayannis, Baumann, Sturgeon, Melloh, & Mackey, 2019), while pain-related mobility and functional limitations might prevent people from participating in social activities (Rosso, Taylor, Tabb, & Michael, 2013; Theis, Murphy, Hootman, & Wilkie, 2013). The social communication model of pain (Craig, 2009) proposes that poor social relationships in people with pain might be explained by intrapersonal (e.g., personal history with pain) and interpersonal (e.g., the situational context of the pain) influences of both the person in pain and the observer (e.g., caregiver). Biological constraints of pain might restrict the person with pain to participate in social activities, while

difficulties in interpretation of pain and/or excessive concern/protectiveness by observers might also act as a restrictive factor (Craig, 2009). When considering the protective effects of social support in people with chronic pain, Finlay et al. (2018) found that a social support group provided a sense of belonging, acceptance of pain, enhanced quality of life, and reduced negative talk about pain. In another study, online social participation buffered the negative relationship between pain and depression among older people who could not perform physical or social activities because of pain (Ang & Chen, 2019).

Understanding social participation and support in relation to other variables (e.g., life-space) that are also important for social mobility is important to further understand the social dimension of pain in older adults. Thus, both social participation and support were tested in the current study.

Pain Outcomes

The CLSA has three pain measures: pain presence; pain intensity; and pain impact. They are operationally defined as whether the participant is usually free of pain or not, the level of pain that is usually experienced, and the extent of activities usually prevented by pain (CLSA, 2015e). Although pain dimensions may be related (Gagliese & Melzack, 2003), there might also be age-related differences between them (Gagliese & Katz, 2003). Thus, measuring multiple pain dimensions might better elucidate the common and unique mechanisms between them compared to a single dimension (Gauthier et al., 2018; Melzack & Casey, 1968). Given that the current study is testing a comprehensive model, it is necessary to understand these similarities and differences between three pain outcomes as they relate to the various sociodemographic,

cognitive, and biopsychosocial dimensions. To demonstrate the variability of pain in the model, all three measures were used in the current study.

Summary of Literature Review

Taken together, the literature reviewed above supports pain and aging as multidimensional constructs which are associated with variables across the cognitive, physical, and biopsychosocial dimensions. The CLSA offers an opportunity to test the biopsychosocial model of pain and aging using variables across the dimensions (outlined in Figure 2) for three pain outcomes. While the variables have been previously investigated in relation to pain and/or aging, they have never been investigated within the biopsychosocial model of pain and aging for all three pain outcomes included in the CLSA. This is the first study to our knowledge that simultaneously examines these variables in a multivariate analysis alongside sociodemographic variables and with a large sample size.

OBJECTIVES

To test the biopsychosocial model of pain and aging (Figure 2) in a large sample of community-dwelling middle-aged and older adults for three pain outcomes: (1) presence; (2) intensity; and (3) impact. One model to identify the commonalities across pain outcomes and three models to identify the uniqueness between the pain outcomes were developed. All models included age- and pain- related variables.

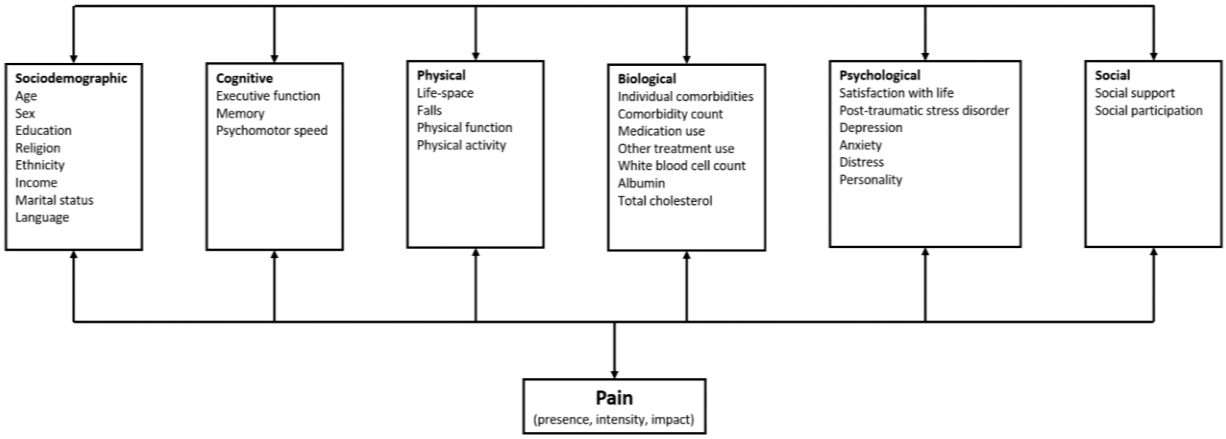

Figure 2. Biopsychosocial model of pain and aging that will be tested.

CHAPTER TWO: PROCEDURES AND METHODOLOGY

This study was part of a larger, population-based prospective cohort study (CLSA; Raina et al., 2008, 2009). Procedures and methodology are fully described in (CLSA, 2017; Raina et al., 2008, 2009) and are briefly summarized below.

Sample, Inclusion and Exclusion Criteria

51,338 people were recruited to the larger study. The 30,097 participants in the baseline comprehensive cohort (version 4.0), collected between 2012 and 2016, were included in this analysis (Raina et al., 2008, 2009).

Inclusion criteria. The CLSA included participants who (1) can read and speak either French or English; (2) lived in households and/or transitional housing arrangements; (3) were between the ages of 45 to 85 years at the time of recruitment; and (4) lived in Canada within a 25 or 50-kilometer radius from a Data Collection Site (DCS) (i.e., in Victoria, Vancouver, Surrey, Calgary, Winnipeg, Hamilton, Ottawa, Montreal, Sherbrooke, Halifax, and St. John's) (Raina et al., 2009).

Exclusion criteria. The CLSA excluded participants who (1) lived in long-term care (i.e., require 24-hour nursing care); (2) had cognitive impairment at the time of recruitment; (3) resided in one of the 3 Canadian territories, First Nation reserves and other First Nation settlements, and/or are full-time members of the Canadian Armed Forces; and (4) were temporary visa holders or had transitional health coverage (Raina et al., 2009). For the present study, participants who did not participate in an in-person visit to a DCS, did not complete the Maintaining Contact Questionnaire (MCQ), or did not answer the pain questions (for presence, intensity, and impact) were also excluded.

Recruitment

The participants were recruited through provincial health registration databases, random digit dialing (RDD), and the Quebec Longitudinal Study on Nutrition and Aging (NuAGE) (CLSA, 2017; Raina et al., 2008); they are being followed for 20 years or till death.

Provincial health registration databases. The National Coordinating Centre (NCC) created an information package (contained an introductory letter, explanation of the CLSA, consent form to be contacted, and a stamped envelope to mail the consent form to the CLSA) that was mailed to potential participants by the provincial government departments or data stewards on behalf of CLSA. The introductory letter, in the package, clarified that the CLSA did not have access to identifying information unless potential participants contacted the CLSA via a telephone number, website, or mail to receive more information about the study and indicate their interest in being contacted. Only those who mailed their contact information to the NCC were contacted (CLSA, 2017; Raina et al., 2008).

RDD. Leger received a script from the CLSA to provide a study description to potential participants. Random landline phone numbers were selected within the geographic restrictions set by CLSA and each number was contacted. If there was no answer, up to 9 further attempts were made at different days and times throughout the week. If potential participants answered the call, the study was described, and eligibility was established. The person was asked to provide their contact information (i.e., name, address, phone number, and preferred day and time of the week for a phone call from the CLSA). Contact information of all interested potential participants was sent to the CLSA on a weekly basis through encrypted electronic files. An

information package (as described above) was mailed to potential participants before the CLSA directly contacted them (CLSA, 2017; Raina et al., 2008).

NuAGE. The NuAGE study included 1,800 men and women born between 1921 and 1935; they were monitored once every 5 years. NuAge investigators asked participants if they consented to sharing their information with the CLSA. Participants between 75 and 85 years, who provided their contact information, were mailed an information package by the CLSA (CLSA, 2017).

For all recruitment strategies, the NCC forwarded the potential participants contact information to the DCS, who made the initial contact via telephone with participants to clarify if they met the inclusion criteria, answer questions, and to confirm his/her interest in participating in the CLSA, after which an in-home interview was arranged (Raina et al., 2008).

Procedure

In-home visit. Informed consent, which took approximately 15 to 20 minutes, was obtained at the beginning of the visit. It comprised of consent to participate in the CLSA (i.e., in the in-home visit and DCS visit every 3 years, and the MCQ every 1.5 years), the provision of blood and urine samples, and the linkage of provincial health information to the CLSA through health insurance numbers. If participants refused to provide blood and urine samples, they still underwent the other assessments. If participants refused to provide health insurance numbers, their public healthcare records were not linked to the information collected by the CLSA. Participants were also told how to withdraw from the study if needed.

The Comprehensive Main-wave In-home questionnaire, which took approximately 60 to 75 minutes to complete, was administered and data were collected in the following order:

sociodemographic information (i.e., age, sex, language, ethnicity, religion, and education), Rey Auditory and Verbal Learning Test (RAVLT), animal naming test, Mental Alternation Test (MAT), Life-Space Index (LSI), Satisfaction with Life Scale (SWLS), Primary Care Post Traumatic Stress Disorder (PC-PTSD) screening tool, the injury and falls module, and other sociodemographic information (i.e., retirement status and income). The interviewer arranged a visit to the DCS, explained what would happen there, and a reminder phone call was made one day prior to the visit. The in-home visit occurred between 2012 and 2015 (Raina et al., 2008).

DCS. The DCS visit took 2.5 hours to complete. Participants underwent a physical assessment, neuropsychological test battery, questionnaires, physical function test battery, and the Comprehensive Main-wave Disease Symptoms questionnaire. Prior to the assessments, participants were screened for contraindications (e.g., inability to stand or walk unassisted, or pregnancy; more detail can be found in (CLSA, 2015d; Raina et al., 2008)) and subsequently underwent the appropriate assessments. Data were collected in the following order: weight, height, body fat percentage, event-based Prospective Memory Task (PMT), Stroop test, Controlled Oral Word Association Test (COWAT), Choice Reaction Time (CRT), Medical Outcomes Study Social Support Survey (MOS-SSS), social participation questionnaire, 4-metre walk test, Timed Up-and-Go (TUG) test, standing balance test, chair rise test, grip strength, time-based PMT, and the chronic and other conditions questionnaire (including the Short Form of the Center of Epidemiologic Studies Depression Scale (CES-D10), medication, and other treatment information). Those who consented to biospecimen donation provided a blood and urine sample (i.e., white blood cell count, albumin, and total cholesterol) (Raina et al., 2008). The order of assessments at the DCS was based on prior pilot testing and the United Kingdom (UK) Biobank resource (Raina et al., 2008; UK Biobank Coordinating Centre, 2007). The DCS visit occurred

between 2012 and 2015. Participants were reimbursed $30 for their travel at the end of the visit (Raina et al., 2008).

MCQ. The MCQ took approximately 30 minutes to complete. A telephone interview was administered 18 months after the in-home interview (i.e., between 2013 and 2016), to maintain contact with the participants and acquire additional questionnaire data, including the pain and discomfort interview (i.e., pain presence, intensity, and impact), the Physical Activity Scale for the Elderly (PASE), the Kessler Psychological Distress Scale (K10), and the Ten-Item Personality Inventory (TIPI) (Raina et al., 2008).

Computer Assisted Personal Interviews (CAPI) were used by trained CLSA interviewers to administer the questionnaires and tests and to record data for the comprehensive cohort during the in-home visit and at the DCS. It reduced interviewer and data processing errors, and securely transmitted the data to the central server (housed in the NCC) at the end of each day. The Computer Assisted Telephone Interview (CATI) was used to conduct the MCQ (Raina et al., 2008).

Data Access Agreement and Ethics

A data access agreement between McMaster University and York University was negotiated and signed by both parties. It covered instructions for the use, storage, privacy, liability and publication of articles and presentations that result from the CLSA dataset (CLSA, 2018a; Raina et al., 2008). Only members (i.e., Dr. Lucia Gagliese, Tasha Fernandez, Dr. Gabriela Chaves, and Dr. Lynn Gauthier) of the identified research team had access to the data. Ethics approval has been received from York University (#e2019-375).

CHAPTER THREE: MEASURES

The following measures from the CLSA were used in the present analyses. Further details of test administration and psychometric properties are available in (CLSA, 2015d, 2015e, 2018c; Raina et al., 2008; Tuokko, Griffith, Simard, & Taler, 2017; Tuokko et al., 2019).

Sociodemographic Dimension

All sociodemographic variables were based on participant self-report. They were age, sex, education, religion, ethnicity, retirement status, household income, marital status, and language (CLSA, 2018c).

Pain Outcomes

The *Pain and Discomfort Interview* assessed the presence and intensity of pain, and whether the pain prevented participants from engaging in activities (Raina et al., 2008).

Pain Presence. Participants were asked, "Are you usually free of pain and discomfort?" They responded "yes" or "no" and the variable was coded as binary in data analyses. This measure has been previously used in the National Population Healthy Survey and the Canadian Community Health Survey which included older adults (Ramage-Morin, 2008).

Pain Intensity. On this 1-item verbal descriptor scale, participants who responded "no" to the pain presence question were subsequently asked, "How would you describe the usual intensity of your pain or discomfort? Would you say it is mild, moderate, or severe?" Participants chose the word (i.e., "mild", "moderate", or "severe") that described the usual intensity of their pain. This was coded as an ordinal variable for all data analyses and was also treated as a continuous ratio variable (i.e., scores ranged from 1-3 with higher scores indicating a higher pain intensity) for

univariate data analysis (i.e., mean ± Standard Deviation (SD)) to describe the range of pain intensity in the sample. Verbal descriptor scales are valid and reliable pain assessments tools for older adults (Gagliese & Katz, 2003; Gagliese & Melzack, 1997; Gagliese, Weizblit, Ellis, & Chan, 2005; Gauthier & Gagliese, 2011).

Pain Impact. On this 1-item verbal descriptor scale, participants who responded "no" to the pain presence question were subsequently asked, "How many activities does your pain or discomfort prevent? Would you say none, a few, some, or most?" Participants chose the word (i.e., "none", "a few", "some", or "most") that described the usual impact of their pain. This was coded as a nominal variable for all data analyses and was also treated as a continuous ratio variable (i.e., scores ranged from 1-4 with higher scores indicating a higher pain impact) for univariate data analysis (i.e., mean ± SD) to describe the range of pain impact in the sample.

Cognitive Dimension

Memory. The *Rey Auditory Verbal Learning Test (RAVLT)* (Raina et al., 2008) is a widely used neuropsychological test that measured learning and retention (Butler, Retzlaff, & Vanderploeg, 1991). In this test, a recorded voice read a list of 15 words to participants. When the recording stopped, participants were asked to recall aloud as many of the words as they remembered; this was the immediate recall portion of the test. After a 5-minute delay (i.e., delayed recall), participants were asked to recall any of the words (CLSA, 2018c). Words were read at a rate of one per second and were recorded in the order that participants recalled them. Scores ranged from 0-15 for immediate and delayed recall, with higher scores indicating better performance (Raina et al., 2008; Tuokko et al., 2019). Both immediate and delayed recall scores were included in the analyses (Tuokko et al., 2019). The RAVLT is sensitive to early cognitive

decline, has high test-retest reliability, and has been used in studies of pain in older adults (John, 2016; Raina et al., 2008; Tuokko et al., 2017).

Executive function. The *Animal Naming Test* (Tuokko et al., 2017) measured verbal fluency which is the ability to retrieve information within specified search parameters (Patterson, 2011). In this measure, the parameters were based on a semantic category, in which participants were asked to name as many animals as possible in 1-minute (Raina et al., 2008). Since the test instructions were broad, the CLSA provided two scoring algorithms to allow researchers to examine which algorithm better identified poor outcomes. In the first, strict scoring method, only taxonomically distinct animals that were different at the species level received one point. In the second, lenient scoring method, participants received one point for each unique animal named (Tuokko et al., 2017). Both scores were included in the analyses with higher scores indicating better performance (CLSA, 2018c). A score of ≤ 17 indicated cognitive impairment (Heerema & Chaves, 2020). The animal naming test is a valid and reliable test (Tuokko et al., 2017), and has been used in studies of pain in older adults (Chiou, Liu, Lee, Peng, & Chen, 2018).

The *Controlled Oral Word Association Test (COWAT)* (Raina et al., 2008) measured verbal fluency. In this task the search parameters were phonemic, in which participants were asked to generate words that began with a given letter for 1-minute. The timer began as soon as the interviewer named the letter. Three letters (i.e., F, A, and S) were used in three separate 1-minute trials. The COWAT score was the sum of the number of correct words across three trials, with higher scores indicating better performance (CLSA, 2015d; Raina et al., 2008; Tuokko et al., 2017, 2019). The COWAT is valid, reliable, and appropriate for use in older adults (Tuokko et al., 2017), and has been used in studies of pain in older adults (Heyer et al., 2000).

The *Mental Alternation Test (MAT)* (Tuokko et al., 2017) measured mental flexibility and processing speed, which is the ability to quickly track and alternate between responses (Loftis, 2016). It involved 2 parts: in part A, which was used as a screening test, participants were asked to count aloud from 1 to 20 and say the alphabet as quickly as possible. If participants could not perform the screening task, part B was not administered.

In part B, participants were asked to alternate between number and letter as quickly as possible for 30 seconds. The score was computed by summing the correct alternations from part B and ranged from 0-52, with higher scores indicating better performance (CLSA, 2018c; Raina et al., 2008; Tuokko et al., 2019). A score of ≥ 15 indicated normal performance (Billick, Siedenburg, Burgert, & Bruni-Solhkhah, 2001). The MAT is sensitive and specific for detecting cognitive impairment in older adults (Raina et al., 2008). A variation of this test (i.e., connecting lines between numbers and letters) has been used in studies of pain in older adults (Oosterman et al., 2012).

The *Miami Prospective Memory Test (MPMT)* (Raina et al., 2008) measured both event- and time-based prospective memory (i.e., the ability to remember to perform future actions (Shum & Fleming, 2011))**,** either after 15- or 30- minute delays. For event-based prospective memory, an envelope of money containing three $1 coins, one $5 bill, one $10 bill, one $20 bill, one quarter, and one nickel was placed either to the left or right of participants and within their reach while performing other tasks. The interviewer instructed participants to give the $5 bill to the interviewer and the $10 bill to themselves when the timer went off. The timer was set for 30-minutes, and participants were allowed a 1-minute grace period, after which a series of three cues were provided by the interviewer to assist participants in making a response. The event-based prospective memory task was scored according to intention to perform, accuracy, and need

for reminders. Intention to perform was scored from 0-3 (0 = provided no response to signal; 1 = provided a non-specific and non-verbal response to signal; 2 = did not grab envelope but verbally indicated that something needed to be done in response to the signal; 3 = grabbed the envelope when the timer went off). Accuracy of response was scored from 0-3 (0 = did not select the correct bills but still selected money, did not attempt to give the bills to anyone, or did not select any of the money; 1 = selected either the $5 or $10 bill and gave it to the interviewer or self; 2 = correctly selected both the $5 and $10 bills but did not give each bill to the right person; 3 = correctly selected and gave the $5 and $10 bills to the interview and self). Need for reminders was scored from 0-3 (0 = needed three reminders; 1 = needed two reminders; 2 = needed one reminder; 3 = no reminders needed).

For time-based prospective memory, an envelope containing cards with numbers written on them (i.e., 28, 14, 17, 13, and 11) and a large clock with the hands pointing to 8:00 o'clock were placed in view of participants while they were performing other tasks. The interviewer asked participants to perform three target actions: (1) interrupt the task they were performing when the hands of the clock reached 8:15 and request the envelope from the interviewer; (2) find the card with the number 17 written on it; and (3) give that card to the examiner. Participants were allowed a 4-minute grace period (i.e., until 8:19), after which the interviewer interrupted participants and a series of three cues were provided to assist them in making a response. The time-based prospective memory task was scored according to intention to perform, accuracy, and need for reminders. Intention to perform was scored from 0-3 (0 = did not interrupt the interviewer before 8:19 or interrupted the interviewer before 8:11; 1 = interrupted the interviewer between 8:11 and 8:19; 2 = interrupted the interviewer between 8:13 and 8:17; 3 = interrupted the interviewer at 8:15). Accuracy of response was scored from 0-3 (0 = did not perform any of

the three target actions; 1 = performed one target action; 2 = performed two target actions; 3 = performed three target actions). Need for reminders was scored from 0-3 (0 = needed three reminders; 1 = needed two reminders; 2 = needed one reminder; 3 = no reminders needed). After summing the scores from both tasks, the final score ranged from 0-18 with higher scores indicating better performance (CLSA, 2015d; Raina et al., 2008; Tuokko et al., 2019). A score of ≤ 12 has previously been used to differentiate between cognitively impaired and cognitively normal performance (Simard et al., 2018). The MPMT is sensitive to cognitive impairment, appropriate for use in older adults (Raina et al., 2008; Tuokko et al., 2017), and is a fairly new measure with strong potential for use in population based studies (Simard et al., 2018).

The *Stroop Neuropsychological Screening Test (Victoria)* (Raina et al., 2008) measured inhibition, attention, mental speed, and control. Participants were asked to (1) name the ink colour of printed dots; (2) read a list of words printed in different ink colours; and (3) name the colour of the ink that words (i.e., names of colours) were written in rather than read the words. The interviewer started a timer for each task after providing the cue (i.e., said "Ready, Go") to begin the task. Each trial had 100 items and scoring was computed by dividing the number of seconds to complete the third task by the number of seconds to complete the first task, with higher scores indicating worse performance (Raina et al., 2008; Tuokko et al., 2017, 2019). The Stroop test has good test-retest reliability, validity, and has been used in studies of older adults and pain (Bunk et al., 2020; Raina et al., 2008; Tassain et al., 2003; Tuokko et al., 2017).

Psychomotor speed. The *Choice Reaction Time (CRT)* (Raina et al., 2008) measured reaction time. It was a computer-administered test in which two blank boxes with an arrow underneath each box was presented on a touch screen monitor. The interviewer explained that when one empty box had a grey square appear in it, participants were required to quickly press the arrow

underneath the appropriate box. Participants were given two practice trials (i.e., the first with one practice test and the second with four practice tests), after which there were 60 test trials (Raina et al., 2008; Tuokko et al., 2017). Scoring was based on mean reaction time in milliseconds, with higher scores indicating worse performance (Tuokko et al., 2019). The CRT is valid and reliable for older adults (Tuokko et al., 2017), and a variation of this test (i.e., auditory cues) has been used in studies of pain (Kurita et al., 2012; Sjøgren, Thomsen, & Olsen, 2000).

Physical Dimension

The *Life-Space Index (LSI)* (Raina et al., 2008) measured participants patterns of mobility during the month preceding the assessment. Participants were asked about their movement in five life-space levels (i.e., "the bedroom"; "outside your home on your deck, patio, hallway in the apartment building, the garage, the yard, or driveway"; "outside your neighbourhood"; "outside your neighbourhood but within your town"; "outside your town"), the frequency at which they reached these levels, and what aids were used (i.e., personal assistance or equipment). Scores ranged from 0-120, with higher scores indicating larger life-spaces (CLSA, 2018b; Peel et al., 2005; Stalvey, Owsley, Sloane, & Ball, 1999). A cut-off score of ≤ 56 has previously been used to indicate dependence when performing daily activities (Shimada et al., 2010). The LSI is a comprehensive, reliable, and valid measure of mobility (P. S. Baker et al., 2003; Barnes et al., 2007; Peel et al., 2005; Stalvey et al., 1999) and has been used in studies of pain in older adults (Rantakokko et al., 2019).

The *Injury and Falls Module* (Raina et al., 2008) included questions about the frequency of falls within the 12 months preceding the assessment and the resultant health care usage. Participants were asked a series of questions (i.e., "How many times have you fallen in the past

12 months? What has been your most serious injury or problem due to a fall within the past 12 months? Did you receive any medical attention from a health professional within 48 hours following this injury? Were you hospitalized for this injury?") and responses were coded into four categories: "no falls"; "no serious injury or medical attention as a result of falls"; "injury with medical attention but not hospitalization as a result of falls"; and "injury with medical attention and hospitalization as a result of falls" (CLSA, 2018c). The injury and falls module has been used in a large population based study (i.e., Canadian Community Health Survey) which included older adults (Raina et al., 2008). To our knowledge, it has yet to be used in studies of pain in older adults.

Weight was measured in kilograms with the 140-10 Healthweigh digital physician scale, which can measure a person weighing up to 250 kilograms (Raina et al., 2008). Participants were asked to remove shoes, excess layers of clothing (including sweaters, sweatshirts, wallet, cellphone), and headwear (except for religious headwear), and stand on the scale with their weight placed evenly on both feet. Two measurements were taken and the average of the two was calculated (CLSA, 2016b). Participants who were unable to stand without the assistance of another person were excluded from this measure (CLSA, 2015d). This measure of weight has been previously used in older adults (Tessier, Wing, Rahme, Morais, & Chevalier, 2019; Velez et al., 2019).

Standing *Height* was measured in metres with the Seca 213 stadiometer (Raina et al., 2008). Participants were asked to step on the stadiometer platform, touch the back of their body to the pole, and inspire deeply while the measuring arm was at the top of their head. Two measurements were taken and the average of the two was calculated (CLSA, 2016b). Participants who were unable to stand without the assistance of another person were excluded from this

measure (CLSA, 2015d). This measure of height has been previously used in older adults (Tessier et al., 2019; Velez et al., 2019).

Body Fat Percentage was measured with the Hologic Discovery A^{TM} Dual energy X-ray Absorptiometry (DXA) (Raina et al., 2008). Participants were asked to close their eyes while laying in a stationary supine position in the middle of the table until the scan was complete. The rotational arm increased efficiency and comfort for participants. Participants who were pregnant, unable to stand without the assistance of another person, involved in a nuclear medicine study within the last 2 days, had intravenous contrast media or magnetic resonance imaging tests within the previous 24 hours, or had a barium test within the last 7 days were excluded from this measure (CLSA, 2015d). The DXA is a valid and reliable measurement of total and fat body mass (Glickman, Marn, Supiano, & Dengel, 2004; Raina et al., 2008) and has been used in older adults (Auyeung et al., 2010; Donges & Duffield, 2012) including those with pain (Ehsanbakhsh et al., 2011).

The *4-Metre Walk Test* assessed gait speed (Raina et al., 2008). In this test, participants were asked to walk along a 4-metre line at their own pace. Participants were given one practice trial, after which the interviewer instructed participants to start the test after hearing the cue (i.e., "Ready, Set, Go"). The interviewer started the stopwatch immediately after providing the cue and stopped the watch once participants completely crossed the finish line (CLSA, 2014c). Participants who were unable to stand or walk without the assistance of another person were excluded from this measure (CLSA, 2015d). The total time, in seconds, to walk the line was reported, with more time indicating slower gait and worse physical function (Cesari et al., 2008; Raina, Wolfson, Kirkland, & Griffith, 2018). A time of > 5 seconds to walk the line indicated an increased risk of frailty (BC Guidelines, 2017). The 4-metre walk test has good test-retest

reliability and inter-rater reliability (Raina et al., 2008) and has been used in older adults (Cesari et al., 2008; Demnitz et al., 2018) including those with pain (Cecchi et al., 2009).

The *Timed-Up-and-Go (TUG) Test* measured mobility and balance (Raina et al., 2008). A CLSA interviewer asked participants to sit in a chair, placed their arms resting on the arm rests, and then asked participants to stand up, walk to a line on the floor 3 metres away, turn around, walk back to the chair, and sit down. Participants were given one practice trial if needed, after which the interviewer instructed the participant to start the test after hearing the cue (i.e., "Ready, Set, Go"). The interviewer started the stopwatch immediately after providing the cue and stopped the watch after participants sat in the chair. If participants had visual problems, the interviewer informed them when to turn and when they reached the chair (CLSA, 2014d). The CLSA did not specify visual impairments accommodations for the other tests included in the study. Participants who were unable to walk, stand, or rise from a chair without the assistance of another person were excluded from this measure (CLSA, 2015d). The test was scored according to how much time (in seconds) participants took to complete the task, with more time indicating worse balance and walking ability and lower physical functioning (Raina et al., 2008). A score of > 14 seconds indicated an increased risk of falls (Shumway-Cook, Brauer, & Woollacott, 2000). The TUG test is valid, reliable, and has been used in older adults (Bohannon, 2006; Spagnuolo, Jürgensen, Iwama, & Dourado, 2010) including those with pain (Hirano et al., 2014).

The *Standing Balance Test* measured the ability to stand upright or to be in control of body movement (Raina et al., 2008). Participants were asked to remove their shoes, position themselves 1-metre from the wall facing it, and lift their dominant leg to the calf level with the knee bent and hands placed on their waist for 1-minute. The test was then repeated with the non-dominant leg. Timing started when the foot left the ground and stopped when the foot touched

the ground, participants lost balance, touched the wall, started to hop, and/or 1-minute was reached on the timer (CLSA, 2014b). Spotters were provided by the CLSA in case participants lost balance (Raina et al., 2008). Participants who were unable to stand without the assistance of another person or used a cane or walker to stand or rise from a chair were excluded from this measure (CLSA, 2015d). Participants were allowed a practice trial, after which the test score was calculated by recording the best attained time (in seconds) participants stayed in a balanced position, with more time indicating better balance and physical functioning (Raina et al., 2008). The standing balance test is valid and reliable (Bohannon & Leary, 1995), and has been used in older adults (Bohannon, Larkin, Cook, Gear, & Singer, 1984; Demnitz et al., 2018) including those with pain (Cecchi et al., 2009).

The *Chair Rise Test* measured balance, coordination, and leg strength (Bohannon, 1995). Participants were asked to sit far back in the chair with their feet positioned at hip distance apart and placed firmly on the floor. The knees were positioned at a 90-degree angle with the arms crossed over the chest. Participants were asked to stand up and sit down five times in a row as fast as possible, without using their hands to assist and without resting in between. One practice trial was allowed, after which the interviewer instructed participants to start the test after hearing the cue (i.e., "Ready, Set, Go"). The interviewer started the stopwatch immediately after providing the cue and counted each chair stand aloud when participants reached the standing position. Timing was stopped on the fifth stand (CLSA, 2014a). Participants who were unable to stand or rise from a chair without the assistance of another person or used a cane or walker to stand or rise from a chair were excluded from this measure (CLSA, 2015d). The amount of time (in seconds) required to complete the task was used for scoring, with less time indicating greater leg strength, and better balance and physical functioning (Raina et al., 2008, 2018). A score of >

12 seconds indicated an increased risk of falls (Tiedemann, Shimada, Sherrington, Murray, & Lord, 2008). The chair rise test is reliable (Bohannon, 1995) and has been used in older adults (Cesari et al., 2008; Demnitz et al., 2018; Kuh, Bassey, Butterworth, Hardy, & Wadsworth, 2005) including those with pain (Cecchi et al., 2009).

Hand Grip Strength measured overall strength (Raina et al., 2008). It was measured through the Tracker Freedom Wireless Grip Dynamometer, which provided fast, accurate, and reliable evaluation. Participants were asked to sit in a straight-backed chair with feet flat on the floor, shoulders relaxed with arms close to the body and unsupported, and elbows flexed at a 90-degree angle. They were instructed to squeeze the dynamometer with the dominant hand and with as much force as possible for three trials, with a rest period of 15-seconds between trials to prevent muscle fatigue and the force was recorded in kilograms (CLSA, 2016a). Participants who had surgery on both hands or wrists within the last 3 months; pain or paralyses in both hands or wrists due to arthritis, tendinitis, or carpal tunnel syndrome; open sores or bruising on both hands; casts on both hands or arms; or prosthetic arms, hands, or fingers were excluded from this measure (CLSA, 2015d). The repetition with the highest value was used for scoring, with higher kilograms indicating greater strength and better physical function. A score of < 37 kilograms in men and 21 kilograms in women indicated an increased risk of mobility limitation (Sallinen et al., 2010). The hand grip strength test has been previously used in studies of pain in older adults (Hirano et al., 2014).

The *Physical Activity Scale for the Elderly (PASE)* (Washburn, Smith, Jette, & Janney, 1993) is a 10-item questionnaire about physical activity in the context of leisure time, household, and work-related activities, in the past week. It addressed traditional domains of activity as well as activities more commonly performed by older adults. (Raina et al., 2008). The score was

computed through weights and frequency values for each item (NERI, 1991; Washburn & Ficker, 1999; Washburn, 2000; Washburn et al., 1993); and ranged from 0-400 or more, with higher scores indicating more physical activity (NERI, 1991; Washburn & Ficker, 1999; Washburn, 2000; Washburn et al., 1993). A score of < 111 has been previously used to indicated severe physical inactivity (DePew, Garofoli, Novotny, & Benzo, 2012). The PASE has been shown to have good validity (Schuit, Schouten, Westerterp, & Saris, 1997; Washburn & Ficker, 1999) and reliability in older adults (Washburn et al., 1993). It has also been used in older adults with pain (Glass et al., 2013; Neogi et al., 2010).

Biological Dimension

Comorbidities were assessed with the *Questionnaire On Chronic Conditions* (Raina et al., 2008), in which participants were asked if a doctor ever told them they had one or more of 47 conditions and responded either "yes" or "no" for each (CLSA, 2015d). Due to overlap between conditions, they were collapsed into 29 conditions (Longe & Gale, 2006). These included: Back Problems or Pain; Allergies; Hypertension; Osteoarthritis; Traumatic Brain Injury; Mental Health Conditions (Mood Disorder, Anxiety Disorder, or Clinical Depression); Urinary Incontinence or Urinary Tract Infection; Diabetes; Heart Disease (Including Congestive Heart Failure, Myocardial Infarction, or Angina); Cancer; Hypo- or Hyper- Thyroidism; Asthma; Migraine; Bowel Disorder (including Crohn's Disease, Ulcerative Colitis, or Irritable Bowel Syndrome) or Incontinence; Osteoporosis; Intestinal or Stomach Ulcers; Influenza; Chronic Obstructive Pulmonary Disease; Peripheral Vascular Disease; Stroke, Mini-Stroke, or Transient Ischemic Attack; Rheumatoid Arthritis; Kidney Disease or Failure; Pneumonia; Epilepsy; Multiple Sclerosis; Macular Degeneration; Memory Problems or Dementia; Parkinson's Disease;

and Other Physical or Mental Conditions (including Other Arthritis or Infections) (Longe & Gale, 2006; Raina et al., 2008). This questionnaire has good internal consistency and test-retest reliability in older adults (Raina, Bonnett, Waltner-Toews, Woodward, & Abernathy, 1999). Conditions were also categorized into Conditions with Potentially Painful Symptoms or without Potentially Painful Symptoms according to diagnostic criteria (Longe & Gale, 2006). For the present analyses, a total Count of Comorbidities was created ranging from 0-18, with higher scores indicating more comorbidities.

Medication Use was assessed during the *Questionnaire On Chronic Conditions* (Raina et al., 2008), in which participants were asked if they took medication for one or more of 13 conditions and responded either "yes" or "no" for each (CLSA, 2015d). Due to overlap between conditions, responses were collapsed into 11 conditions with reported medication use: Hypertension; Hypo- or Hyper- Thyroidism; Diabetes; Depression; Respiratory Problems; Osteoporosis; Arthritis; Stroke or Mini-Stroke; Heart Disease; Parkinson's Disease; and whether they have ever taken Systemic Corticosteroids (Longe & Gale, 2006; Raina et al., 2008). For the present analyses, the Count of Medications was derived and ranged from 0-7, with higher scores indicating more medication use.

Other Treatment Use was assessed with the *Questionnaire On Chronic Conditions* (Raina et al., 2008). Participants were asked if they were currently undergoing other treatment for one or more of 5 conditions and responded either "yes" or "no" for each (CLSA, 2015d). Since medication was the only treatment participants were directly interviewed about, "other treatment" was left up to interpretation by the participant and would be considered as any treatment other than the medications they reported. Due to overlap between conditions, responses were collapsed into 4 conditions with reported other treatment use: Hypertension; Depression;

Stroke or Mini-Stroke; and Parkinson's Disease (Longe & Gale, 2006; Raina et al., 2008). For the present analyses, the Count of Other Treatments was derived and ranged from 0-3, with higher scores indicating more conditions with reported other treatment use.

Blood and *Urine* samples were collected from participants who consented to donating biospecimens (Raina et al., 2008). White blood cell count, albumin, and total cholesterol were measured from the blood and urine samples. For the blood collection, participants were asked to sit in a phlebotomy chair and to remove any food or drink from the mouth. Next, participants were asked to extend both arms so that the veins were accessible. They were offered a pillow to support the arm if needed and were instructed to rotate their arm with the palm towards the ceiling. A tourniquet was placed 10 centimetres (cm) above the site chosen for venipuncture and applied for a maximum of 1-minute at a time. Participants were asked to clench their fist, during which the site was cleaned with an alcohol wipe and participants were informed that the venipuncture was about to occur. About 50 millilitres (mL) of blood were drawn, after which pressure was applied to the site until bleeding stopped and a bandage was applied for a minimum of 15-minutes (CLSA, 2015b).

For the urine sample, a container was provided to participants who were directed to a washroom and instructed to wash their hands with soap and water, remove the lid of the container without touching the inside, urinate into the container, cover the container with the lid to seal it and prevent leakage, and wash hands with soap and water (CLSA, 2015c). Detailed steps on the post-collection processes of these biospecimens can be found in (CLSA, 2015a). Those who had chemotherapy within the last 4 weeks, haemophilia or other blood clotting disease, received blood transfusion or donated blood in the last 24 hours, surgery of both arms,

breasts, or both sides of the chest within the last 3 months, arteriovenous shunt, a cast, or prosthetic arms were excluded from these measures (CLSA, 2015d).

Psychological Dimension

The *Satisfaction With Life Scale (SWLS)* (Diener, Emmons, Larsen, & Griffin, 1985) is a 5-item measure of life satisfaction in which participants were asked about their overall judgement of life (Raina et al., 2008). Participants responded on a 7-point Likert scale and the final score ranged from 5-35, with higher scores indicating greater satisfaction (Diener et al., 1985). A score of < 20 indicated dissatisfaction (Pavot & Diener, 2013). The SWLS has high internal consistency, temporal reliability, and validity, and can be used in different age groups including older adults (Arrindell, Meeuwesen, & Huyse, 1991; Diener et al., 1985; Raina et al., 2008). It has also previously been used in studies of pain in older adults (Motl, McAuley, Snook, & Gliottoni, 2009; Walker, Esterhuyse, & Van Lill, 2010).

The *Primary Care Post-Traumatic Stress Disorder (PC-PTSD)* (Prins et al., 2003) is a 4-item screening tool for PTSD. Participants were asked about four factors that were specific to PTSD (i.e., re-experiencing, numbing, avoidance, and hyperarousal) to which they responded either yes or no (Raina et al., 2008). Scores ranged from 0-4, with a cut-off score of ≥ 3 indicating PTSD (Prins et al., 2003). The PC-PTSD tool is sensitive, specific, and efficient. It has been used in older adults (Prins et al., 2003; Raina et al., 2008) including those with pain (Langford et al., 2018; Outcalt et al., 2015).

The *Short Form of the Center for Epidemiologic Studies Depression Scale (CES-D10)* (Andresen, Malmgren, Carter, & Patrick, 1994) is a 10-item measure of depression symptomatology over the last week, in which participants responded on a 4-point Likert scale

(Raina et al., 2008). The total score for the scale ranged from 0-30. Scores ≥ 10 indicated those with clinically relevant depressive symptomatology (Andresen et al., 1994). The CES-D10 is valid and reliable (Andresen et al., 1994; Raina et al., 2008) and has been used in studies of pain with older adults (J. Lee, Jang, & Cho, 2018).

The *Kessler Psychological Distress Scale (K10)* (Kessler et al., 2002) is a 10-item measure of non-specific psychological distress in which participants were asked about how they were feeling in the past 30 days and responded on a 5-point Likert scale (Raina et al., 2008). The total score for the scale ranged from 0-50, with higher scores indicating more distress (CLSA, 2015e; Kessler et al., 2003; Raina et al., 2008). A person whose score was 10-19 is likely not to have psychological distress, 20-24 is likely to have a mild psychological distress, 25-29 is likely to have a moderate psychological distress, and 30-50 is likely to have a severe psychological distress (Victorian Government Department of Human Services, 2002). The K-10 has high internal consistency, diagnostic accuracy, and can be used as a broad screening scale for mental illness (Kessler et al., 2002; Raina et al., 2008). The K10 has been used in studies of pain with older adults (Dominick et al., 2012a; Hill et al., 2007).

The *Ten-Item Personality Inventory (TIPI)* (Gosling, Rentfrow, & Swann Jr, 2003; Raina et al., 2008) measured the Big Five personality traits (i.e., Openness, Conscientiousness, Extraversion, Agreeableness, and Emotional Stability). Participants were presented with ten pairs of personality traits and asked to indicate whether they disagreed strongly, disagreed moderately, disagreed a little, neither agreed nor disagreed, agreed a little, agreed moderately, or agreed strongly with each pair. Scores ranged from 1-7 for each Big Five personality trait, with higher scores indicating the respective personality type. The TIPI has good construct validity and test-

retest reliability (Gosling et al., 2003; Raina et al., 2008). It has been used in older adults (Loke, Abdullah, Chai, Hamid, & Yahaya, 2011) including those with pain (Krok & Baker, 2014).

Social Dimension

Social support was assessed with the *Medical Outcomes Study Social Support Survey (MOS-SSS)* (Sherbourne & Stewart, 1991). It is a 19-item measure of emotional, informational, tangible, positive social interaction, and affectionate support in which participants were asked if these types of support were available to them if needed (Raina et al., 2008). Participants responded on a 5-point Likert scale, with higher scores indicating greater perceived social support (CLSA, 2015d; Sherbourne & Stewart, 1991). The MOS-SSS has high validity and reliability (Raina et al., 2008; Sherbourne & Stewart, 1991), and is universally applicable (Raina et al., 2008) including in studies of pain with older adults (Gauthier et al., 2018, 2009).

Social participation was assessed with a questionnaire on the *Frequency Of Participant Involvement In Social Activities* in the past 12 months (Raina et al., 2008). These included family, friends, church, sports, educational, cultural, or physical activities. The CLSA categorized participants into five categories: “did not participate”; “participated at least once a year”; “participated at least once a month”; “participated at least once a week”; and “participated at least once a day” (CLSA, 2015d). The questions have previously been used for older adults (Raina et al., 2008).

For the order in which all measures were collected, please refer to Figure 3.

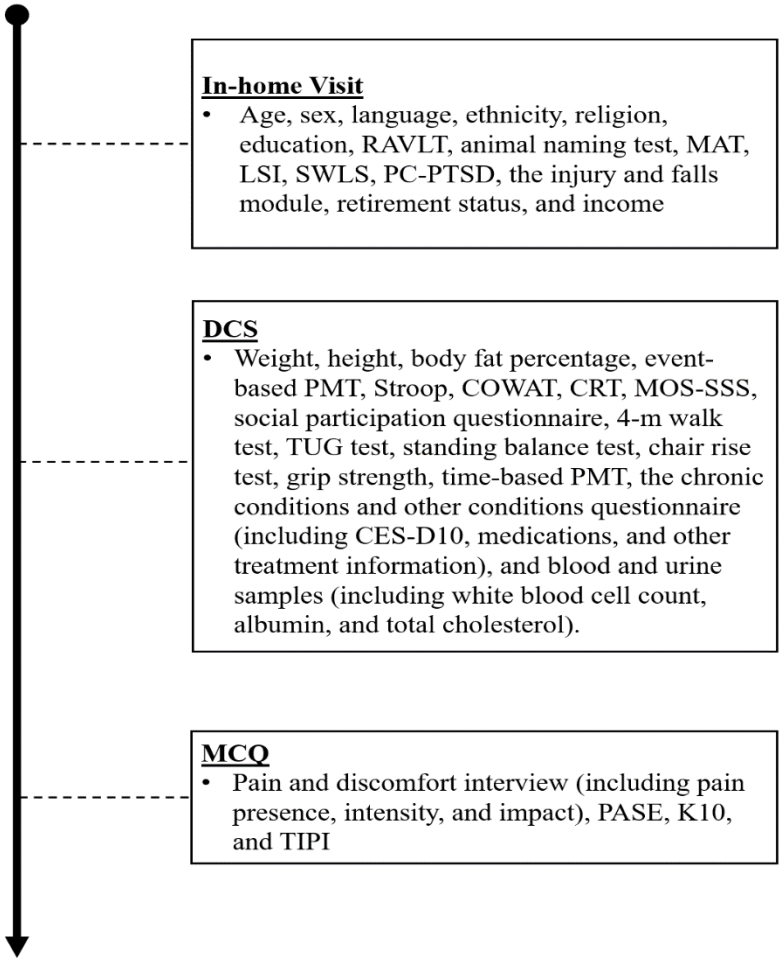

Figure 3. Order of measures collected by the CLSA beginning with the in-home visit, the DCS, and the MCQ.

RAVLT = Rey Auditory Verbal Learning Test; MAT = Mental Alternation Test; LSI = Life-Space Index; SWLS = Satisfaction With Life Scale; PC-PTSD = Primary Care Post-Traumatic Stress Disorder; PMT = Prospective Memory Task; COWAT = Controlled Oral Word Association Test; CRT = Choice Reaction Time; MOS-SSS = Medical Outcomes Study Social Support Survey; CES-D10 = short form of the Center for Epidemiologic Studies Depression Scale; PASE = Physical Activity Scale for the Elderly; K10 = Kessler Psychological Distress Scale; TIPI = Ten-Item Personality Inventory.

CHAPTER FOUR: DATA ANALYSES

Missing Data

Missing data were coded into user-designated missing values; imputation was not conducted due to the use of valid skip-pattern questioning in CLSA data (Raina et al., 2008). When possible, pairwise deletion was used in bivariate and multivariate analyses for missing values to maximize usage of data.

Descriptive Statistics

To characterize the sample, frequency distributions and valid percent were calculated for categorical variables; means and standard deviations for normally distributed continuous variables; and medians and interquartile ranges for non-normally distributed continuous variables. Due to the varying amounts of missing values for individual comorbidities, Conditions with Reported Medication Use, and Conditions with Reported Other Treatment Use, frequencies and percent were calculated since valid percent would portray a less comparable percentage for each. To check for a normal distribution, histograms, and absolute skewness and kurtosis values were examined; skewness above 2 and kurtosis above 7 represented a non-normal distribution (H.-Y. Kim, 2013). Appropriate transformations were applied as needed to convert the data to a normal distribution (Field, 2009; Tabachnick & Fidell, 2013).

Transformations. An inverse square root transformation was applied for the MPMT. A log 10 transformation, plus a constant of 1 to account for the presence of 0, was applied for the Stroop Test. A log 10 transformation was applied for the CRT, 4-m walk test, TUG Test, and white blood cell count. A square root transformation was applied for the chair rise test and the PC-PTSD.

Included and excluded participants

In order to compare continuous sociodemographic characteristics (i.e., age in years) between included and excluded participants, an independent samples t-test was calculated; if the Levene test showed significance ($p \leq 0.05$), the p-value from the Welch t-test was calculated (Field, 2009). To compare categorical sociodemographic variables (i.e., age group, sex, education, religion, ethnicity, income, retirement status, martial status, and language) between included and excluded participants, Pearson's χ^2 were calculated. To correct for multiple comparisons, a Bonferroni adjustment was applied; using the formula $\alpha=0.05/9$, the new alpha level was $\alpha=0.006$. If the Pearson χ^2 was significant, the test of column proportions was calculated as a post-hoc test to identify which cell proportions within the included column significantly differed from the excluded column (IBM, 2019); to correct for multiple comparisons, the Bonferroni adjustment was specified on a p-value of 0.05 (IBM, 2019). The results for the test of column proportions was formatted according to (IBM, 2019). To assist in explaining the multivariate results on income, retirement status was only included in the descriptive analyses.

Pain Groups

Pain Presence. To describe differences in sociodemographic and biological continuous variables (i.e., age in years and Comorbidity Count) between participants who reported they were usually free of pain or not, an independent samples t-test was calculated; if the Levene test showed significance ($p \leq 0.05$), the p-value from the Welch test was calculated (Field, 2009). To compare categorical sociodemographic variables (i.e., age group, sex, education, religion, ethnicity, income, retirement status, martial status, and language) between participants who

reported they were usually free of pain or not, Pearson's χ^2 were calculated. To correct for multiple comparisons, a Bonferroni adjustment was applied; using the formula $\alpha=0.05/9$, the new alpha level was $\alpha=0.006$. If the Pearson χ^2 was significant, the test of column proportions was calculated as a post-hoc test to identify which cell proportions in the free of pain column significantly differed from the pain column; to correct for multiple comparisons, the Bonferroni adjustment was specified on a p-value of 0.05 (IBM, 2019). To assist in explaining the multivariate results on income, retirement status was only included in the descriptive analyses.

Pain Intensity. To describe differences in each of the means of the dependent variables (i.e., age in years and Comorbidity Count) between the groups of the independent variable (i.e., mild, moderate, and severe pain), one-way ANOVAs were calculated. If the Levene test (based on mean) showed significance ($p \leq 0.05$), the p-value from the Welch test was calculated. To identify which means significantly differed from each other ($p < 0.05$), the Bonferroni post-hoc test was used for homogenous groups while the Games-Howell post-hoc test was used for heterogeneous groups (Field, 2009). To describe differences in categorical sociodemographic variables (i.e., age group, sex, education, religion, ethnicity, income, retirement status, martial status, and language) between participants who reported mild, moderate, or severe pain, Pearson's χ^2 were calculated. To correct for multiple comparisons, a Bonferroni adjustment was applied; using the formula $\alpha=0.05/9$, the new alpha level was $\alpha=0.006$. If the Pearson χ^2 was significant, the test of column proportions was calculated as a post-hoc test to identify which cell proportions in the mild, moderate, and severe columns significantly differed from each other; to correct for multiple comparisons, the Bonferroni adjustment was specified on a p-value of 0.05 (IBM, 2019). To assist in explaining the multivariate results on income, retirement status was only included in the descriptive analyses.

Pain Impact. To describe differences in each of the means of the dependent variables (i.e., age in years and Comorbidity Count) between the groups of the independent variable (i.e., none, a few, some, and most activities), one-way ANOVAs were calculated. If the Levene test (based on mean) showed significance ($p \leq 0.05$), the p-value from the Welch test was calculated. To identify which means significantly differed from each other ($p < 0.05$), the Bonferroni post-hoc test was used for homogenous groups while the Games-Howell post-hoc test was used for heterogeneous groups (Field, 2009). To describe differences in categorical sociodemographic variables (i.e., age group, sex, education, religion, ethnicity, income, retirement status, martial status, and language) between participants who reported none, a few, some, or most activities prevented by pain, Pearson's χ^2 were calculated. To correct for multiple comparisons, a Bonferroni adjustment was applied; using the formula $\alpha=0.05/9$, the new alpha level was $\alpha=0.006$. If the Pearson χ^2 was significant, the test of column proportions was calculated as a post-hoc test to identify which cell proportions in the none, a few, some, and most columns significantly differed from each other; to correct for multiple comparisons, the Bonferroni adjustment was specified on a p-value of 0.05 (IBM, 2019). To assist in explaining the multivariate results on income, retirement status was only included in the descriptive analyses.

Principal Component Analysis (PCA)

To test each objective and identify correlates of pain presence, intensity, and impact, logistic regression modelling was conducted. Prior to conducting the modelling, however, a PCA was conducted to group the variables together and create more parsimonious modelling. Specifically,

a PCA condenses many related variables into fewer clusters of variables, making it easier to understand (Field, 2009).

There were several assumptions to be met for the PCA (Field, 2009). They included: continuous variables; no multicollinearity, which was checked by examining the determinant ($p > 0.00001$ met the assumption) or examining the correlation matrix (correlations should be < 0.90); a large sample size, which was checked with Kaiser-Meyer-Olkin measure of sampling adequacy (> 0.50 met the assumption); and large enough correlations between variables, which was checked with Bartlett's test of sphericity ($p < 0.05$ met the assumption). To check if it was a good model, residuals were examined (< 50% of residuals must be over an absolute value of 0.05).

An oblique (promax) rotation was used since oblique rotations allow factors to correlate with each other fitting in line with a biopsychosocial approach, and promax is used for large data sets (Field, 2009). To check if it was acceptable to use an oblique (promax) rotation, the component correlation matrix was examined; if no correlations were 0, it was acceptable to use an oblique (promax) rotation.

A PCA was then conducted on the following variables with pairwise deletion (Field, 2009): RAVLT (immediate recall), RAVLT (delayed recall), animal naming test strict scoring, animal naming test lenient scoring, MAT, MPMT, Stroop test, COWAT, CRT, weight, height, body fat percentage, 4-m walk test, TUG Test, standing balance test, chair rise test, hand grip strength, PASE, LSI, Comorbidity Count, Medication Count, Other Treatment Count, white blood cell count, total cholesterol, albumin, SWLS, PC-PTSD, CES-D10, K10, Openness, Conscientiousness, Extraversion, Agreeableness, Emotional Stability, and MOS-SSS. Since one of the goals of a PCA is to have a variable associated with only one factor, it is problematic if

variables cross-load on more than one factor. If this occurred, correlations between the variables were examined and the variable that had larger magnitudes of correlations with all other variables was included. This is because the PCA functions better when items are more correlated with each other compared to less as it condenses related variables into components (Field, 2009).

To extract the factors, the Kaiser criterion of eigenvalues above 1 was used. However, if the number of factors extracted with this criterion did not align with the scree plot, the scree plot was used as it is more reliable than the Kaiser criterion for large data sets ($n > 200$). The pattern matrix was examined for factor loadings > |0.40|, which represented substantive values. The factor scores were saved through a regression method as it was simple, easy to interpret, and allowed for factors to be correlated (Field, 2009).

Objective 1: Testing the Biopsychosocial Model of Pain and Aging for Pain Presence

Identifying Candidate Correlates

Prior to conducting the logistic regressions, significant candidate correlates were identified. To determine if there were significant relationships between continuous candidate correlates (i.e., age and the resultant factors from the PCA) and pain presence, independent samples t-tests were calculated; if the Levene test showed significance ($p \leq 0.05$), the p-value from the Welch t-test was calculated (Field, 2009). To compare the categorical candidate correlates (i.e., sex, education, religion, ethnicity, income, marital status, and language) between the pain presence groups, Pearson's χ^2 were calculated. A p-value of < 0.25 was used for inclusion of variables into the logistic regression model since a high significance level for entry is generally a good practice and creates a more comprehensive model (Hosmer & Lemeshow, 2000; Tabachnick & Fidell, 2013). To correct for multiple comparisons, Bonferroni adjustments were applied using the

formula $\alpha=0.25/4$ for the Pearson correlations and $\alpha=0.25/7$ for the χ^2; the new alpha level for the Pearson correlations was $\alpha=0.06$ and $\alpha=0.04$ for the χ^2.

Binary Logistic Regression

Binary logistic regression with an entry method was conducted for pain presence with the significant candidate correlates. An entry method was used to account for consistency across the regressions for each pain outcome and a p-value of ≤ 0.05 indicated significance in the model. The first category was used as the reference category for pain presence (i.e., "free of pain") and the categorical correlates. Numerous assumptions needed to be met for the binary regression. There could be no multicollinearity between the correlates which was checked by examining the Tolerance/VIF values; tolerance scores needed to be above 0.10 and VIF scores below 10 (Field, 2009; UCLA: Statistical Consulting Group, n.d.). If the Tolerance/VIF values were not within the specified limits, the collinearity diagnostics were interpreted (Field, 2009); if the correlates had high proportions (> 0.90) on the same small eigenvalues, collinearity was present (Regorz, 2020). The Hosmer-Lemeshow goodness-of-fit statistic needed to be nonsignificant at $p > 0.05$, indicating a good model. The Box-Tidwell approach was taken to test for linearity between the continuous correlates and the logit transformation of the dependent variable (Tabachnick & Fidell, 2013). If 1 or more of the added interaction terms were significant ($p < 0.05$), the assumption was violated, and transformations were applied to the correlates that violated the assumption. If the interaction term was just below 0.05, it was treated as nonsignificant due to the large sample size. Cook's distance (< 1), leverage values (> 0 and < 1), studentized residuals (only 5% should be outside ±1.96 and 1% outside ±2.58), and DFbeta for the constant (< 1) were examined to check for outliers and influential cases (Field, 2009).

Individual Comorbidities

To compare the presence of each comorbidity between the pain presence groups, Pearson's χ^2 were calculated. To compare Back Problems or Pain and Hypertension between the pain presence groups, user-designated missing values were treated as the "no" category. To correct for multiple comparisons, Bonferroni adjustments were applied using the formula $\alpha=0.05/29$ and the new alpha level was $\alpha=0.002$. Since small changes in a large sample size can produce significant p-values, effect sizes (i.e., Phi's φ) were calculated; ≥ 0.10 indicated a small effect size, ≥ 0.30 a medium effect size, and ≥ 0.50 a large effect size (Field, 2009).

Remaining Continuous Variables

To compare the means of the dependent continuous variables that did not load onto a factor in the PCA between the groups (i.e., "free of pain" and "pain") a one-way MANCOVA was calculated. To examine age-differences in the model, age was also included as a dependent variable. Sociodemographic variables that were identified as significant from the Identifying Candidate Correlates' section were dummy coded and included as covariates. Effect sizes (partial eta squared (η^2)) were examined for each significant variable; ≥ 0.01 indicated a small effect size, ≥ 0.06 a medium effect size, and ≥ 0.14 a large effect size (Cohen, 1988).

There were several assumptions to be met for the one-way MANCOVA (Tabachnick & Fidell, 2013). Independence of observations and a sufficient sample size (minimum of 20 scores for the dependent variable at each level of the independent variable) were needed. No multivariate outliers were allowed, which were checked with Mahalanobis distance calculated with a linear regression. There needed to be multivariate normality, which was tested by

examining normality for each dependent variable as previously described in the descriptive statistics section. No multicollinearity between all the dependent variables was allowed; if the Pearson correlation coefficient was greater than 0.90, then there was multicollinearity. There needed to be homogeneity of variance-covariance matrices, which was tested with Box's M test of equality of covariance ($p > 0.001$ met the assumption); if the assumption was violated, Pillai's trace was used to report multivariate significance. There needed to be a linear relationship between all pairs of dependent variables and all dependent-covariate pairs in each group of the independent variable; if all the dependent variables in each group had a normal distribution (skewness below absolute value of 2, kurtosis below absolute value of 7) and if the dependent-covariate pairs showed an elliptical shape in the scatterplot matrix the assumption was satisfied. There needed to be homogeneity of regression slopes, which was checked through an interaction term in a MANCOVA for the dependent variables and the covariate. If the interaction term was significant ($p < 0.05$), the assumption was violated; however, if there was reason to support its inclusion, the covariate was still included in the analysis.

Remaining Categorical Variables

Since falls and social participation were not included in the PCA because they were categorical, Pearson's χ^2 were calculated to compare both between the pain presence groups. Effect sizes (i.e., Phi's φ) were also examined; ≥ 0.10 indicated a small effect size, ≥ 0.30 a medium effect size, and ≥ 0.50 a large effect size (Field, 2009). To identify which combination of categories contributed to the overall significance in the corresponding χ^2 ($p < 0.05$), the adjusted standardized residual was used as a post-hoc test (MacDonald & Gardner, 2000). The adjusted standardized residuals were saved and converted to p-values, to which the Bonferroni

correction was applied to correct for multiple comparisons. For falls, a 2x4 χ^2 was conducted and, using the formula $\alpha=0.05/8$, the adjusted alpha level was $\alpha=0.006$. For social participation, a 2x5 χ^2 was conducted and, using the formula $\alpha=0.05/10$, the adjusted alpha level was $\alpha=0.005$.

Objective 2: Testing the Biopsychosocial Model of Pain and Aging for Pain Intensity

Identifying Candidate Correlates

To determine if there were significant relationships between each of the means of the dependent, continuous, candidate correlates between the groups of the independent variable (i.e., "mild", "moderate", and "severe" pain), one-way ANOVAs were calculated; if the Levene test (based on mean) showed significance ($p \leq 0.05$), the p-value from the Welch test was calculated (Field, 2009). To compare the categorical candidate correlates between the pain intensity groups, Pearson's χ^2 were calculated. A p-value of < 0.25 was used for inclusion of variables (Hosmer & Lemeshow, 2000; Tabachnick & Fidell, 2013). To correct for multiple comparisons, Bonferroni adjustments were applied using the formula $\alpha=0.25/4$ for the one-way ANOVAs and $\alpha=0.25/7$ for the χ^2; the new alpha level for the one-way ANOVAs was $\alpha=0.06$ and $\alpha=0.04$ for the χ^2.

Ordinal Logistic Regression

Ordinal logistic regression with an entry method was conducted for pain intensity with the significant candidate correlates. An entry method was used to account for consistency across the regressions for each pain outcome and a p-value of ≤ 0.05 indicated significance in the model. SPSS used the last category as the reference category for pain intensity ("severe" is the reference) and the categorical correlates. Odds ratios and their 95% CI's were calculated using SPSS syntax (Laerd Statistics, 2018). There were a few assumptions that needed to be met for

ordinal regression. There must be no multicollinearity between the correlates which was checked by examining the Tolerance/VIF values; tolerance scores needed to be above 0.10 and VIF scores below 10 (Field, 2009; UCLA: Statistical Consulting Group, n.d.). If the Tolerance/VIF values were not within the specified limits, the collinearity diagnostics were interpreted (Field, 2009); if the correlates had high proportions (> 0.90) on the same small eigenvalues, collinearity was present (Regorz, 2020). The Pearson goodness-of-fit statistic also needed to be nonsignificant at $p > 0.05$. There must be proportional odds, which was tested with the test of parallel lines ($p > 0.05$ met the assumption).

Individual Comorbidities

To compare the presence of each comorbidity between the pain intensity groups, Pearson's χ^2 were calculated. To compare Back Problems or Pain and Hypertension between the pain intensity groups, user-designated missing values were treated as the "no" category. To correct for multiple comparisons, Bonferroni adjustments were applied using the formula $\alpha=0.05/29$ and the new alpha level was $\alpha=0.002$. Since small changes in a large sample size can produce significant p-values, effect sizes (i.e., Cramer's V) were calculated; ≥ 0.10 indicated a small effect size, ≥ 0.30 a medium effect size, and ≥ 0.50 a large effect size (Field, 2009).

Remaining Continuous Variables

To compare the means of the dependent continuous variables that did not load onto a factor in the PCA between the groups (i.e., "mild", "moderate", and "severe" pain) a one-way MANCOVA was calculated. To examine age-differences in the model, age was also included as a dependent variable. Sociodemographic variables that were identified as significant from the

'Identifying Candidate Correlates' section were dummy coded and included as covariates. Effect sizes (η^2) were examined for each significant variable; ≥ 0.01 indicated a small effect size, ≥ 0.06 a medium effect size, and ≥ 0.14 a large effect size (Cohen, 1988).

There were several assumptions to be met for the one-way MANCOVA (Tabachnick & Fidell, 2013). Independence of observations and a sufficient sample size (minimum of 20 scores for the dependent variable at each level of the independent variable) were needed. No multivariate outliers were allowed, which were checked with Mahalanobis distance calculated with a linear regression. There needed to be multivariate normality, which was tested by examining normality for each dependent variable, which was completed in the descriptive statistics section previously explained. No multicollinearity between all the dependent variables was allowed; if the Pearson correlation coefficient was greater than 0.90, then there was multicollinearity. There needed to be homogeneity of variance-covariance matrices, which was tested with Box's M test of equality of covariance ($p > 0.001$ met the assumption); if the assumption was violated, Pillai's trace was used to report multivariate significance. There needed to be a linear relationship between all pairs of dependent variables and all dependent-covariate pairs in each group of the independent variable; if all the dependent variables in each group had a normal distribution (skewness below absolute value of 2, kurtosis below absolute value of 7) and if the dependent-covariate pairs showed an elliptical shape in the scatterplot matrix the assumption was satisfied. There needed to be homogeneity of regression slopes, which was checked through an interaction term in a MANCOVA for the dependent variables and the covariate. If the interaction term was significant ($p < 0.05$), the assumption was violated; however, if there was reason to support its inclusion, the covariate was still included in the analysis.

Remaining Categorical Variables

Since falls and social participation were not included in the PCA because they were categorical, Pearson's χ^2 were calculated to compare both between the pain intensity groups and effect sizes (i.e., φ) were examined; ≥ 0.10 indicated a small effect size, ≥ 0.30 a medium effect size, and ≥ 0.50 a large effect size (Field, 2009). To identify which combination of categories contributed to the overall significance in the corresponding χ^2 ($p < 0.05$), the adjusted standardized residual was used as a post-hoc test (MacDonald & Gardner, 2000). The adjusted standardized residuals were saved and converted to p-values, to which the Bonferroni correction was applied to correct for multiple comparisons. For falls, a 3x4 χ^2 analysis was conducted and, using the formula $\alpha=0.05/12$, the adjusted alpha level was $\alpha=0.004$. For social participation, a 3x5 χ^2 analysis was conducted and, using the formula $\alpha=0.05/15$, the adjusted alpha level was $\alpha=0.003$.

Objective 3: Testing the Biopsychosocial Model of Pain and Aging for Pain Impact

Identifying Candidate Correlates

To determine if there were significant relationships between each of the means of the dependent, continuous, candidate correlates between the groups of the independent variable (i.e., "none", "a few", "some", and "most" activities), one-way ANOVAs were calculated; if the Levene test (based on mean) showed significance ($p \leq 0.05$), the p-value from the Welch test was calculated (Field, 2009). To compare the categorical candidate correlates between the pain impact groups, Pearson's χ^2 were calculated. A p-value of < 0.25 was used for inclusion of variables (Hosmer & Lemeshow, 2000; Tabachnick & Fidell, 2013). However, to correct for

multiple comparisons, Bonferroni adjustments were applied using the formula $\alpha=0.25/4$ for the one-way ANOVAs and $\alpha=0.25/7$ for the χ^2; the new alpha level for the one-way ANOVAs was $\alpha=0.06$ and $\alpha=0.04$ for the χ^2.

Multinomial Logistic Regression

Multinomial logistic regression with an entry method was conducted for pain impact with the significant candidate correlates. An entry method was used to account for consistency across the regressions for each pain outcome and a p-value of ≤ 0.05 indicates significance. The first category was the reference category for pain impact ("none" is the reference) and the last category was used as the reference category for the categorical correlates. There were a few assumptions that needed to be met for multinomial regression. There must be no multicollinearity between the correlates which was checked by examining the Tolerance/VIF values; tolerance scores needed to be above 0.10 and VIF scores below 10 (Field, 2009; UCLA: Statistical Consulting Group, n.d.). If the Tolerance/VIF values were not within the specified limits, the collinearity diagnostics were interpreted (Field, 2009); if the correlates had high proportions (> 0.90) on the same small eigenvalues, collinearity was present (Regorz, 2020). The Pearson goodness-of-fit statistic also needed to be nonsignificant at $p > 0.05$. The Box-Tidwell approach was taken to test for linearity between the continuous correlates and the logit transformation of the dependent variable (Tabachnick & Fidell, 2013). If 1 or more of the added interaction terms were significant ($p < 0.05$), the assumption was violated, and transformations were applied to the correlates that violated the assumption. If the interaction term was just below 0.05, it was treated as nonsignificant due to the large sample size (Tabachnick & Fidell, 2013).

Individual Comorbidities

To compare the presence of each comorbidity between the pain impact groups, Pearson's χ^2 were calculated. To compare Back Problems or Pain and Hypertension between the pain impact groups, user-designated missing values were treated as the "no" category. To correct for multiple comparisons, Bonferroni adjustments were applied using the formula $\alpha=0.05/29$ and the new alpha level was $\alpha=0.002$. Since small changes in a large sample size can produce significant p-values (Field, 2009), effect sizes (Cramer's V) were calculated; ≥ 0.10 indicated a small effect size, ≥ 0.30 a medium effect size, and ≥ 0.50 a large effect size (Field, 2009).

Remaining Continuous Variables

To compare the means of the dependent continuous variables that did not load onto a factor in the PCA between the groups (i.e., "none", "a few", "some", and "most" activities) a one-way MANCOVA was calculated. To examine age-differences in the model, age was also included as a dependent variable. Sociodemographic variables that were identified as significant from the 'Identifying Candidate Correlates' section were dummy coded and included as covariates. Effect sizes (η^2) were examined for each significant variable; ≥ 0.01 indicated a small effect size, ≥ 0.06 a medium effect size, and ≥ 0.14 a large effect size (Cohen, 1988).

There were several assumptions to be met for the one-way MANCOVA (Tabachnick & Fidell, 2013). Independence of observations and a sufficient sample size (minimum of 20 scores for the dependent variable at each level of the independent variable) were needed. No multivariate outliers were allowed, which were checked with Mahalanobis distance calculated with a linear regression. There needed to be multivariate normality, which was tested by examining normality for each dependent variable, which was completed in the descriptive

statistics above. No multicollinearity between all the dependent variables was allowed; if the Pearson correlation coefficient was greater than 0.90, then there was multicollinearity. There needed to be homogeneity of variance-covariance matrices, which was tested with Box's M test of equality of covariance ($p > 0.001$ met the assumption); if the assumption was violated, Pillai's trace was used to report multivariate significance. There needed to be a linear relationship between all pairs of dependent variables and all dependent-covariate pairs in each group of the independent variable; if all the dependent variables in each group had a normal distribution (skewness below absolute value of 2, kurtosis below absolute value of 7) and if the dependent-covariate pairs showed an elliptical shape in the scatterplot matrix the assumption was satisfied. There needed to be homogeneity of regression slopes, which was checked through an interaction term in a MANCOVA for the dependent variables and the covariate. If the interaction term was significant ($p < 0.05$), the assumption was violated; however, if there was reason to support its inclusion, the covariate was still included in the analysis.

Remaining Categorical Variables

Since falls and social participation were not included in the PCA because they were categorical, Pearson's χ^2 were calculated to compare both between the pain impact groups and effect sizes (i.e., Phi's φ) were examined; ≥ 0.10 indicated a small effect size, ≥ 0.30 a medium effect size, and ≥ 0.50 a large effect size (Field, 2009). To identify which combination of categories contributed to the overall significance in the corresponding χ^2 ($p < 0.05$), the adjusted standardized residual was used as a post-hoc test (MacDonald & Gardner, 2000). The adjusted standardized residuals were saved and converted to p-values, to which the Bonferroni correction was applied to correct for multiple comparisons. For falls, a 4x4 χ^2 analysis was conducted and,

using the formula $\alpha=0.05/16$, the adjusted alpha level was $\alpha=0.003$. For social participation, a 4x5 χ^2 analysis was conducted and, using the formula $\alpha=0.05/20$, the adjusted alpha level was $\alpha=0.003$.

All analyses were conducted using IBM SPSS Statistics v 26.0 2019 and v 27.0 2020.

CHAPTER FIVE: RESULTS

Of the 30,097 participants included in the comprehensive CLSA cohort, 137 (0.46%) people did not participate in an in-person DCS visit and were excluded from the analyses since the measures completed in-home and over the phone differed from those completed in-person (Raina et al., 2008). Next, 1,294 (4.30%) participants who did not complete the MCQ were excluded since the questions about pain presence, intensity, and impact were asked in the MCQ (CLSA, 2015e). Lastly, 257 (0.86%) participants who responded “do not know”, refused, or did not answer any of the pain questions were excluded from the final sample. Therefore, the final number of participants included in the analysis was 28,409 (94.39%). A CONSORT diagram is presented in Figure 4.

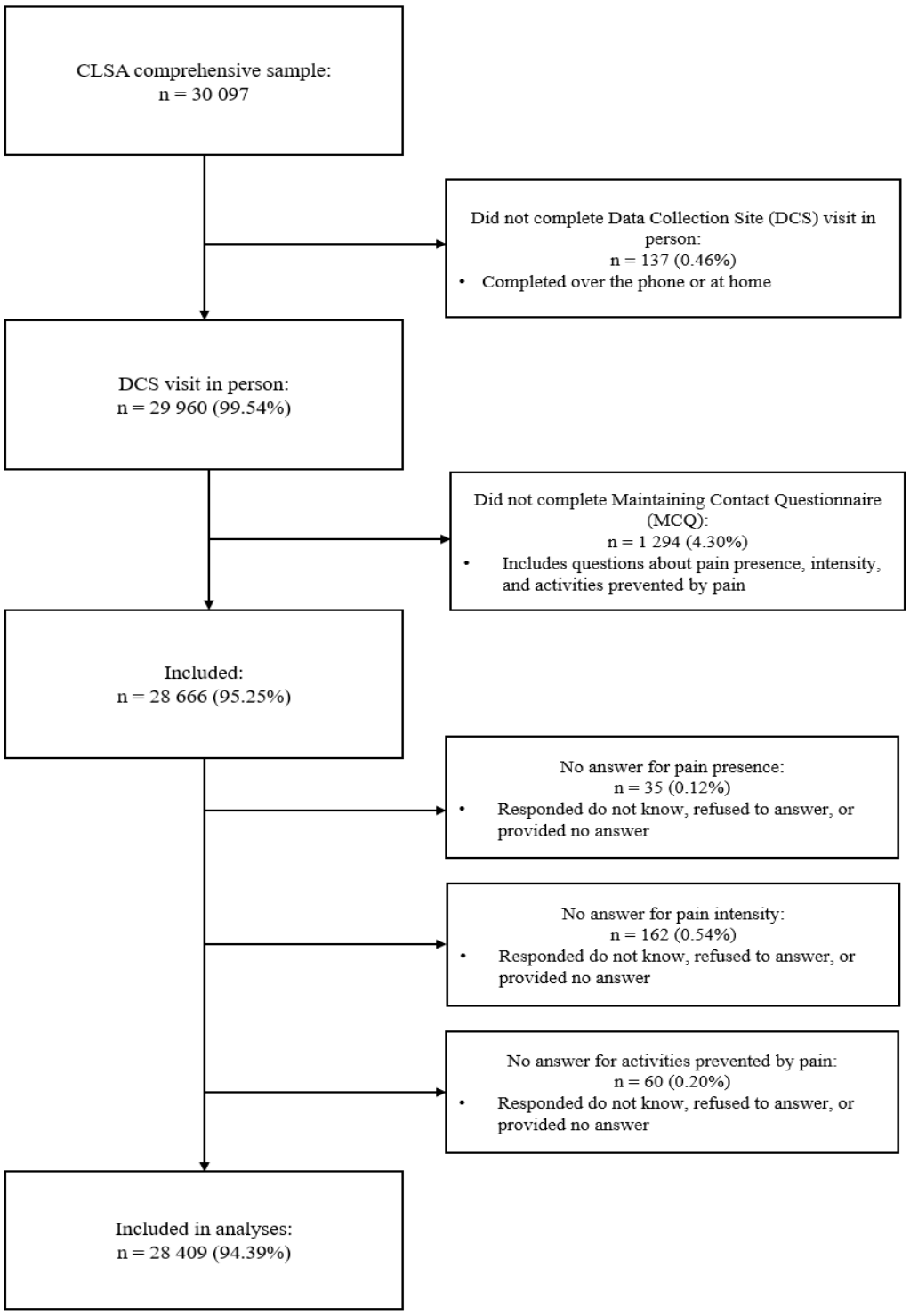

Figure 4. CONSORT diagram of participants.

Data Transformations

Initially, the MPMT showed a skewness of -2.85 and kurtosis of 11.22; after the transformation was applied, the resulting skewness was 1.48 and kurtosis was 0.98. The Stroop test initially showed a skewness of 10.46 and kurtosis of 380.77; after the transformation was applied, the resulting skewness was 0.96 and kurtosis was 5.83. CRT initially showed a skewness of 7.52 and kurtosis of 186.19; after the transformation, the resulting skewness was 1.18 and kurtosis was 4.47. The 4-m walk test initially showed a skewness of 4.15 and kurtosis of 64.72; after the transformation was applied, the resulting skewness was 0.83 and kurtosis was 3.35. The TUG test initially showed a skewness of 7.60 and kurtosis of 187.47; after the transformation was applied, the resulting skewness was 0.97 and kurtosis of 5.39. The chair rise test initially showed a skewness of 2.47 and kurtosis of 39.24; after the transformation was applied, the resulting skewness was 0.73 and kurtosis was 4.48. White blood cell count initially showed a skewness of 10.40 and kurtosis of 285.78; after the transformation was applied, the resulting skewness was 0.44 and kurtosis was 3.70. The PC-PTSD initially showed a skewness of 2.47 and kurtosis of 5.54; after the transformation was applied, the resulting skewness was 1.78 and kurtosis was 1.63.

Participant, Pain, and Biopsychosocial Characteristics

Sociodemographic Characteristics (Table 1)

For the included participants, age ranged from 45 to 86 years; the average age was 62.87 ± 10.19 years, and the largest age group was between 55 to 64 years (33%). The sample was almost equally divided between the sexes with 13,965 (49.16%) men and 14,444 (50.84%) women. The predominant education level was a post-secondary degree/diploma (78.07%), religion was Christian (86.25%), ethnicity was European (71.87%), total household income was

≥ $50,000 but < $100,000 (35.53%), retirement status was almost equally divided between completely retired (44.37%) and not retired (44.52%), marital status was married/common-law relationship (69.29%), and language conversation was English (57.31%).

Participants who were retained in the analysis differed from those who were excluded by age ($p < 0.001$) and distribution of age groups ($p < 0.001$), education ($p < 0.001$), ethnicity ($p = 0.005$), income ($p < 0.001$), retirement status ($p = 0.005$), marital status ($p < 0.001$), and language ($p < 0.001$). Specifically, those who were excluded were older, with the test of column proportions resulting in a lower proportion of people who were excluded and in the 55 to 64 age group, and a greater proportion of people who were excluded and in the 75+ age group compared to those who were retained in the analysis. There was a greater proportion of people who were excluded and had less than a secondary school education or a secondary school education, and a lower proportion of people who were excluded and had a post-secondary degree/diploma compared to those who were retained. There was a greater proportion of people who were excluded of other ethnicities compared to those who were retained. There were greater proportions of people who were excluded with an income of < $20,000 or ≥ $20,000 but < $50,000, and lower proportions of people who were excluded with an income of ≥ $50,000 but < $100,000, ≥ $100,000 but < $150,000, or ≥ $150,000 compared to those who were retained. There was a greater proportion of people who were excluded and completely retired and a lower proportion of people who were excluded and not retired compared to those who were retained. There was a greater proportion of people who were excluded who were single, widowed, or divorced/separated, and a lower proportion of people who were excluded and were married/common-law relationship compared to those who were retained. There was a lower proportion of people who were excluded whose language conversation was French and a greater

proportion of people who were excluded and whose language conversation was other compared to those who were retained.

Table 1. Sociodemographic characteristics of included and excluded participants.

	Included (n = 28 409)	Excluded (n = 1 688)	p - value
Age			
Years	62.87 ± 10.19	64.44 ± 11.07	< 0.001
Age group			
45-54	7 189 (25.31) [a]	406 (24.05) [a]	< 0.001
55-64	9 375 (33) [a]	481 (28.50) [b]	
65-74	6 977 (24.56) [a]	385 (22.81) [a]	
75+	4 868 (17.14) [a]	416 (24.64) [b]	
Sex			
Men	13 965 (49.16)	812 (48.10)	0.40
Women	14 444 (50.84)	876 (51.90)	
Education			
Less than secondary school	1 461 (5.15) [a]	182 (10.80) [b]	< 0.001
Secondary school	2 626 (9.26) [a]	213 (12.64) [b]	
Some post-secondary	2 095 (7.39) [a]	143 (8.49) [a]	
Post-secondary degree/diploma	22 180 (78.20) [a]	1 147 (68.07) [b]	
Missing	47 (0.17)	3 (0.18)	
Religion			
Christian	18 838 (86.25)	1 123 (85.99)	0.79
Other	3 003 (13.75)	183 (14.01)	
Missing	6 568 (23.12)	382 (22.63)	
Ethnicity			
Canadian	2 505 (8.88) [a]	133 (7.97) [a]	0.005
European	20 268 (71.87) [a]	1 162 (69.66) [a]	
Indigenous	884 (3.13) [a]	50 (3) [a]	
Other	4 544 (16.11) [a]	323 (19.36) [b]	
Missing	208 (0.73)	20 (1.18)	
Income			
< $20 000	1 358 (5.10) [a]	208 (13.45) [b]	< 0.001
≥ $20 000 but < $50 000	5 862 (22.03) [a]	498 (32.19) [b]	
≥ $50 000 but < $100 000	9 453 (35.53) [a]	454 (29.35) [b]	
≥ $100 000 but < $150 000	5 284 (19.86) [a]	240 (15.51) [b]	
≥ $150 000	4 652 (17.48) [a]	147 (9.50) [b]	
Missing	1 800 (6.34)	141 (8.35)	
Retirement status			
Completely retired	12 564 (44.37) [a]	808 (48.33) [b]	0.005
Partly retired	3 146 (11.11) [a]	164 (9.81) [a]	
Not retired	12 605 (44.52) [a]	700 (41.87) [b]	
Missing	94 (0.33)	16 (0.95)	
Marital Status			
Single	2 473 (8.71) [a]	181 (10.72) [b]	< 0.001
Married or common-law	19 679 (69.29) [a]	972 (57.58) [b]	
Widowed	2 583 (9.09) [a]	226 (13.39) [b]	
Divorced or separated	3 666 (12.91) [a]	309 (18.31) [b]	
Missing	8 (0.03)	0 (0)	

Language			
English	16 243 (57.31) $_{a}$	983 (58.34) $_{a}$	< 0.001
French	7 855 (27.72) $_{a}$	386 (22.91) $_{b}$	
Other	4 244 (14.97) $_{a}$	316 (18.75) $_{b}$	
Missing	67 (0.24)	3 (0.18)	

Values are means ± SD or frequency (valid %).
Notes. Bonferroni adjusted p-value for Pearson χ^2 is p = 0.006. According to the test of column proportions (only conducted for significant χ^2): if the subscript letter is different between columns, then the respective categories statistically differ from each other; the category with the larger percentage is the larger category. If the subscript letter is the same between columns, then the categories do not statistically differ from each other.

Pain Characteristics (Table 2)

The participants predominantly reported that they were usually "free of pain" (63.62%). The mean ± SD for pain intensity was 1.65 ± 0.64, with most (90.79%) of participants reporting "mild" to "moderate" pain. Similarly, the mean ± SD for Pain Impact was 1.95 ± 0.99, with 72.22% of participants reporting that "no" or only "a few" activities were prevented by pain. Nonetheless, just over 9% of participants reported "severe" pain and a similar percentage that their pain interfered with "most" of their activities.

Table 2. Pain characteristics.

	Total (n = 28 409)
Free of pain	
Yes	18 073 (63.62)
No	10 336 (36.38)
Pain intensity [a]	1.65 ± 0.64
Mild	4 551 (44.03)
Moderate	4 833 (46.76)
Severe	952 (9.21)
Activities prevented by pain [b]	1.95 ± 0.99
None	4 377 (42.35)
A few	3 087 (29.87)
Some	1 881 (18.20)
Most	991 (9.59)

Values are means ± SD or frequency (valid %).
[a] only includes participants who responded they are not free of pain and subsequently answered the question for pain intensity. [b] only includes participants who responded they are not free of pain and subsequently answered the question for pain impact.

Cognitive, physical, and biopsychosocial characteristics (Table 3)

Cognitive function. For the memory measures, participants had a mean score of 5.88 ± 1.90 on the RAVLT (immediate recall) and 4.07 ± 2.16 on the RAVLT (delayed recall). For the executive function measures, participants had a mean score of 19.79 ± 5.67 on the strict scoring method of the animal naming test and 21.54 ± 6.44 on the lenient scoring method of the test. Both scores were above the cut-off, indicating that they were normal (Heerema & Chaves, 2020). Participants had a mean score of 26.69 ± 8.69 on the MAT indicating normal performance (Billick et al., 2001), a median score of 18 (1) on the MPMT indicating normal performance (Simard et al., 2018), 2 (0.70) on the Stroop test, and a mean score of 39.39 ± 12.74 on the COWAT. For the psychomotor measure, participants had a median score of 799.23 (228.24) on the CRT.

Physical. Participants had a mean score of 85.53 ± 17.94 on the LSI, indicating independence when performing daily activities (Shimada et al., 2010). For falls, participants predominantly reported "no falls" (95%), followed by "falls that resulted in injury and required medical attention" (2.43%), "falls that did not result in serious injury or medical attention" (1.99%), and "falls that resulted in injury and required medical attention and hospitalization" (0.58%). Participants had a mean body fat percentage of 34.14 ± 8.10, weight (in kilograms; kg) of 79.77 ± 17.59, and height (in metres; m) of 1.68 ± 0.10. Participants had a median time (in seconds) of 4.10 (1.05) on the 4-m walk test indicating normal performance (BC Guidelines, 2017), 9.19 (2.22) on the TUG test indicating normal performance (Shumway-Cook et al., 2000), 12.88 (4.43) on the chair rise test indicating normal performance (Tiedemann et al., 2008), and a mean time (in seconds) of 35.39 ± 24.36 on the standing balance test and a mean maximum grip strength (kg) of 35.25 ± 11.83. Participants had a mean score of 141.29 ± 73.92 on the PASE.

Biological. Participants had a mean Comorbidity Count of 4.22 ± 2.66, a mean Count of Conditions with Reported Medication Use of 0.92 ± 1.04, and a mean Count of Conditions with Reported Other Treatment Use of 0.31 ± 0.51. Participants had a median white blood cell count of 6.40 (2.10), mean albumin of 39.36 ± 2.68, and 5.14 ± 1.11 for total cholesterol.

Psychological. Participants had a mean score of 27.89 ± 6.32 on the SWLS indicating they were satisfied with life (approximately 10% of participants were below the cut-off, indicating dissatisfaction) (Pavot & Diener, 2013), 5.21 ± 4.63 on the CES-D10 which is below the cut-off score to indicate depressive symptomatology (less than 10% of participants were above the cut-off) (Andresen et al., 1994), 14.26 ± 4.56 on the K10 which indicates participants are likely not to have psychological distress (Victorian Government Department of Human Services, 2002), and a median score of 0 (0) on the PC-PTSD which is below the cut-off score to indicate PTSD (Prins et al., 2003). For personality, participants had a mean score of 4.37 ± 1.79 on Extraversion, 5.89 ± 1.13 on Agreeableness, 6.19 ± 1.11 on Conscientiousness, 5.83 ± 1.37 on Emotional Stability, and 5.45 ± 1.37 on Openness.

Social. Participants had a mean score of 81.35 ± 17.23 on the MOS-SSS. For the frequency of participation in social activities, participants predominantly reported participating in activities "at least once a week" (68.60%), followed by "at least once a day" (17.59%), "at least once a month" (12.37%), "at least once a year" (1.32%), and "not participating" in activities (0.12%).

Table 3. Descriptive statistics of cognitive, physical, and biopsychosocial variables.

	Total (n = 28 409)
Cognitive	
Memory	
RAVLT	
Immediate recall	5.88 ± 1.90
Missing	924 (3.25)
Delayed recall	4.07 ± 2.16

Missing	943 (3.32)
Executive Function	
Animal naming (strict)	19.79 ± 5.67
Missing	653 (2.30)
Animal naming (lenient)	21.54 ± 6.44
Missing	653 (2.30)
MAT	26.69 ± 8.69
Missing	1 346 (4.74)
MPMT	18 (1) [a]
Missing	370 (1.30)
Stroop	2 (0.70) [a]
Missing	254 (0.89)
COWAT	39.39 ± 12.74
Missing	862 (3.03)
Psychomotor Speed	
CRT (mean reaction time (ms))	799.23 (228.24) [a]
Missing	267 (0.94)
Physical	
LSI	85.53 ± 17.94
Missing	47 (0.17)
Falls	
No falls reported	26 985 (95)
No serious injury/no medical attention	566 (1.99)
Injury with medical attention	691 (2.43)
Injury with medical attention and hospitalization	164 (0.58)
Missing	3 (0.01)
Body fat percentage	34.14 ± 8.10
Missing	1 069 (3.76)
Weight (kg)	79.77 ± 17.59
Missing	110 (0.39)
Height (m)	1.68 ± 0.10
Missing	88 (0.31)
4-m walk (s)	4.10 (1.05) [a]
Missing	220 (0.77)
TUG (s)	9.19 (2.22) [a]
Missing	247 (0.87)
Standing balance (s)	35.29 ± 24.36
Missing	1 318 (4.64)
Chair rise (s)	12.88 (4.43) [a]
Missing	1 053 (3.71)
Maximum hand grip strength (kg)	35.25 ± 11.83
Missing	1 971 (6.94)
PASE	141.29 ± 73.92
Missing	235 (0.83)
Biological	
Comorbidity count [b]	4.22 ± 2.66
Count of conditions with reported medication use [b]	0.92 ± 1.04
Count of conditions with reported other treatment use [b]	0.31 ± .51
Blood count	
White blood cell	6.40 (2.10) [a]
Missing	4 228 (14.88)
Albumin	39.86 ± 2.68
Missing	2 713 (9.55)

Total cholesterol	5.14 ± 1.11
Missing	2 713 (9.55)
Psychological	
SWLS	27.89 ± 6.32
Missing	317 (1.12)
PC-PTSD	0 (0) [a]
Missing	161 (0.57)
CES-D10	5.21 ± 4.63
Missing	129 (0.45)
K10	14.26 ± 4.56
Missing	344 (1.21)
TIPI	
Extraverted	4.37 ± 1.79
Missing	369 (1.30)
Agreeableness	5.89 ± 1.10
Missing	290 (1.02)
Conscientiousness	6.19 ± 1.11
Missing	239 (0.84)
Emotional stability	5.83 ± 1.37
Missing	240 (0.84)
Openness	5.45 ± 1.37
Missing	517 (1.82)
Social	
Social support	
MOS-SSS	81.35 ± 17.23
Missing	532 (1.87)
Social participation	
Did not participate	34 (0.12)
At least once a year	375 (1.32)
At least once a month	3 511 (12.37)
At least once a week	19 465 (68.60)
At least once a day	4 990 (17.59)
Missing	34 (0.12)

Values are means ± SD or median (IQR)[a] or frequency (valid %).

Notes. [b] = See Table 4 for frequencies of each comorbidity, conditions with reported medications, and conditions with reported other treatments.

RAVLT = Rey Auditory Verbal Learning Test; MAT = Mental Alternation Test; MPMT = Miami Prospective Memory Test; COWAT = Controlled Oral Word Association Test; CRT = Choice Reaction Time; LSI = Life Space Index; TUG = Timed-up-and-go; PASE = Physical Activity Scale for the Elderly; SWLS = Satisfaction With Life Scale; PC-PTSD = Primary Care Post Traumatic Stress Disorder; CES-D10 = short form of the Center for Epidemiologic Studies Depression Scale; K10 = Kessler Psychological Distress Scale; TIPI = Ten Item Personality Inventory; MOS-SSS = Medical Outcomes Study Social Support Survey.

Comorbidity, Medication, and Other Treatment frequencies (Table 4)

Individual comorbidities, medications, and other treatments are presented in Table 4. The five most frequently reported Conditions with Potentially Painful Symptoms were Back Problems or Pain (42.21%), Allergies (38.23%), Hypertension (36.60%), Osteoarthritis (26.22%), and Other Physical or Mental Conditions (including Other Arthritis or Infections) (56.63%). The

Conditions Without Potentially Painful Symptoms were Macular Degeneration (4.17%), Memory Problems or Dementia (1.67%), and Parkinson's Disease (0.42%). In total, Conditions with Diagnostically Potentially Painful Symptoms accounted for 89.16% on the sample and Conditions without Potentially Painful Symptoms accounted for 6.09% of the sample.

The top five medications were taken for Hypertension (28.77%), with Systemic Corticosteroids the next most common medication (13.13%), followed by medications taken for Hypo- Or Hyper- Thyroidism (11.29%), Diabetes (8.42%), and Depression (7.93%).

Conditions that participants reported they took other treatments for were Hypertension (24.47%), Depression (2.20%), Stroke or Mini-Stroke (0.34%), and Parkinson's Disease (0.11%).

Table 4. Descriptive statistics of each Comorbidity, Medication, and Other Treatment.

	Total (n = 28 409)
COMORBIDITIES	
Conditions with potentially painful symptoms (n = 25 329, 89.16%)	
Back problems or pain	11 991 (42.21)
Allergies	10 861 (38.23)
Hypertension	10 397 (36.60)
Osteoarthritis	7 450 (26.22)
Traumatic brain injury	6 899 (24.28)
Mental health conditions (mood disorder, anxiety disorder, or clinical depression)	6 485 (22.83)
Urinary incontinence or urinary tract infection	5 457 (19.21)
Diabetes	5 425 (19.10)
Heart disease (including congestive heart failure, myocardial infarction, or angina)	4 510 (15.88)
Cancer	4 340 (15.28)
Hypo- or hyper- thyroidism	4 114 (14.48)
Asthma	3 747 (13.19)
Migraine	3 605 (12.69)
Bowel disorder (including Crohn's disease, ulcerative colitis, or irritable bowel syndrome) or incontinence	3 017 (10.62)
Osteoporosis	2 518 (8.86)
Intestinal or stomach ulcers	2 140 (7.53)
Influenza	1 831 (6.45)
Chronic obstructive pulmonary disease	1 578 (5.55)
Peripheral vascular disease	1 484 (5.22)
Stroke, mini-stroke, or transient ischemic attack	1 223 (4.30)
Rheumatoid arthritis	893 (3.14)
Kidney disease or failure	799 (2.81)

Pneumonia	726 (2.56)
Epilepsy	303 (1.07)
Multiple sclerosis	189 (0.67)
Other physical or mental conditions (including other arthritis or infections)	16 089 (56.63)
Conditions without potentially painful symptoms (n = 1 730, 6.09%)	
Macular degeneration	1 185 (4.17)
Memory problems or dementia	475 (1.67)
Parkinson's disease	118 (0.42)
CONDITIONS WITH REPORTED MEDICATION USE	
Hypertension	8 173 (28.77)
Systemic corticosteroids	3 730 (13.13)
Hypo- or hyper- thyroidism	3 208 (11.29)
Diabetes	2 391 (8.42)
Depression	2 252 (7.93)
Respiratory problems	1 313 (4.62)
Osteoporosis	1 246 (4.39)
Arthritis	963 (3.39)
Stroke or mini-stroke	697 (2.45)
Heart disease	545 (1.92)
Parkinson's disease	98 (0.34)
CONDITIONS WITH REPORTED OTHER TREATMENT USE	
Hypertension	6 952 (24.47)
Depression	626 (2.20)
Stroke or mini-stroke	97 (0.34)
Parkinson's disease	31 (0.11)

Values are frequency (%).

Notes. Valid percent was not used due to varying missing value counts for the conditions, conditions with reported medications, and conditions with reported other treatments; this was done to allow the percentages to be comparable with each other. Conditions were categorized into potentially painful or non-painful symptoms according to diagnostic criteria (Longe & Gale, 2006). For comorbidities, participants were asked whether a doctor ever told them they had the stated condition or if they have seen a doctor within the past year for the stated condition or if they ever suffered from a traumatic brain injury. For conditions with reported medication use, participants were asked if they were currently taking medications for the stated condition or if they have ever taken systemic corticosteroids. For conditions with reported other treatment use, participants were asked if they were currently undergoing other treatment for the stated conditions (CLSA, 2015d).

Comparing Sociodemographic and Health Characteristics Between Pain Groups

Pain Presence (Table 5)

Comparing participants who reported they were usually free of pain or not resulted in differences in age ($p < 0.001$) and by distribution of age groups ($p < 0.001$), sex ($p < 0.001$), education ($p < 0.001$), ethnicity ($p < 0.001$), income ($p < 0.001$), retirement status ($p < 0.001$), marital status ($p < 0.001$), language ($p < 0.001$), and Comorbidity Count ($p < 0.001$). Specifically, those who reported pain were older, with the test of column proportions resulting in a lower proportion of people who reported pain and were in the 45 to 54 age group, and greater proportions of people who reported pain and were in the 65 to 74 age group or in the 75+ age

group compared to those who reported they were free of pain. There was a lower proportion of people who reported pain and were men and a greater proportion of people who reported pain and were women compared to those who reported they were free of pain. There were greater proportions of people who reported pain and had less than a secondary school education, secondary school education, or some post-secondary education, and a lower proportion of people who reported pain and had a post-secondary degree/diploma compared to those who reported they were free of pain. There were greater proportions of people who reported pain and were Canadians or Indigenous, and lower proportions of people who reported pain and were Europeans or other ethnicities compared to those who reported they were free of pain. There were greater proportions of people who reported pain and had incomes of < $20,000 or ≥ $20,000 but < $50,000, and lower proportions of people who reported pain and had incomes of ≥ $100,000 but < $150,000 or ≥ $150,000 compared to those who reported they were free of pain. There was a greater proportion of people who reported pain and were completely retired, and lower proportions of people who reported pain and were partly retired or not retired compared to those who reported they were free of pain. There were greater proportions of people who reported pain and were single, widowed, or divorced/separated, and a lower proportion of people who reported pain and were married/common-law relationship compared to those who reported they were free of pain. There was a lower proportion of people who reported pain and whose language conversation was English, and a greater proportion who reported pain and whose language conversation was French compared to those who reported they were free of pain. People who reported pain had a higher mean Comorbidity Count than those who reported they were free of pain.

Table 5. Sociodemographic and comorbidity characteristics of the CLSA sample who report they are free of pain or pain.

	Free of Pain	Pain	Test statistic	p-value
Age				
Years	62.45 ± 10.19 n = 18 073	63.61 ± 10.16 n = 10 336	t (28 407) = -9.21	< 0.001
Age group				
45-54	4 858 (26.88) $_a$	2 331 (22.55) $_b$	x^2 (3) = 83.30	< 0.001
55-64	5 970 (33.03) $_a$	3 405 (32.94) $_a$		
65-74	4 318 (23.89) $_a$	2 659 (25.73) $_b$		
75+	2 927 (16.20) $_a$	1 941 (18.78) $_b$		
Sex				
Men	9 510 (52.62) $_a$	4 455 (43.10) $_b$	x^2 (1) = 238.35	< 0.001
Women	8 563 (47.38) $_a$	5 881 (56.90) $_b$		
Education				
Less than secondary school	722 (4) $_a$	739 (7.17) $_b$	x^2 (3) = 187.81	< 0.001
Secondary school	1 557 (8.63) $_a$	1 069 (10.37) $_b$		
Some post-secondary	1 267 (7.02) $_a$	828 (8.03) $_b$		
Post-secondary degree/diploma	14 505 (80.36) $_a$	7 675 (74.44) $_b$		
Religion				
Christian	11 939 (86.10)	6 899 (86.51)	x^2 (1) = .70	0.40
Other	1 927 (13.90)	1 076 (13.49)		
Ethnicity				
Canadian	1 455 (8.11) $_a$	1 050 (10.23) $_b$	x^2 (3) = 72.19	< 0.001
European	13 039 (72.69) $_a$	7 229 (70.44) $_b$		
Indigenous	484 (2.70) $_a$	400 (3.90) $_b$		
Other	2 960 (16.50) $_a$	1 584 (15.43) $_b$		
Income				
< $20 000	623 (3.66) $_a$	735 (7.65) $_b$	x^2 (4) = 611.89	< 0.001
≥ $20 000 but < $50 000	3 257 (19.21) $_a$	2 595 (27.02) $_b$		
≥ $50 000 but < $100 000	6 048 (35.57) $_a$	3 405 (35.45) $_a$		
≥ $100 000 but < $150 000	3 634 (21.37) $_a$	1 650 (17.18) $_b$		
≥ $150 000	3 432 (20.18) $_a$	1 220 (12.70) $_b$		
Retirement status				
Completely retired	7 584 (42.07) $_a$	4 980 (48.42) $_b$	x^2 (2) = 107.43	< 0.001
Partly retired	2 070 (11.48) $_a$	1 076 (10.46) $_b$		
Not retired	8 375 (46.45) $_a$	4 230 (41.12) $_b$		
Marital Status				
Single	1 501 (8.31) $_a$	972 (9.41) $_b$	x^2 (3) = 135.84	< 0.001
Married or common-law	12 945 (71.65) $_a$	6 734 (65.16) $_b$		
Widowed	1 492 (8.26) $_a$	1 091 (10.56) $_b$		
Divorced or separated	2 129 (11.78) $_a$	1 537 (14.87) $_b$		
Language				
English	10 504 (58.26) $_a$	5 739 (55.65) $_b$	x^2 (2) = 34.53	< 0.001
French	4 784 (26.53) $_a$	3 071 (29.78) $_b$		
Other	2 742 (15.21) $_a$	1 502 (14.57) $_a$		
Comorbidity count	3.58 ± 2.32 n = 18 073	5.34 ± 2.84 n = 10 336	t (18 195.47) = -53.66	< 0.001

Values are means ± SD or frequency (valid %).

Notes. Bonferroni adjusted p-value for Pearson χ^2 is p = 0.006. According to the test of column proportions (only conducted for significant χ^2): if the subscript letter is different between columns, then the respective categories statistically differ from each other; the category with the

larger percentage is the larger category. If the subscript letter is the same between columns, then the categories do not statistically differ from each other.

Pain Intensity (Table 6)

Comparing those who reported “mild”, “moderate”, or “severe” pain resulted in differences in age ($p < 0.001$) and by distribution of age groups ($p < 0.001$), sex ($p < 0.001$), education ($p < 0.001$), ethnicity ($p < 0.001$), income ($p < 0.001$), retirement status ($p < 0.001$), marital status ($p < 0.001$), language ($p < 0.001$), and Comorbidity Count ($p < 0.001$). Specifically, those who reported severe pain were older, followed by those with “moderate” and then “mild” pain. The results from the test of column proportions resulted in a greater proportion of people who reported “mild” pain and were in the 45 to 54 age group followed by “moderate” and then “severe” pain, a greater proportion of people who reported “mild” pain and were in the 55 to 65 age group compared to “moderate” pain, and a greater proportion of people who reported “severe” pain and were in the 75+ age group followed by “moderate” and then “mild” pain. There was a greater proportion of people who reported “mild” pain and were men followed by “moderate” and then “severe” pain, and a greater proportion of people who reported “severe” pain and were women followed by “moderate” and then “mild” pain. There was a greater proportion of people who reported “severe” pain and had less than a secondary school education followed by “moderate” and then “mild” pain, greater proportions of people who reported “moderate” or “severe” pain and had a secondary school education compared to “mild” pain, and a greater proportion who reported “mild” pain and had a post-secondary degree/diploma followed by “moderate” and then “severe” pain. There were greater proportions of people who reported “moderate” or “severe” pain and were Canadians compared to “mild” pain, a greater proportion of people who reported “mild” pain and were Europeans compared to “severe” pain, and a greater proportion of people who reported “severe” pain and were Indigenous compared to

"mild" or "moderate" pain. There were greater proportions of people who reported "severe" pain and had incomes of < $20,000 or ≥ $20,000 but < $50,000 followed by "moderate" and then "mild" pain, greater proportions of people who reported "mild" or "moderate" pain and had an income of ≥ $50,000 but < $100,000 compared to "severe" pain, and greater proportions of people who reported "mild" pain and had incomes of ≥ $100,000 but < $150,000 or ≥ $150,000 followed by "moderate" and then "severe" pain. There was a greater proportion of people who reported "severe" pain and were completely retired followed by "moderate" and then "mild" pain, and a greater proportion of people who reported "mild" pain and were not retired followed by "moderate" and then "severe" pain. There was a greater proportion of people who reported "mild" pain and were married/common-law relationship followed by "moderate" and then "severe" pain, greater proportions of people who reported "moderate" or "severe" pain and were widowed compared to "mild" pain, and a greater proportion of people who reported "severe" pain and were divorced/separated followed by "moderate" and then "mild" pain. There were greater proportions of people who reported "mild" or "moderate" pain and whose language conversation was English compared to "severe" pain, and a greater proportion of people who reported "severe" pain and whose language conversation was French followed by "moderate" and then "mild" pain. People who reported "severe" pain had a higher mean Comorbidity Count followed by "moderate" and then "mild" pain.

Table 6. Sociodemographic and comorbidity characteristics of the CLSA sample who report mild, moderate, or severe pain.

	Mild	Moderate	Severe	Test statistic	p-value
Age Years	62.44 ± 9.94 * n = 4 551	64.32 ± 10.19 * n = 4 833	65.52 ± 10.37 * n = 952	F (2, 2 661.10) = 59.45	< 0.001
Age group 45-54	1 176 (25.84) [a]	994 (20.57) [b]	161 (16.91) [c]	x^2 (6) = 119.90	< 0.001

55-64	1 573 (34.56) $_a$	1 539 (31.84) $_b$	293 (30.78) $_{a, b}$		
65-74	1 113 (24.46) $_a$	1 286 (26.61) $_a$	260 (27.31) $_a$		
75+	689 (15.14) $_a$	1 014 (20.98) $_b$	238 (25) $_c$		
Sex					
Men	2 131 (46.82) $_a$	1 982 (41.01) $_b$	342 (35.92) $_c$	x^2 (2) = 54.35	< 0.001
Women	2 420 (53.18) $_a$	2 851 (58.99) $_b$	610 (64.08) $_c$		
Education					
Less than secondary school	209 (4.61) $_a$	403 (8.35) $_b$	127 (13.37) $_c$	x^2 (6) = 175.44	< 0.001
Secondary school	380 (8.38) $_a$	564 (11.69) $_b$	125 (13.16) $_b$		
Some post-secondary	331 (7.30) $_a$	413 (8.56) $_a$	84 (8.84) $_a$		
Post-secondary degree/diploma	3 617 (79.72) $_a$	3 444 (71.39) $_b$	614 (64.63) $_c$		
Religion					
Christian	3 075 (86.67)	3 196 (86.15)	628 (87.59)	x^2 (2) = 1.21	0.55
Other	473 (13.33)	514 (13.85)	89 (12.41)		
Ethnicity					
Canadian	396 (8.75) $_a$	539 (11.24) $_b$	115 (12.22) $_b$	x^2 (6) = 39.02	< 0.001
European	3 244 (71.67) $_a$	3 361 (70.08) $_{a, b}$	624 (66.31) $_b$		
Indigenous	150 (3.31) $_a$	195 (4.07) $_a$	55 (5.84) $_b$		
Other	736 (16.26) $_a$	701 (14.62) $_a$	147 (15.62) $_a$		
Income					
< $20 000	196 (4.57) $_a$	403 (9.03) $_b$	136 (15.94) $_c$	x^2 (8) = 357.49	< 0.001
≥ $20 000 but < $50 000	969 (22.59) $_a$	1 320 (29.58) $_b$	306 (35.87) $_c$		
≥ $50 000 but < $100 000	1 551 (36.15) $_a$	1 590 (35.63) $_a$	264 (30.95) $_b$		
≥ $100 000 but < $150 000	872 (20.33) $_a$	685 (15.35) $_b$	93 (10.90) $_c$		
≥ $150 000	702 (16.36) $_a$	464 (10.40) $_b$	54 (6.33) $_c$		
Retirement status					
Completely retired	1 911 (42.09) $_a$	2 511 (52.23) $_b$	558 (59.49) $_c$	x^2 (4) = 152.17	< 0.001
Partly retired	500 (11.01) $_a$	489 (10.17) $_a$	87 (9.28) $_a$		
Not retired	2 129 (46.89) $_a$	1 808 (37.60) $_b$	293 (31.24) $_c$		
Marital Status					
Single	406 (8.92) $_a$	461 (9.54) $_a$	105 (11.04) $_a$	x^2 (6) = 89.36	< 0.001
Married or common-law	3 145 (69.11) $_a$	3 063 (63.39) $_b$	526 (55.31) $_c$		
Widowed	396 (8.70) $_a$	573 (11.86) $_b$	122 (12.83) $_b$		
Divorced or separated	604 (13.27) $_a$	735 (15.21) $_b$	198 (20.82) $_c$		
Language					
English	2 588 (57.04) $_a$	2 683 (55.58) $_a$	468 (49.37) $_b$	x^2 (4) = 27.53	< 0.001
French	1 263 (27.84) $_a$	1 473 (30.52) $_b$	335 (35.34) $_c$		
Other	686 (15.12) $_a$	671 (13.90) $_a$	145 (15.30) $_a$		
Comorbidity count	4.64 ± 2.56 * n = 4 551	5.77 ± 2.87 * n = 4 833	6.54 ± 3.17 * n = 952	F (2, 2 579.85) = 287.58	< 0.001

Values are means ± SD or frequency (valid %).

Notes. Bonferroni adjusted p-value for Pearson χ^2 is p = 0.006. According to the test of column proportions (only conducted for significant χ^2): if the subscript letter is different between columns, then the respective categories statistically differ from each other; the category with the larger percentage is the larger category. If the subscript letter is the same between columns, then the categories do not statistically differ from each other.

Pain Impact (Table 7)

Comparing those who reported “none”, “a few”, “some”, and “most” activities prevented by pain resulted in differences in sex ($p < 0.001$), education ($p < 0.001$), ethnicity ($p < 0.001$), income ($p < 0.001$), marital status ($p < 0.001$), language ($p < 0.001$), and Comorbidity Count ($p < 0.001$). Specifically, there was a greater proportion of people who reported “none” and were men compared to those who reported “a few” or “some”, and greater proportion of people who reported “a few” or “some” and were women compared to those who reported “none”. There was a greater proportion of people who reported “most” and had less than a secondary school education compared to those who reported “none”, “a few”, or “some”, a greater proportion of people who reported “most” and had a secondary school education compared to those who reported “a few” or “some”, a greater proportion of people who reported “most” and had some post-secondary education compared to those who reported “none” or “a few”, and a lower proportion of people who reported “most” and had a post-secondary degree/diploma compared to those who reported “none”, “a few”, or “some”. There were greater proportions of people who reported “none” or “a few” and were Canadians compared to those who reported “some” or “most”, a greater proportion of those who reported “none” and were Europeans compared to those who reported “a few”, a greater proportion of people who reported “most” and were Indigenous compared to those who reported “none”, and greater proportions of people who reported “a few” or “some” and had other ethnicities compared to those who reported “none”. There was a greater proportion of people who reported “most” and had an income of < $20,000 compared to those who reported “none”, “a few”, or “most”; there was also a greater proportion of people who reported “some” and had an income of < $20,000 compared to those who reported “none”. There was a greater proportion of people who reported “most” and had an income of ≥ $20,000 but < $50,000 compared to those who reported “none”, “a few”, or “some”, and lower

proportions of people who reported “most” and had an income of ≥ $100,000 but < $150,000 or ≥ $150,000 compared to those who reported “none”, “a few”, or “some”. There were greater proportions of people who reported “none” or “a few” and were married/common-law relationship compared to those who reported “most”, and a greater proportion of people who reported “most” and were divorced/separated compared to those who reported “none”. There were greater proportions of people who reported “some” or “most” and whose language conversation was English compared to those who reported “none” or “a few”, greater proportions of people who reported “none” or “a few” and whose language conversation was French compared to those who reported “some” or “most”, and a greater proportion of people who reported “some” and whose language conversation was other compared to those who reported “none”, “a few”, or “most”. People who reported “most” had a higher mean Comorbidity Count followed by “some”, “a few”, and then “none”.

Table 7. Sociodemographic and comorbidity characteristics of the CLSA sample who reported activities prevented by pain as none, a few, some, or most.

	None	A few	Some	Most	Test statistic	p-value
Age Years	63.52 ± 10.03 n = 4 377	63.58 ± 10.20 n = 3 087	63.61 ± 10.14 n = 1 881	64.05 ± 10.61 n = 991	F (3, 3 496.42) = 0.71	0.55
Age group 45-54	981 (22.41)	708 (22.93)	411 (21.85)	231 (23.31)	x^2 (9) = 11.02	0.28
55-64	1 464 (33.45)	1 000 (32.39)	633 (33.65)	308 (31.08)		
65-74	1 131 (25.84)	802 (25.98)	492 (26.16)	234 (23.61)		
75+	801 (18.30)	577 (18.69)	345 (18.34)	218 (22)		
Sex Men	2 063 (47.13) [a]	1 212 (39.26) [b]	750 (39.87) [b]	430 (43.39) [a, b]	x^2 (3) = 55.60	< 0.001
Women	2 314 (52.87) [a]	1 875 (60.74) [b]	1 131 (60.13) [b]	561 (56.61) [a, b]		
Education Less than secondary school	314 (7.19) [a]	198 (6.42) [a]	108 (5.75) [a]	119 (12.07) [b]	x^2 (9) = 81.78	< 0.001

Secondary school	464 (10.63) [a, b]	302 (9.80) [b]	171 (9.11) [b]	132 (13.39) [a]		
Some post-secondary	331 (7.58) [a]	224 (7.27) [a]	172 (9.16) [a, b]	101 (10.24) [b]		
Post-secondary degree/diploma	3 257 (74.60) [a]	2 358 (76.51) [a]	1 426 (75.97) [a]	634 (64.30) [b]		
Religion						
Christian	2 961 (87.17)	2 020 (85.96)	1 256 (85.91)	662 (86.42)	x^2 (3) = 2.32	0.51
Other	436 (12.83)	330 (14.04)	206 (14.09)	104 (13.58)		
Ethnicity						
Canadian	527 (12.10) [a]	338 (11.04) [a]	111 (5.95) [b]	74 (7.55) [b]	x^2 (9) = 97.40	< 0.001
European	3 104 (71.26) [a]	2 094 (68.39) [b]	1 339 (71.80) [a, b]	692 (70.61) [a, b]		
Indigenous	143 (3.28) [a]	128 (4.18) [a, b]	73 (3.91) [a, b]	56 (5.71) [b]		
Other	582 (13.36) [a]	502 (16.39) [b]	342 (18.34) [b]	158 (16.12) [a. b]		
Income						
< $20 000	256 (6.24) [a]	192 (6.69) [a, b]	151 (8.79) [b]	136 (14.91) [c]	x^2 (12) = 134.28	< 0.001
≥ $20 000 but < $50 000	1 074 (26.17) [a]	770 (26.82) [a]	459 (26.72) [a]	292 (32.02) [b]		
≥ $50 000 but < $100 000	1 455 (35.45) [a]	1 057 (36.82) [a]	587 (34.17) [a]	306 (33.55) [a]		
≥ $100 000 but < $150 000	774 (18.86) [a]	481 (16.75) [a]	293 (17.05) [a]	102 (11.18) [b]		
≥ $150 000	545 (13.28) [a]	371 (12.92) [a]	228 (13.27) [a]	76 (8.33) [b]		
Retirement status						
Completely retired	2 067 (47.41)	1 486 (48.33)	910 (48.64)	517 (52.76)	x^2 (6) = 12.12	0.06
Partly retired	444 (10.18)	343 (11.15)	194 (10.37)	95 (9.69)		
Not retired	1 849 (42.41)	1 246 (40.52)	767 (40.99)	368 (37.55)		
Marital Status						
Single	418 (9.55) [a]	287 (9.30) [a]	162 (8.62) [a]	105 (10.60) [a]	x^2 (9) = 30.66	< 0.001
Married or common-law	2 922 (66.76) [a]	2 032 (65.85) [a]	1 191 (63.35) [a, b]	589 (59.43) [b]		
Widowed	439 (10.03) [a]	312 (10.11) [a]	223 (11.86) [a]	117 (11.81) [a]		
Divorced or separated	598 (13.66) [a]	455 (14.74) [a, b]	304 (16.17) [a, b]	180 (18.16) [b]		
Language						
English	2 247 (51.42) [a]	1 668 (54.16) [a]	1 192 (63.68) [b]	632 (63.84) [b]	x^2 (6) = 194.76	< 0.001
French	1 510 (34.55) [a]	985 (31.98) [a]	351 (18.75) [b]	225 (22.73) [b]		
Other	613 (14.03) [a]	427 (13.86) [a]	329 (17.57) [b]	133 (13.43) [a]		

Comorbidity count	4.61 ± 2.52 * n = 4 377	5.47 ± 2.74 * n = 3 087	6.01 ± 2.97 * n = 1 881	6.87 ± 3.25 * n = 991	F (3, 3 366.58) = 222.14	< 0.001

Values are means ± SD or frequency (valid %).
Notes. Bonferroni adjusted p-value for Pearson χ^2 is p = 0.006. According to the test of column proportions (only conducted for significant χ^2): if the subscript letter is different between columns, then the respective categories statistically differ from each other; the category with the larger percentage is the larger category. If the subscript letter is the same between columns, then the categories do not statistically differ from each other.

Principal Component Analysis (Table 8)

The PCA was conducted on 35 items but there was significant multicollinearity between the strict and lenient scoring methods of the animal naming test ($r = 0.98$, $p < 0.001$) even though both methods had similar correlations with the pain outcomes and other variables. Since one of the assumptions of a PCA is no multicollinearity, the lenient scoring method was used in the analyses as it is more inclusive (Raina et al., 2008) and frequently used in studies of older adults with pain (Murata et al., 2017; Oosterman et al., 2011; Van Der Leeuw et al., 2016; Veronese et al., 2018). Weight and body fat percentage cross-loaded on two factors. To solve this problem, correlations between weight, body fat percentage, and the rest of the variables were examined which resulted in body fat percentage having larger correlations with the rest of the variables compared to weight. Hence, weight was excluded from the analysis and body fat percentage was retained.

A PCA was then conducted on 33 items with oblique rotation (promax). The Kaiser-Meyer-Olkin measure supported sampling adequacy for the analysis, KMO = 0.82 (considered 'great' (Field, 2009)). Bartlett's test of sphericity χ^2 (528) = 181,619.79, $p < 0.001$, indicated that correlations between the items were sufficiently large for PCA. An initial analysis was conducted to obtain eigenvalues for each component in the data. Nine components had eigenvalues over Kaiser's criterion of 1 and explained 54.22% of the cumulative variance. However, the scree plot showed an inflexion that justified retaining only 3 components. Due to the large sample size, the

scree plot was used to retain factors in the analysis (Field, 2009). Table 8 shows the factor loadings after rotation.

Examination of the items that cluster on each component allowed labels to be generated for each one. Items loading on Component 1 were decreased grip strength, increased body fat percentage, shorter height, increased Conditions with Reported Medication Use, and increased Comorbidities. The component was labelled "Biophysical" due to the widely known associations between the biological and physical function measures (Jackson et al., 2015; Ryan, Wallace, O'Hara, & Smith, 2015; Vancampfort, Stubbs, Firth, & Koyanagi, 2018; Wei, Kabeto, Galecki, & Langa, 2019; Yorke, Curtis, Shoemaker, & Vangsnes, 2017). Higher scores on the "Biopphysical" component reflect worse biophysical health. Items loading on Component 2 were increased performance on the RAVLT (immediate recall), RAVLT (delayed recall), animal naming test, COWAT, TUG, MAT, standing balance, and the 4-m walk. The component was labelled "Cognitive-motor" due to the widely known associations between the cognitive and physical function measures (Adamo, Anderson, Koochaki, & Fritz, 2020; Ansai et al., 2017, 2018; Auyeung et al., 2008; Callisaya et al., 2015; Clouston et al., 2013; Fitzpatrick et al., 2007; Garcia-Pinillos, Cozar-Barba, Munoz-Jimenez, Soto-Hermoso, & Latorre-Roman, 2016; Rosano et al., 2005; Tomita, Tanaka, Takahashi, & Takeuchi, 2020). Higher scores on the "Cognitive-motor" component reflect better cognitive-motor health. Items loading on Component 3 were decreased CES-D10, K10, and PC-PTSD scores, and increased SWLS, Emotional Stability, MOS-SSS, Conscientiousness, and Agreeableness scores. The component was labelled "Psychosocial" due to associations between psychological and social measures (Finlay et al., 2018; Hadjistavropoulos et al., 2011; Park, Newman, Engstrom, Hammar, & Swall, 2017). Higher scores on the "Psychosocial" component reflect better psychosocial health.

Variables that did not load on any of the components included the PASE, LSI, albumin count, count of Conditions with Reported Other Treatment Use, white blood cell count, CRT, chair rise test, MPMT, total cholesterol count, Stroop test, Extraversion, and Openness. As described in the 'Data Analyses' section, these variables were included in MANCOVAs for pain presence, intensity, and impact.

Table 8. PCA of cognitive, physical, and biopsychosocial factors.

	Rotated Factor Loadings		
Item	Biophysical	Cognitive-motor	Psychosocial
Grip strength	**-0.85**	-0.10	-0.11
Body fat percentage	**0.82**	0.18	0.08
Height	**-0.78**	-0.18	-0.11
Conditions with reported medications count	**0.44**	-0.19	-0.13
Comorbidity count	**0.43**	-0.08	-0.27
PASE	-0.35	0.22	0.06
LSI	-0.32	0.20	0.17
Albumin count	-0.25	0.08	-0.02
Count of conditions with reported other treatment use	0.20	-0.16	-0.07
White blood cell count	0.18	-0.15	-0.05
RAVLT (immediate)	0.22	**0.75**	-0.02
RAVLT (delayed)	0.24	**0.73**	-0.03
Animal naming	-0.12	**0.59**	-0.08
COWAT	0.05	**0.57**	-0.03
TUG	0.30	**-0.50**	-0.06
MAT	-0.13	**0.47**	-0.02
Standing Balance	-0.35	**0.44**	-0.07
4-m walk	0.36	**-0.42**	-0.03
CRT	0.20	-0.40	0.07
Chair rise	0.22	-0.37	-0.03
MPMT	0.09	-0.36	-0.03
Total cholesterol count	0.16	0.34	0.02
Stroop	0.13	-0.29	0.08
CES-D10	0.10	0.05	**-0.75**
K10	0.05	0.09	**-0.74**
SWLS	-0.01	-0.04	**0.68**
Emotional stability	0.01	-0.11	**0.68**
MOS-SSS	0.01	0.13	**0.52**
PC-PTSD	0.10	0.14	**-0.45**
Conscientiousness	0.03	-0.04	**0.44**
Agreeableness	0.29	0.03	**0.44**
Extraversion	0.16	0.13	0.33
Openness	0.03	0.16	0.20
Eigenvalues	5.17	2.83	2.42
% of variance	15.66	8.57	7.33

Notes. Bolded values indicate items loaded onto the factor (> |0.40|).
PASE = Physical Activity Scale for the Elderly; LSI = Life Space Index; RAVLT = Rey Auditory Verbal Learning Test COWAT = Controlled Oral Word Association Test; TUG = Timed-Up-and-Go; MAT = Mental Alternation Test; CRT = Choice Reaction Time; MPMT = Miami Prospective Memory Test; CES-D10 = short form of the Center for Epidemiologic Studies Depression Scale; K10 = Kessler Psychological Distress Scale; SWLS = Satisfaction With Life Scale; MOS-SSS = Medical Outcomes Study Social Support Survey; PC-PTSD = Primary Care Post Traumatic Stress Disorder.

Objective 1: Testing the Biopsychosocial Model of Pain and Aging for Pain Presence

Identifying Candidate Correlates (Table 9)

Table 9 shows the variables that met the inclusion criteria for the binary regression model for pain presence. They were age ($p < 0.001$), the "Biophysical" factor ($p < 0.001$), "Cognitive-motor" factor ($p < 0.001$), "Psychosocial" factor ($p < 0.001$), sex ($p < 0.001$), education ($p < 0.001$), ethnicity ($p < 0.001$), income ($p < 0.001$), marital status ($p < 0.001$), and language ($p < 0.001$).

Table 9. Candidate correlates for pain presence.

		N	T (p) or χ^2 (p)
T-TESTS	Age	28 409	**-9.21 (< 0.001)**
	Biophysical factor	17 268	**-26.40 (< 0.001)**
	Cognitive-motor factor	17 268	**-11.97 (< 0.001)**
	Psychosocial factor	17 268	**29.90 (< 0.001)**
χ^2	Sex	28 409	**238.35 (< 0.001)**
	Education	28 362	**187.81 (< 0.001)**
	Religion	21 841	0.70 (0.40)
	Ethnicity	28 201	**72.19 (< 0.001)**
	Income	26 609	**611.90 (< 0.001)**
	Marital status	28 401	**135.84 (< 0.001)**
	Language	28 342	**34.53 (< 0.001)**

Notes. Bolded=met criteria for inclusion in multivariate model (t-tests: $p<0.06$, χ^2: $p<0.04$).

Binary Logistic Regression (Table 10 and Figure 5)

The binary logistic regression model was statistically significant, χ^2 (20) = 1,441.06, $p < 0.001$. Table 10 shows the model, while Figure 5 shows the significant variables from the model.

Twelve variables were significant for the report of pain – three of them spanned the biopsychosocial spectrum: "Biophysical" factor (OR: 1.66, 95% CI: 1.56-1.77, p < 0.001), "Cognitive-motor" factor (OR: 0.94, 95% CI: 0.89-0.98, p = 0.01), and the "Psychosocial" factor (OR: 0.65, 95% CI: 0.63-0.68, p < 0.001); the other nine were sociodemographic variables: women (OR: 1.34, 95% CI: 1.19-1.50, p < 0.001), secondary school education (OR: 1.21, 95% CI: 1.02-1.44, p = 0.03), European ethnicity (OR: 1.22, 95% CI: 1.05-1.43, p = 0.01), other ethnicity (OR: 1.31, 95% CI: 1.07-1.62, p = 0.01), incomes of ≥ $20,000 but < $50,000 (OR: 1.48, 95% CI: 1.19-1.82, p < 0.001), ≥ $50,000 but < $100,000 (OR: 1.23, 95% CI: 1.08-1.41, p = 0.002), and ≥ $100,000 but < $150,000 (OR: 1.16, 95% CI: 1.04-1.29, p = 0.01), and martial statuses of married/common-law relationship (OR: 0.81, 95% CI: 0.70-0.95, p = 0.01) and widowed (OR: 1.16, 95% CI: 1.03-1.30, p = 0.01).

Accordingly, variables with higher odds of reporting pain were increased scores on the "Biophysical" factor, women compared to men, secondary school compared to less than secondary school, European ethnicity and other ethnicity compared to Canadian ethnicity, incomes of ≥ $20,000 but < $50,000, ≥ $50,000 but < $100,000, and ≥ $100,000 but < $150,000 compared to an income of < $20,000, and being widowed compared to being single, after adjusting for all other variables. Variables with lower odds of reporting pain were increased scores on the "Cognitive-motor" factor and "Psychosocial" factor and being married/common-law relationship compared to being single, after adjusting for all other variables.

Table 10. Binary logistic regression of pain presence groups, n = 16,213.

	Odds Ratio	95% CI (lower-upper)	p-value
Age	1.00	0.98 – 0.99	< 0.001
Biophysical factor	1.66	1.56 – 1.77	< 0.001
Cognitive-motor factor	0.94	0.89 – 0.98	0.01
Psychosocial factor	0.65	0.63 – 0.68	< 0.001

Men	1.00		
Women	1.34	1.19 – 1.50	< 0.001
Less than secondary school	1.00		
Secondary school	1.21	1.02 – 1.44	0.03
Some post-secondary	1.08	0.95 – 1.22	0.23
Post-secondary degree/diploma	1.00	0.87 – 1.14	0.98
Canadian	1.00		
European	1.22	1.05 – 1.43	0.01
Indigenous	1.07	0.96 – 1.18	0.22
Other ethnicity	1.31	1.07 – 1.62	0.01
< $20 000	1.00		
≥ $20 000 but < $50 000	1.48	1.19 – 1.82	< 0.001
≥ $50 000 but < $100 000	1.23	1.08 – 1.41	0.002
≥ $100 000 but < $150 000	1.16	1.04 – 1.29	0.01
≥ $150 000	1.12	1.00 – 1.25	0.05
Single	1.00		
Married or common-law	0.81	0.70 – 0.95	0.01
Widowed	1.16	1.03 – 1.30	0.01
Divorced or separated	0.97	0.82 – 1.14	0.69
English	1.00		
French	0.96	0.86 – 1.07	0.43
Other language	1.09	0.96 – 1.22	0.18

Model is significant: χ^2 (20) = 1441.06, p<0.001.
Notes. Odds for reporting the presence of pain.

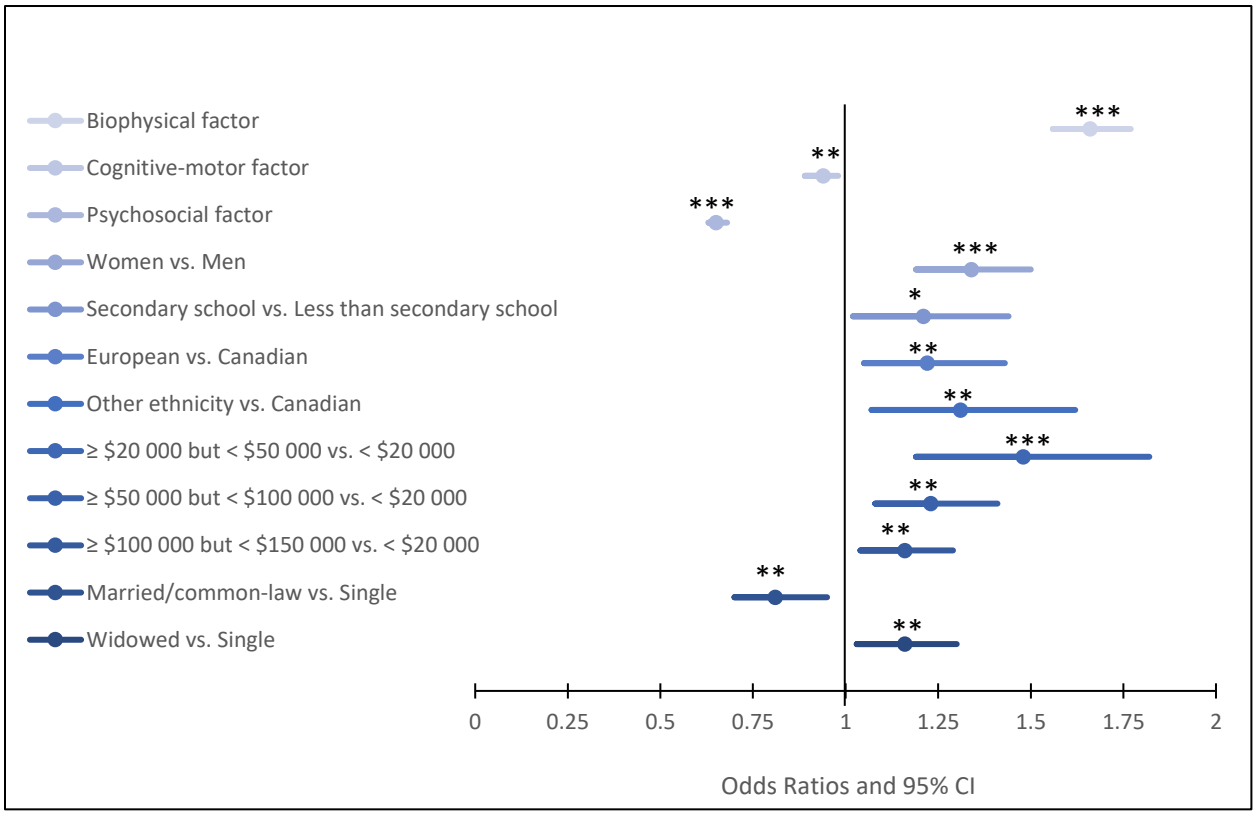

Figure 5. Odds Ratios and 95% CI for significant correlates of pain presence.
Notes. * p ≤ 0.05. ** p ≤ 0.01. *** p ≤ 0.001.

Individual Comorbidities (Table 11)

Results comparing each comorbidity between the pain presence groups (i.e., "free of pain" or "pain") are presented in Table 11. Eight significant Conditions with Potentially Painful Symptoms reached a small effect size: Back Problems or Pain ($p < 0.001$; phi $\varphi = 0.23$); Hypertension ($p < 0.001$; phi $\varphi = 0.11$); Osteoarthritis ($p < 0.001$; phi $\varphi = 0.24$); Mental Health Conditions ($p < 0.001$; phi $\varphi = 0.14$); Urinary Incontinence or Urinary Tract Infection ($p < 0.001$; phi $\varphi = 0.11$); Migraine ($p < 0.001$; phi $\varphi = 0.11$); Bowel Disorder (including Crohn's Disease, Ulcerative Colitis, or Irritable Bowel Syndrome) or Incontinence ($p < 0.001$; phi $\varphi = 0.11$); and Other Physical or Mental Conditions (including Other Arthritis or Infections) ($p < 0.001$; phi $\varphi = 0.15$).

Table 11. Pain presence and individual conditions.

	N	χ^2 (p)	Phi φ
Conditions with potentially painful symptoms			
Back problems or pain	28 409	1 504.32 (< 0.001)	0.23*
Allergies	28 161	168.12 (< 0.001)	0.08
Hypertension	28 409	316.83 (< 0.001)	0.11*
Osteoarthritis	27 884	1 660.11 (< 0.001)	0.24*
Traumatic brain injury	28 409	98.42 (< 0.001)	0.06
Mental health conditions (mood disorder, anxiety disorder, or clinical depression)	28 281	553.10 (< 0.001)	0.14*
Urinary incontinence or urinary tract infection	28 285	330.47 (< 0.001)	0.11*
Diabetes	15 096	66.86 (< 0.001)	0.07
Heart disease (including congestive heart failure, myocardial infarction, or angina)	28 184	198.50 (< 0.001)	0.08
Cancer	28 329	26.47 (< 0.001)	0.03
Hypo- or hyper- thyroidism	28 034	91.59 (< 0.001)	0.06
Asthma	28 287	177.42 (< 0.001)	0.08
Migraine	28 312	316.84 (< 0.001)	0.11*
Bowel disorder (including Crohn's disease, ulcerative colitis, or irritable bowel syndrome) or incontinence	28 281	331.71 (< 0.001)	0.11*
Osteoporosis	28 157	132.99 (< 0.001)	0.07

Intestinal or stomach ulcers	28 286	208.86 (< 0.001)	0.09
Influenza	28 315	58.51 (< 0.001)	0.05
Chronic obstructive pulmonary disorder	28 245	192.39 (< 0.001)	0.08
Peripheral vascular disease	28 264	212.47 (< 0.001)	0.09
Stroke, mini-stroke, or transient ischemic attack	28 208	74.66 (< 0.001)	0.05
Rheumatoid arthritis	28 067	221.08 (< 0.001)	0.09
Kidney disease or failure	28 294	44.71 (< 0.001)	0.04
Pneumonia	28 336	55.20 (< 0.001)	0.04
Epilepsy	28 339	14.61 (< 0.001)	0.02
Multiple sclerosis	28 344	18.39 (< 0.001)	0.03
Other physical or mental conditions (including other arthritis or infections)	28 193	664.78 (< 0.001)	0.15*
Conditions without potentially painful symptoms			
Macular degeneration	28 220	30.80 (< 0.001)	0.03
Memory problems or dementia	28 313	62.59 (< 0.001)	0.05
Parkinson's disease	28 347	12.04 (< 0.001)	0.02

Notes. * = small effect size (≥ 0.10 to < 0.30) based on Phi's φ. df for all is 1. Bonferroni adjusted p-value is p = 0.002.

Remaining Continuous Variables (Table 12 and Figure 6)

Using Pillai's trace, there was a significant difference between the pain presence groups on the combined dependent variables after controlling for sex, education, income, martial status, and language, [F (13, 20,428) = 23.87, p < 0.001, Pillai's trace = 0.02, partial η^2 = 0.02]. However, after Bonferroni adjusted pairwise comparisons, separate univariate tests on the dependent variables revealed a non-significant difference between the pain presence groups on age [F (1, 20,440) = 1.57, p = 0.21], CRT [F (1, 20,440) = 0.44, p = 0.51], Extraversion [F (1, 20,440) = 1.24, p = 0.27], and Openness [F (1, 20,440) = 2.53, p = 0.11]. Table 12 reports the mean ± SD and the EMM ± SE of the dependent variables for each pain presence group, as well as the results from the MANCOVA.

Calculation of effect sizes (partial η^2; Figure 6) for each significant dependent variable revealed a small effect size only for chair rise (partial η^2 = 0.01) and Other Treatment Count (partial η^2 = 0.01). After adjusting for covariates, the pain group required significantly more time than the free-of-pain group to complete the chair rise test (3.65 ± 0.01 vs 3.58 ± 0.00; p < 0.001).

The pain group had a significantly higher count of Conditions with Reported Other Treatment Use than the free-of-pain group (0.36 ± 0.01 vs 0.28 ± 0.00; $p < 0.001$).

Table 12. MANCOVA of variables not included in the PCA and age between pain presence groups.

		Free of Pain n = 13 387	Pain n = 7 071	F (p)	Partial η^2
Age	***Mean ± SD***	61.84 ± 9.91	62.76 ± 9.84	1.50 (0.22)	0.00
	EMM ± SE	62.10 ± 0.08	62.26 ± 0.11		
MPMT	***Mean ± SD***	0.40 ± 0.75	0.49 ± 0.81	25.90 (< 0.001)	0.001
	EMM ± SE	3.58 ± 0.00	3.65 ± 0.01		
Stroop	***Mean ± SD***	0.31 ± 0.12	0.32 ± 0.12	21.34 (< 0.001)	0.001
	EMM ± SE	0.31 ± 0.00	0.32 ± 0.00		
CRT	***Mean ± SD***	2.91 ± 0.10	2.91 ± 0.10	0.44 (0.51)	0.00
	EMM ± SE	2.91 ± 0.00	2.91 ± 0.00		
Chair rise	***Mean ± SD***	3.57 ± 0.47	3.67 ± 0.52	105.13 (< 0.001)	0.01 *
	EMM ± SE	3.58 ± 0.00	3.65 ± 0.01		
PASE	***Mean ± SD***	149.32 ± 73.28	139.76 ± 74.78	17.07 (< 0.001)	0.001
	EMM ± SE	147.54 ± 0.62	143.12 ± 0.86		
LSI	***Mean ± SD***	88.15 ± 16.11	84.64 ± 18.02	66.26 (< 0.001)	0.003
	EMM ± SE	87.61 ± 0.14	85.66 ± 0.19		
Count of conditions with reported other treatment use	***Mean ± SD***	0.28 ± 0.48	0.36 ± 0.54	100.19 (< 0.001)	0.01 *
	EMM ± SE	0.28 ± 0.00	0.36 ± 0.01		
White blood cell count	***Mean ± SD***	0.80 ± 0.11	0.82 ± 0.11	28.03 (< 0.001)	0.001
	EMM ± SE	0.81 ± 0.00	0.81 ± 0.00		
Albumin	***Mean ± SD***	39.97 ± 2.60	39.80 ± 2.75	6.55 (0.01)	0.00
	EMM ± SE	39.95 ± 0.02	39.85 ± 0.03		
Cholesterol	***Mean ± SD***	5.17 ± 1.08	5.14 ± 1.14	12.70 (< 0.001)	0.001
	EMM ± SE	5.18 ± 0.01	5.12 ± 0.01		
Extraversion	***Mean ± SD***	4.39 ± 1.79	4.35 ± 1.81	0.98 (0.32)	0.00
	EMM ± SE	4.38 ± 0.02	4.36 ± 0.02		
Openness	***Mean ± SD***	5.48 ± 1.35	5.40 ± 1.40	2.27 (0.13)	0.00
	EMM ± SE	5.47 ± 0.01	5.44 ± 0.02		
MULTIVARIATE TEST (PILLAI'S TRACE): F (13, 20,428) = 23.87, p < 0.001					

Notes. * = small effect size (≥ 0.01 to < 0.06) based on partial η^2. MPMT shows inverse score because of data transformation. The mean ± SD describes the variables without adjusting for the covariates. EMM ± SE shows the means and standard errors after adjusting for the covariates in the model. Reporting both shows the difference in the means after accounting for the covariates.
SD = Standard Deviation; EMM = Estimated Marginal Means; SE = Standard Error; MPMT = Miami Prospective Memory Test; CRT = Choice Reaction Time; PASE = Physical Activity Scale for the Elderly; LSI = Life Space Index

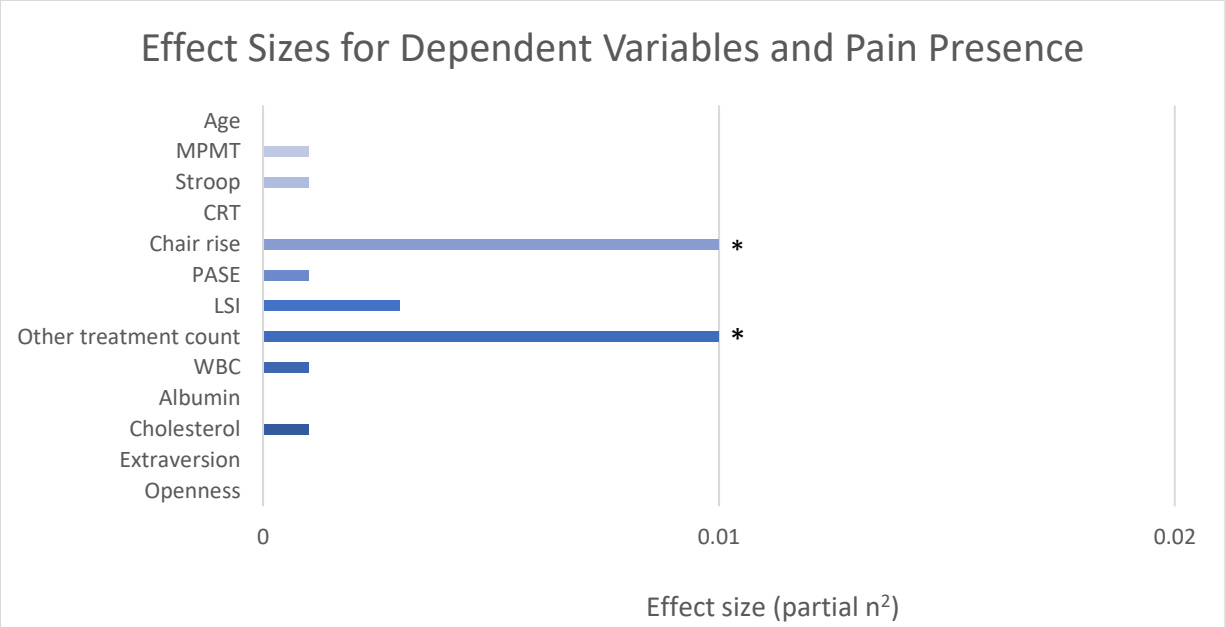

Figure 6. Effect sizes (partial n^2) from MANCOVA for pain presence and dependent variables.

Notes. * = small effect size (≥ 0.01 to < 0.06) based on partial η^2.
MPMT = Miami Prospective Memory Test; CRT = Choice Reaction Time; PASE = Physical Activity Scale for the Elderly; LSI = Life Space Index; WBC = White Blood Cell count

Remaining Categorical Variables (Tables 13 and 14)

Falls. There was a significant association between the pain presence groups and falls, [χ^2 (3) = 61.32; $p < 0.00$] (refer to Table 13). After a Bonferroni adjustment, all the cells significantly contributed to the overall χ^2 statistic – those who were free of pain and had "no falls" (observed count was more than expected; $p < 0.006$); those who were free of pain and have "falls that did not result in serious injury/medical attention" (observed count was less than expected; $p < 0.006$); those who were free of pain and had "falls that resulted in injury that required medical attention" (observed count was less than expected; $p < 0.006$); those who were free of pain and had "falls that resulted in injury that required medical attention and hospitalization" (observed count was less than expected; $p = 0.003$); those who had pain and "no falls" (observed count was less than expected, $p < 0.006$); those who had pain and "falls that did not result in serious injury/medical attention" (observed count was more than expected; $p < 0.006$); those who had

pain and “falls that resulted in injury requiring medical attention” (observed count was more than expected; $p < 0.006$); and those who had pain and “falls that resulted in injury requiring medical attention and hospitalization” (observed count was more than expected; $p = 0.002$). Cramer’s V, however, suggested that a small effect size was not reached (Cramer’s $V = 0.05$).

Table 13. χ^2 of pain presence and falls.

	Total (n = 28 406)	**Free of pain (n = 18 071)**	**Pain (n = 10 335)**	χ^2	**df**	**p**	**Cramer’s V**
No falls	26 985 (95%)	17 305 (95.76%) [a]	9 680 (93.66%) [b]	61.32	3	<0.001	0.05
No serious injury/medical attention	566 (1.99%)	310 (1.72%) [b]	256 (2.48%) [a]				
Injury with medical attention	691 (2.43%)	370 (2.05%) [b]	321 (3.11%) [a]				
Injury with medical attention and hospitalization	164 (0.58%)	86 (0.48%) [b]	78 (0.75%) [a]				

Notes. [a] = observed count is significantly more than expected count ($p < 0.006$). [b] = observed count is significantly less than expected count ($p < 0.006$).

Social Participation. There was a significant association between the pain presence groups and social participation, [χ^2 (4) = 95.55; $p < 0.001$] (refer to Table 14). After a Bonferroni adjustment, the following significantly contributed to the overall χ^2 statistic: those who were free of pain and “did not participate” in activities (observed count was less than expected; $p < 0.005$); those who were free of pain and participated in activities “at least once a year” (observed count was less than expected; $p < 0.005$); those who were free of pain and participated in activities “at least once a month” (observed count was less than expected; $p < 0.005$); those who were free of pain and participated in activities “at least once a day” (observed count was more than expected; $p < 0.005$); those who had pain and “did not participate” in activities (observed count was more than expected; $p < 0.005$); those who had pain and participated in activities “at least once a year” (observed count was more than expected; $p < 0.005$); those who had pain and participated in

activities “at least once a month” (observed count was more than expected; $p < 0.005$); those who had pain and participated in activities “at least once a day” (observed count was less than expected; $p < 0.005$). Cramer’s V, however, suggested that a small effect size was not reached (Cramer’s V = 0.06).

Table 14. χ^2 of pain presence and social participation.

	Total (n=28 375)	**Free of pain (n = 18 052)**	**Pain (n = 10 323)**	χ^2	**df**	**p**	**Cramer’s V**
Did not participate	34 (0.12%)	9 (0.05%) [b]	25 (0.24%) [a]	95.55	4	<0.001	0.06
Participated at least once a year	375 (1.32%)	182 (1.01%) [b]	193 (1.87%) [a]				
Participated at least once a month	3 511 (12.37%)	2 089 (11.57%) [b]	1 422 (13.78%) [a]				
Participated at least once a week	19 465 (68.60%)	12 489 (69.18%)	6 976 (67.58%)				
Participated at least once a day	4 990 (17.59%)	3 283 (18.19%) [a]	1 707 (16.54%) [b]				

Notes. [a] = observed count is significantly more than expected count ($p < 0.005$). [b] = observed count is significantly less than expected count ($p < 0.005$).

Objective 2: Testing the Biopsychosocial Model of Pain and Aging for Pain Intensity

Identifying Candidate Correlates (Table 15)

Table 15 shows the variables that met the inclusion criteria for the ordinal regression model for Pain Intensity. They were age ($p < 0.001$), the “Biophysical” factor ($p < 0.001$), “Cognitive-motor” factor ($p < 0.001$), “Psychosocial” factor ($p < 0.001$), sex ($p < 0.001$), education ($p < 0.001$), ethnicity ($p < 0.001$), income ($p < 0.001$), marital status ($p < 0.001$), and language ($p < 0.001$).

Table 15. Candidate correlates for pain intensity.

		N	F (p) or χ^2 (p)
ANOVAS	Age	10 336	**59.45 (< 0.001)**
	Biophysical factor	5 654	**99.09 (< 0.001)**
	Cognitive-motor factor	5 654	**79.58 (< 0.001)**
	Psychosocial factor	5 654	**61.11 (< 0.001)**
χ^2	Sex	10 336	**54.35 (< 0.001)**
	Education	10 311	**175.44 (< 0.001)**
	Religion	7 975	1.21 (0.55)
	Ethnicity	10 263	**39.02 (< 0.001)**
	Income	9 605	**357.49 (< 0.001)**
	Marital status	10 334	**89.36 (< 0.001)**
	Language	10 312	**27.53 (< 0.001)**

Notes. Bolded=met criteria for inclusion in multivariate model (ANOVAs: p<0.06, χ^2: p<0.04).

Ordinal Logistic Regression (Table 16 and Figure 7)

The ordinal logistic regression model was statistically significant, χ^2 (20) = 407.09, p < 0.001. Table 16 shows the model, while Figure 7 shows the significant variables from the model. There were nine significant variables – three of them spanned the biopsychosocial spectrum: "Biophysical" factor (OR: 1.39, 95% CI: 1.27-1.52, p < 0.001), "Cognitive-motor" factor (OR: 0.79, 95% CI: 0.73-0.85, p < 0.001), "Psychosocial" factor (OR: 0.83, 95% CI: 0.78-0.88, p < 0.001); the other six were sociodemographic variables: less than a secondary school education (OR: 1.45, 95% CI: 1.14-1.85, p = 0.002), secondary school education (OR: 1.28, 95% CI: 1.07-1.54, p = 0.01), Canadian ethnicity (OR: 1.37, 95% CI: 1.08-1.73, p < 0.001), and income levels of < $20,000 (OR: 1.52, 95% CI: 1.13-2.06, p = 0.01), ≥ $20,000 but < $50,000 (OR: 1.25, 95% CI: 1.01-1.53, p = 0.04), and ≥ $50,000 but < $100,000 (OR: 1.21, 95% CI: 1.02-1.45, p = 0.03).

Accordingly, variables with higher odds for reporting increased pain intensity were increased scores on the "Biophysical" factor, less than a secondary school education and a secondary school education compared to a post-secondary degree/diploma, Canadian ethnicity compared to other ethnicity, and incomes of < $20,000, ≥ $20,000 but < $50,000, ≥ $50,000 but < $100,000 compared to ≥ $150,000, after adjusting for all other variables. Variables with lower odds for

reporting increased pain intensity included increased scores on the "Cognitive-motor" factor and "Psychosocial" factor, after adjusting for all other variables.

Table 16. Ordinal logistic regression of pain intensity groups, n = 5,308.

	Odds Ratio	95% CI (lower-upper)	p-value
Age	1.00	.99 – 1.00	0.12
Biophysical factor	1.39	1.27 – 1.52	< 0.001
Cognitive-motor factor	0.79	0.73 – 0.85	< 0.001
Psychosocial factor	0.83	0.78 – 0.88	< 0.001
Men	1.16	0.97 – 1.38	0.11
Women	1.00		
Less than secondary school	1.45	1.14 – 1.85	0.002
Secondary school	1.28	1.07 – 1.54	0.01
Some post-secondary	1.04	.85 – 1.28	0.71
Post-secondary degree/diploma	1.00		
Canadian	1.37	1.08 – 1.73	0.01
European	1.04	.88 – 1.23	0.64
Indigenous	1.25	.93 – 1.70	0.15
Other ethnicity	1.00		
< $20 000	1.52	1.13 – 2.06	0.01
≥ $20 000 but < $50 000	1.25	1.01 – 1.53	0.04
≥ $50 000 but < $100 000	1.21	1.02 – 1.45	0.03
≥ $100 000 but < $150 000	1.11	.92 – 1.34	0.29
≥ $150 000	1.00		
Single	0.87	.70 – 1.10	0.25
Married or common-law	1.06	.89 – 1.26	0.53
Widowed	0.96	.75 – 1.22	0.73
Divorced or separated	1.00		
English	1.02	.86 – 1.21	0.84
French	1.16	.96 – 1.41	0.12
Other language	1.00		

Model is significant: χ^2 (20) = 407.09, p<0.001.
Notes. Reference category is severe pain.

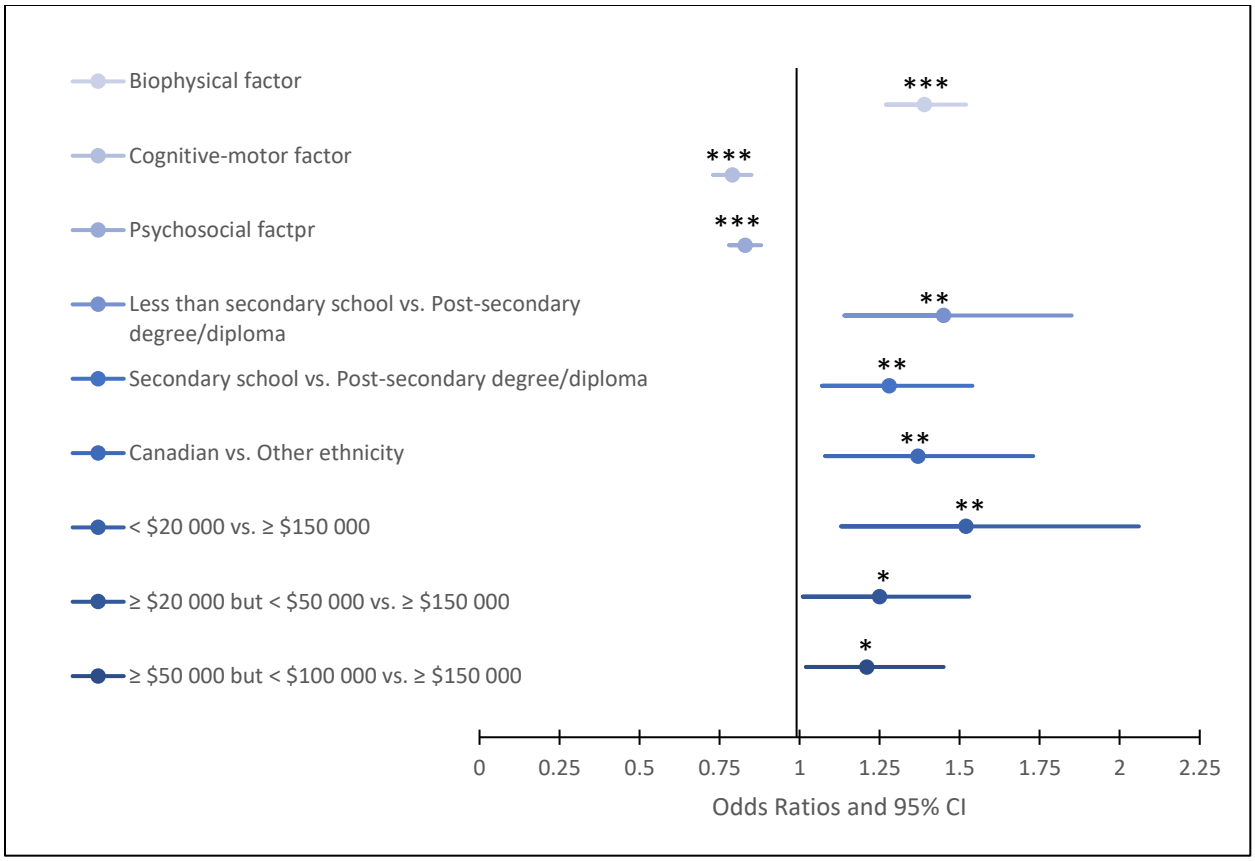

Figure 7. Odds Ratios and 95% CI for significant correlates of pain intensity.

Notes. * $p \leq 0.05$. ** $p \leq 0.01$. *** $p \leq 0.001$

Individual Comorbidities (Table 17)

Results comparing each comorbidity between the pain intensity groups (i.e., "mild", "moderate", or "severe" pain) are presented in Table 17. Five significant Conditions with Potentially Painful Symptoms reached a small effect size: Back Problems or Pain ($p < 0.001$; Cramer's $V = 0.13$); Osteoarthritis ($p < 0.001$; Cramer's $V = 0.13$); Mental Health Conditions ($p < 0.001$; Cramer's $V = 0.10$); Heart Disease (including Congestive Heart Failure, Myocardial Infarction, or Angina) ($p < 0.001$; Cramer's $V = 0.10$); and Peripheral Vascular Disease ($p < 0.001$; Cramer's $V = 0.10$).

Table 17. Pain intensity and individual conditions.

	N	χ^2 (p)	Cramer's V
Conditions with potentially painful symptoms			
Back problems or pain	10 336	161.63 (< 0.001)	0.13*
Allergies	10 238	3.82 (0.15)	0.02
Hypertension	10 336	80.41 (< 0.001)	0.09
Osteoarthritis	10 095	172.25 (< 0.001)	0.13*
Traumatic brain injury	10 336	14.60 (0.001)	0.04
Mental health conditions (mood disorder, anxiety disorder, or clinical depression)	10 280	106.82 (< 0.001)	0.10*
Urinary incontinence or urinary tract infection	10 282	64.37 (< 0.001)	0.08
Diabetes	6 235	38.31 (< 0.001)	0.08
Heart disease (including congestive heart failure, myocardial infarction, or angina)	10 236	111.48 (< 0.001)	0.10*
Cancer	10 300	14.14 (0.001)	0.04
Hypo- or hyper- thyroidism	10 163	33.07 (< 0.001)	0.06
Asthma	10 280	14.27 (< 0.001)	0.04
Migraine	10 294	59.01 (< 0.001)	0.08
Bowel disorder (including Crohn's disease, ulcerative colitis, or irritable bowel syndrome) or incontinence	10 276	69.18 (< 0.001)	0.08
Osteoporosis	10 215	49.62 (< 0.001)	0.07
Intestinal or stomach ulcers	10 269	59.33 (< 0.001)	0.08
Influenza	10 295	18.51 (< 0.001)	0.04
Chronic obstructive pulmonary disorder	10 265	79.71 (< 0.001)	0.09
Peripheral vascular disease	10 268	94.61 (< 0.001)	0.10*
Stroke, mini-stroke, or transient ischemic attack	10 238	46.75 (< 0.001)	0.07
Rheumatoid arthritis	10 150	27.44 (< 0.001)	0.05
Kidney disease or failure	10 283	34.20 (< 0.001)	0.06
Pneumonia	10 302	27.92 (< 0.001)	0.05
Epilepsy	10 304	11.07 (0.004)	0.03
Multiple sclerosis	10 308	0.02 (0.99)	0.00
Other physical or mental conditions (including other arthritis or infections)	10 248	57.23 (< 0.001)	0.08
Conditions without potentially painful symptoms			
Macular degeneration	10 265	1.76 (0.42)	0.01
Memory problems or dementia	10 297	25.25 (< 0.001)	0.05
Parkinson's disease	10 307	2.73 (0.26)	0.02

Notes. * = small effect size (≥ 0.10 to < 0.30) based on Cramer's V. df for all is 1. Bonferroni adjusted p-value is p = 0.002.

Remaining Continuous Variables (Table 18 and Figure 8)

Using Pillai's trace, there was a significant difference between the pain intensity groups on the combined dependent variables after controlling for sex, education, income, martial status, and language, [F (26, 14,082) = 7.19, $p < 0.001$, Pillai's trace = 0.03, partial $\eta^2 = 0.01$]. However, after Bonferroni adjusted pairwise comparisons, separate univariate tests on the dependent variables revealed a non-significant difference between the pain intensity groups on cholesterol [F (2, 7,052) = 1.85, p = 0.16], albumin [F (2, 7,052) = 0.54, p = 0.59], and Openness [F (2, 7,052) = 0.09, p = 0.91]. Table 18 reports the mean ± SD and the EMM ± SE of the dependent variables for each pain intensity group, as well as the results from the MANCOVA.

Calculation of effect sizes (partial η^2; Figure 8) for each significant dependent variable showed small effect sizes only for chair rise (partial $\eta^2 = 0.01$) and PASE (partial $\eta^2 = 0.01$). After adjusting for covariates, the "severe" pain intensity group required significantly more time to complete the chair rise test compared to both "mild" and "moderate" groups (3.77 ± 0.02 vs 3.63 ± 0.01 and 3.70 ± 0.01; $p < 0.001$). The "mild" pain intensity group had a significantly higher PASE score followed by the "moderate" and "severe" groups (142.14 ± 1.27 vs 141.22 ± 1.27 vs 117.52 ± 3.06; $p < 0.001$).

Table 18. MANCOVA of variables not included in the PCA and age between pain intensity groups.

		Mild n = 3 273	**Moderate n = 3 234**	**Severe n = 564**	**F (p)**	**Partial η^2**
Age	***Mean ± SD***	61.85 ± 9.63	63.38 ± 9.91	64.51 ± 10.14	7.42 (< 0.001)	0.002
	EMM ± SE	62.36 ± 0.16	63.02 ± 0.16	63.66 ± 0.37		
MPMT	***Mean ± SD***	0.44 ± 0.77	0.52 ± 0.82	0.64 ± 0.92	7.10 (< 0.001)	0.002
	EMM ± SE	0.46 ± 0.01	0.51 ± 0.01	0.59 ± 0.03		
Stroop	***Mean ± SD***	0.31 ± 0.12	0.33 ± 0.12	0.35 ± 0.12	10.66 (< 0.001)	0.003
	EMM ± SE	0.32 ± 0.00	0.32 ± 0.00	0.34 ± 0.01		
CRT	***Mean ± SD***	2.91 ± 0.10	2.92 ± 0.10	2.93 ± 0.10	6.68 (0.001)	0.002
	EMM ± SE	2.91 ± 0.00	2.92 ± 0.00	2.92 ± 0.00		
Chair rise	***Mean ± SD***	3.61 ± 0.49	3.71 ± 0.52	3.81 ± 0.61	29.42 (< 0.001)	0.01 *
	EMM ± SE	3.63 ± 0.01	3.70 ± 0.01	3.77 ± 0.02		

PASE	***Mean ± SD***	145.01 ± 72.92	139.43 ± 75.85	111.16 ± 72.80	28.77 (< 0.001)	0.01 *
	EMM ± SE	142.14 ± 1.27	141.22 ± 1.27	117.52 ± 3.06		
LSI	***Mean ± SD***	86.27 ± 16.75	83.99 ± 18.43	78.82 ± 21.06	14.04 (< 0.001)	0.004
	EMM ± SE	85.29 ± 0.30	84.59 ± 0.30	81.11 ± 0.73		
Count of conditions with reported other treatment use	***Mean ± SD***	0.33 ± 0.51	0.38 ± 0.56	0.40 ± 0.59	6.72 (0.001)	0.002
	EMM ± SE	0.33 ± 0.01	0.37 ± 0.01	0.40 ± 0.02		
White blood cell count	***Mean ± SD***	0.81 ± 0.11	0.82 ± 0.11	0.84 ± 0.12	15.49 (< 0.001)	0.004
	EMM ± SE	0.81 ± 0.00	0.82 ± 0.00	0.84 ± 0.01		
Albumin	***Mean ± SD***	39.85 ± 2.65	39.76 ± 2.80	39.64 ± 2.95	0.54 (0.59)	0.00
	EMM ± SE	39.83 ± 0.05	39.78 ± 0.05	39.71 ± 0.12		
Cholesterol	***Mean ± SD***	5.16 ± 1.10	5.13 ± 1.16	5.09 ± 1.19	1.85 (0.16)	0.001
	EMM ± SE	5.16 ± 0.02	5.13 ± 0.02	5.07 ± 0.05		
Extraversion	***Mean ± SD***	4.31 ± 1.81	4.38 ± 1.81	4.37 ± 1.79	4.13 (0.02)	0.001
	EMM ± SE	4.28 ± 0.03	4.40 ± 0.03	4.43 ± 0.08		
Openness	***Mean ± SD***	5.45 ± 1.35	5.37 ± 1.42	5.31 ± 1.51	0.09 (0.91)	0.00
	EMM ± SE	5.41 ± 0.02	5.40 ± 0.02	5.38 ± 0.06		
MULTIVARIATE TEST (PILLAI'S TRACE): F (26, 14,082) = 7.19, p < 0.001						

Notes. * = small effect size (≥ 0.01 to < 0.06) based on partial η^2. MPMT shows inverse score because of data transformation. The mean ± SD describes the variables without adjusting for the covariates. EMM ± SE shows the means and standard errors after adjusting for the covariates in the model. Reporting both shows the difference in the means after accounting for the covariates.
SD = Standard Deviation; EMM = Estimated Marginal Means; SE = Standard Error; MPMT = Miami Prospective Memory Test; CRT = Choice Reaction Time; PASE = Physical Activity Scale for the Elderly; LSI = Life Space Index

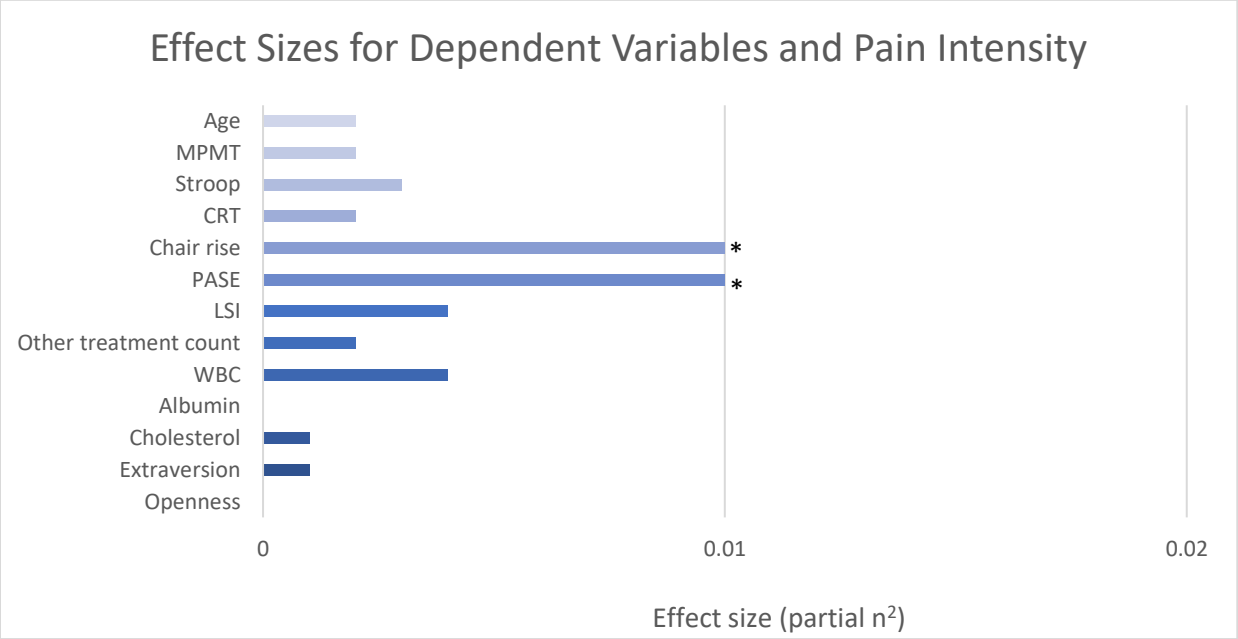

Figure 8. Effect sizes (partial n^2) from MANCOVA for pain intensity and dependent variables.

Notes. * = small effect size (≥ 0.01 to < 0.06) based on partial η^2.

MPMT = Miami Prospective Memory Test; CRT = Choice Reaction Time; PASE = Physical Activity Scale for the Elderly; LSI = Life Space Index; WBC = White Blood Cell count

Remaining Categorical Variables (Tables 19 and 20)

Falls. There was a significant association between the pain intensity groups and falls [χ^2 (6) = 23.06; p = < 0.001] (refer to Table 19). After a Bonferroni adjustment, the following cells significantly contributed to the overall χ^2 statistic: those who reported "mild" pain and "no falls" (observed count was more than expected; p < 0.004); and those who reported "mild" pain and "falls that resulted in injury that required medical attention" (observed count was less than expected; p < 0.004). Cramer's V, however, suggested that a small effect size was not reached (Cramer's V = 0.03).

Table 19. χ^2 of pain intensity and falls

	Total (n = 10 335)	**Mild (n = 4 551)**	**Moderate (n = 4 833)**	**Severe (n = 951)**	**χ^2**	**df**	**p**	**Cramer's V**
No falls	9 680 (93.66%)	4 317 (94.86%) [a]	4 492 (92.94%)	871 (91.59%)	23.06	6	<0.001	0.03
No serious injury/medical attention	256 (2.48%)	92 (2.02%)	133 (2.75%)	31 (3.26%)				
Injury with medical attention	321 (3.11%)	112 (2.46%) [b]	171 (3.54%)	38 (4%)				
Injury with medical attention and hospitalization	78 (0.75%)	30 (0.66%)	37 (0.77%)	11 (1.16%)				

Notes. [a] = observed count is significantly more than expected count (p < 0.004). [b] = observed count is significantly less than expected count (p < 0.004).

Social Participation. There was a significant association between the pain intensity groups and social participation [χ^2 (8) = 76.61, p < 0.001] (refer to Table 20). After a Bonferroni adjustment, the following significantly contribute to the overall χ^2 statistic: those who reported "mild" pain and participated in social activities "at least once a year" (observed count was less

than expected; $p < 0.003$); those who reported "severe" pain and "did not participate" in social activities (observed count was more than expected; $p < 0.003$); those who reported "severe" pain participated in social activities "at least once a year" (observed count was more than expected; $p < 0.003$); those who reported "severe" pain and participated in social activities "at least once a month" (observed count was more than expected; $p < 0.003$); those who reported "severe" pain and participated in social activities "at least once a week" (observed count was less than expected; $p < 0.003$). Cramer's V, however, suggested that a small effect size was not reached (Cramer's V = 0.06).

Table 20. χ^2 of pain intensity and social participation.

	Total (n = 10 323)	**Mild (n = 4 546)**	**Moderate (n = 4 827)**	**Severe (n = 950)**	**χ^2**	**df**	**p**	**Cramer's V**
Did not participate	25 (0.24%)	6 (0.13%)	9 (0.19%)	10 (1.05%) [a]	76.61	8	<0.001	0.06
Participated at least once a year	193 (1.87%)	52 (1.14%) [b]	107 (2.22%)	34 (3.58%) [a]				
Participated at least once a month	1 422 (13.78%)	588 (12.93%)	669 (13.86%)	165 (17.37%) [a]				
Participated at least once a week	6 976 (67.58%)	3 139 (69.05%)	3 243 (67.18%)	594 (62.53%) [b]				
Participated at least once a day	1 707 (16.54%)	761 (16.74%)	799 (16.55%)	147 (15.47%)				

Notes. [a] = observed count is significantly more than expected count ($p < 0.003$). [b] = observed count is significantly less than expected count ($p < 0.003$).

Objective 3: Testing the Biopsychosocial Model of Pain and Aging for Pain Impact

Identifying Candidate Correlates (Table 21)

Table 21 shows the variables that met the inclusion criteria for the multinomial regression model for pain impact. They were the "Biophysical" factor ($p < 0.001$), "Cognitive-motor" factor

(p < 0.001), "Psychosocial" factor (p < 0.001), sex (p < 0.001), education (p < 0.001), ethnicity (p < 0.001), income (p < 0.001), marital status (p < 0.001), and language (p < 0.001).

Table 21. Candidate correlates for pain impact.

		N	F (p) or χ^2 (p)
ANOVAS	Age	10 336	0.71 (0.55)
	Biophysical factor	5 654	**72.37 (< 0.001)**
	Cognitive-motor factor	5 654	**23.46 (< 0.001)**
	Psychosocial factor	5 654	**67.49 (< 0.001)**
χ^2	Sex	10 336	**55.60 (< 0.001)**
	Education	10 311	**81.78 (< 0.001)**
	Religion	7 975	2.32 (0.51)
	Ethnicity	10 263	**97.40 (< 0.001)**
	Income	9 605	**134.28 (< 0.001)**
	Marital status	10 334	**30.66 (< 0.001)**
	Language	10 312	**194.76 (< 0.001)**

Notes. Bolded=met criteria for inclusion in multivariate model (ANOVAs: p<0.06, χ^2: p<0.04).

Multinomial Logistic Regression (Table 22 and Figure 9)

The multinomial logistic regression model was statistically significant, χ^2 (57) = 590.92, p < 0.001. Table 22 shows the model, while Figure 9 shows the significant variables from the model.

A few vs. None. There were five significant variables – two of them were biopsychosocial factors: "Biophysical" factor (OR: 1.29, 95% CI: 1.16-1.44, p < 0.001) and "Psychosocial" factor (OR: 0.79, 95% CI: 0.73-0.84, p < 0.001); the other three were sociodemographic variables: Canadian ethnicity (OR: 0.74, 95% CI: 0.56-0.97, p = 0.03), European ethnicity (OR: 0.74, 95% CI: 0.61-0.90, p= 0.003), and English language conversation (OR: 1.24, 95% CI: 1.01-1.53, p = 0.04). Accordingly, variables with higher odds for reporting "a few" activities prevented by pain compared to "none" were increased scores on the "Biophysical" factor and English language conversation compared to other languages, after adjusting for all other variables. Variables with lower odds for reporting "a few" activities prevented by pain compared to "none" were increased

scores on the “Psychosocial” factor, and Canadian and European ethnicities compared to other ethnicities, after adjusting for all other variables.

Some vs. None. There were seven significant variables – two of them were biopsychosocial factors: “Biophysical” factor (OR: 1.71, 95% CI: 1.50-1.95, $p < 0.001$) and “Psychosocial” factor (OR: 0.72, 95% CI: 0.66-0.78, $p < 0.001$); the other five were sociodemographic variables: male sex (OR: 1.37, 95% CI: 1.06-1.77, $p = 0.02$), Canadian ethnicity (OR: 0.61, 95% CI: 0.41-0.89, $p = 0.01$), European ethnicity (OR: 0.78, 95% CI: 0.62-0.98, $p = 0.03$), ≥ $20,000 but < $50,000 (OR: 0.68, 95% CI: 0.51-0.92, $p = 0.01$), and French language conversation (OR: 0.53, 95% CI: 0.40-0.71, $p < 0.001$). Accordingly, variables with higher odds for reporting “some” activities prevented by pain compared to “none” were increased scores on the “Biophysical” factor and men compared to women, after adjusting for all other variables. Variables with lower odds for reporting “some” activities prevented by pain compared to “none” included increased scores on the “Psychosocial” factor, Canadian and European ethnicities compared to other ethnicity, an income of ≥ $20,000 but < $50,000 compared to ≥ $150,000, and French language conversation compared to other languages, after adjusting for all other variables.

Most vs. None. There were three significant variables – two of them were biopsychosocial factors: “Biophysical” factor (OR: 2.48, 95% CI: 2.06-2.97, $p < 0.001$) and “Psychosocial” factor (OR: 0.62, 95% CI: 0.55-0.68, $p < 0.001$); one of them was a sociodemographic variable: male sex (OR: 2.63, 95% CI: 1.83-3.78, $p < 0.001$). Accordingly, variables with higher odds for reporting “most” activities prevented by pain compared to “none” included increased scores on the “Biophysical” factor and men compared to women, after adjusting for all other variables. The variable with lower odds for reporting “most” activities prevented by pain compared to “none” was increased scores on the “Psychosocial” factor, after adjusting for all other variables.

Table 22. Multinomial logistic regression of pain impact groups, n = 5,308.

	Odds Ratio	95% CI (lower-upper)	p-value
A few vs. None			
Biophysical factor	1.29	1.16 – 1.44	< 0.001
Cognitive-motor factor	1.03	0.94 – 1.12	0.57
Psychosocial factor	0.79	0.73 – 0.84	< 0.001
Men	0.96	0.78 – 1.18	0.69
Women	1.00		
Less than secondary school	0.92	0.68 – 1.24	0.58
Secondary school	0.93	0.74 – 1.16	0.51
Some post-secondary	0.93	0.72 – 1.20	0.56
Post-secondary degree/diploma	1.00		
Canadian	0.74	0.56 – 0.97	0.03
European	0.74	0.61 – 0.90	0.003
Indigenous	1.16	0.80 – 1.66	0.43
Other ethnicity	1.00		
< $20 000	0.84	0.59 – 1.22	0.37
≥ $20 000 but < $50 000	0.84	0.66 – 1.07	0.15
≥ $50 000 but < $100 000	0.92	0.75 – 1.13	0.41
≥ $100 000 but < $150 000	0.92	0.74 – 1.15	0.47
≥ $150 000	1.00		
Single	0.90	0.68 – 1.19	0.47
Married or common-law	1.08	0.87 – 1.32	0.49
Widowed	0.94	0.70 – 1.25	0.66
Divorced or separated	1.00		
English	1.24	1.01 – 1.53	0.04
French	1.15	0.92 – 1.45	0.22
Other language	1.00		
Some vs. None			
Biophysical factor	1.71	1.50 – 1.95	< 0.001
Cognitive-motor factor	1.04	0.93 – 1.15	0.52
Psychosocial factor	0.72	0.66 – 0.78	< 0.001
Men	1.37	1.06 – 1.77	0.02
Women	1.00		
Less than secondary school	1.01	0.70 – 1.47	0.96
Secondary school	1.02	0.77 – 1.34	0.91
Some post-secondary	0.98	0.73 – 1.33	0.90
Post-secondary degree/diploma	1.00		
Canadian	0.61	0.41 – 0.89	0.01
European	0.78	0.62 – 0.98	0.03
Indigenous	0.82	0.51 – 1.32	0.42
Other ethnicity	1.00		
< $20 000	0.65	0.41 – 1.02	0.06
≥ $20 000 but < $50 000	0.68	0.51 – 0.92	0.01
≥ $50 000 but < $100 000	0.78	0.60 – 1.00	0.05
≥ $100 000 but < $150 000	0.94	0.72 – 1.23	0.66
≥ $150 000	1.00		
Single	0.98	0.70 – 1.38	0.91
Married or common-law	0.97	0.75 – 1.25	0.81

Widowed	0.85	0.59 – 1.21	0.37
Divorced or separated	1.00		
English	1.21	0.95 – 1.53	0.13
French	0.53	0.40 – 0.71	< 0.001
Other language	1.00		
Most vs. None			
Biophysical factor	2.48	2.06 – 2.97	< 0.001
Cognitive-motor factor	0.89	0.77 – 1.03	0.12
Psychosocial factor	0.62	0.55 – 0.68	< 0.001
Men	2.63	1.83 – 3.78	< 0.001
Women	1.00		
Less than secondary school	1.45	0.96 – 2.21	0.08
Secondary school	1.11	0.77 – 1.61	0.58
Some post-secondary	1.04	0.69 – 1.56	0.86
Post-secondary degree/diploma	1.00		
Canadian	0.69	0.41 – 1.18	0.18
European	0.88	0.62 – 1.24	0.47
Indigenous	1.47	0.82 – 2.65	0.20
Other ethnicity	1.00		
< $20 000	1.03	0.58 – 1.84	0.92
≥ $20 000 but < $50 000	0.76	0.49 – 1.18	0.22
≥ $50 000 but < $100 000	0.79	0.54 – 1.16	0.23
≥ $100 000 but < $150 000	0.73	0.47 – 1.14	0.17
≥ $150 000	1.00		
Single	1.16	0.74 – 1.82	0.53
Married or common-law	1.30	0.90 – 1.87	0.16
Widowed	0.79	0.49 – 1.29	0.35
Divorced or separated	1.00		
English	1.37	0.95 – 1.98	0.10
French	0.72	0.47 – 1.10	0.13
Other language	1.00		

Model is significant: χ^2 (57) = 590.92, p < 0.001.
Notes. Reference category is “none”.

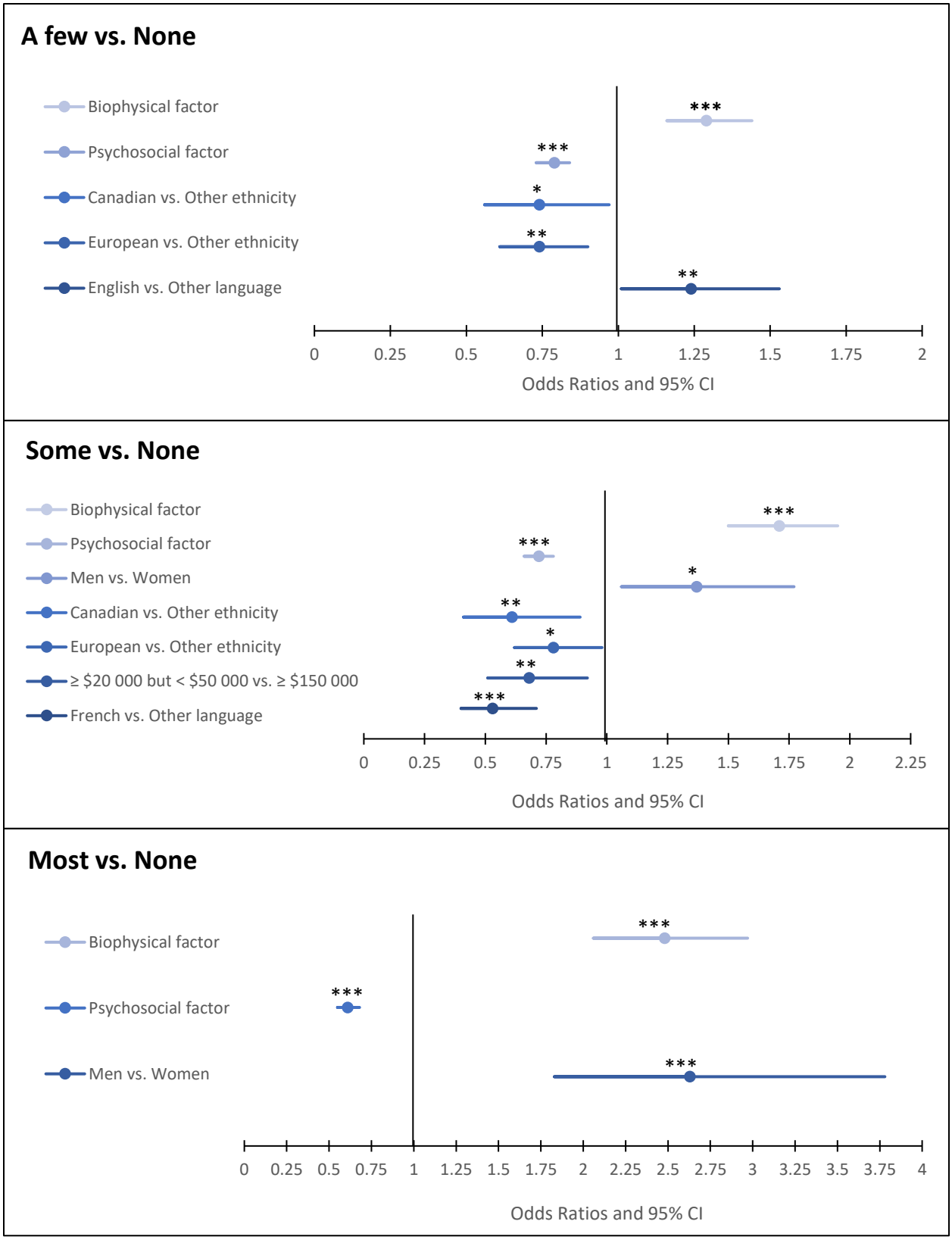

Figure 9. Odds Ratios and 95% CI for significant correlates of pain impact.
Notes. * $p \leq 0.05$. ** $p \leq 0.01$. *** $p \leq 0.001$.

Individual Comorbidities (Table 23)

Results comparing each comorbidity between the pain impact groups (i.e., "none", "a few", "some", or "most" activities) are presented in Table 23. Six significant Conditions with Potentially Painful Symptoms reached a small effect size: Back Problems or Pain ($p < 0.001$; Cramer's $V = 0.13$); Osteoarthritis ($p < 0.001$; Cramer's $V = 0.15$); Mental Health Conditions ($p < 0.001$; Cramer's $V = 0.10$); Diabetes ($p < 0.001$; Cramer's $V = 0.11$); Chronic Obstructive Pulmonary Disorder ($p < 0.001$; Cramer's $V = 0.12$); and Other Physical or Mental Conditions (including Other Arthritis or Infections) ($p < 0.001$; Cramer's $V = 0.11$).

Table 23. Pain impact and individual conditions.

	N	χ^2 (p)	Cramer's V
Conditions with potentially painful symptoms			
Back problems or pain	10 336	160.36 (< 0.001)	0.13*
Allergies	10 238	53.96 (< 0.001)	0.07
Hypertension	10 336	55.25 (< 0.001)	0.07
Osteoarthritis	10 095	218.58 (< 0.001)	0.15*
Traumatic brain injury	10 336	31.10 (< 0.001)	0.06
Mental health conditions (mood disorder, anxiety disorder, or clinical depression)	10 280	141.82 (< 0.001)	0.12*
Urinary incontinence or urinary tract infection	10 282	74.07 (< 0.001)	0.09
Diabetes	6 235	74.90 (< 0.001)	0.11*
Heart disease (including congestive heart failure, myocardial infarction, or angina)	10 236	75.49 (< 0.001)	0.09
Cancer	10 300	7.99 (0.05)	0.03
Hypo- or hyper- thyroidism	10 163	17.92 (< 0.001)	0.04
Asthma	10 280	35.68 (< 0.001)	0.06
Migraine	10 294	77.53 (< 0.001)	0.09
Bowel disorder (including Crohn's disease, ulcerative colitis, or irritable bowel syndrome) or incontinence	10 276	86.49 (< 0.001)	0.09
Osteoporosis	10 215	20.58 (< 0.001)	0.05
Intestinal or stomach ulcers	10 269	63.61 (< 0.001)	0.08
Influenza	10 295	34.96 (< 0.001)	0.06
Chronic obstructive pulmonary disorder	10 265	141.68 (< 0.001)	0.12*
Peripheral vascular disease	10 268	54.75 (< 0.001)	0.07

Stroke, mini-stroke, or transient ischemic attack	10 238	79.59 (< 0.001)	0.09
Rheumatoid arthritis	10 150	65.42 (< 0.001)	0.08
Kidney disease or failure	10 283	33.91 (< 0.001)	0.06
Pneumonia	10 302	54.18 (< 0.001)	0.07
Epilepsy	10 304	10.60 (0.01)	0.03
Multiple sclerosis	10 308	2.11 (0.55)	0.01
Other physical or mental conditions (including other arthritis or infections)	10 248	130.22 (< 0.001)	0.11*
Conditions without potentially painful symptoms			
Macular degeneration	10 265	13.95 (0.003)	0.04
Memory problems or dementia	10 297	53.53 (< 0.001)	0.07
Parkinson's disease	10 307	6.98 (0.07)	0.03

Notes. * = small effect size (≥ 0.10 to < 0.30) based on Cramer's V. df for all is 1. Bonferroni adjusted p-value is p = 0.002.

Remaining Continuous Variables (Table 24 and Figure 10)

Using Pillai's trace, there was a significant difference between the pain impact groups on the combined dependent variables after controlling for sex, education, income, martial status, and language, [F (39, 21,123) = 10.74, p < 0.001, Pillai's trace = 0.06, partial $\eta^2 = 0.02$]. However, after Bonferroni adjusted pairwise comparisons, separate univariate tests on the dependent variables revealed a non-significant difference between the pain impact groups on age [F (3, 7,051) = 1.63, p = 0.18], CRT [F (3, 7,051) = 2.02, p = 0.11], cholesterol [F (3, 7,051) = 2, p = 0.11], Extraversion [F (3, 7,051) = 0.07, p = 0.98], and Openness [F (3, 7,051) = 1.75, p = 0.15]. Table 24 reports the mean ± SD and the EMM ± SE of the dependent variables for each pain impact group, as well as the results from the MANCOVA.

Calculation of effect sizes (partial η^2; Figure 10) for each significant dependent variable revealed only small effect sizes for chair rise (partial $\eta^2 = 0.01$), PASE (partial $\eta^2 = 0.02$), LSI (partial $\eta^2 = 0.01$), Count of Conditions with Reported Other Treatment Use (partial $\eta^2 = 0.01$), and white blood cell count (partial $\eta^2 = 0.01$). After adjusting for covariates, the "most" group required significantly more time to complete the chair rise test followed by both the "some" and

"a few" groups, and then the "none" group (3.83 ± 0.02 vs 3.71 ± 0.01 and 3.68 ± 0.01 vs 3.62 ± 0.0; $p < 0.001$. The "none" group had a significantly higher PASE score followed by both the "a few" and "some" groups, and then the "most" group (147.09 ± 1.28 vs 140.64 ± 1.56 and 134.30 ± 2.04 vs 107.34 ± 3.04; $p < 0.001$). Both the "none" and "a few" groups scored significantly higher on the LSI followed by the "some" and "most" groups (85.81 ± 0.30 and 85.34 ± 0.37 vs 82.66 ± 0.49 vs 79.75 ± 0.72; $p < 0.001$). The "most", "some", and "a few" groups had a significantly higher Count of Conditions with Reported Other Treatment Use, followed by the "none" group (0.41 ± 0.02 and 0.41 ± 0.02 and 0.36 ± 0.01 vs 0.32 ± 0.01; $p < 0.001$). The "none" group had a significantly lower white blood cell count compared to the "a few", "some" and "most" groups (0.81 ± 0.00 vs 0.82 ± 0.00 and 0.82 ± 0.00 and 0.84 ± 0.01; $p < 0.001$).

Table 24. MANCOVA of variables not included in the PCA and age between pain impact groups.

		None n = 3 151	A few n = 2 119	Some n = 1 239	Most n = 562	F (p)	Partial η^2
Age	***Mean ± SD***	62.85 ± 9.76	62.66 ± 9.95	62.67 ± 9.75	62.83 ± 10.11	1.63 (0.18)	0.001
	EMM ± SE	62.88 ± 0.16	62.86 ± 0.19	62.63 ± 0.25	62.03 ± 0.37		
MPMT	***Mean ± SD***	0.46 ± 0.79	0.49 ± 0.80	0.54 ± 0.84	0.58 ± 0.84	3.85 (0.01)	0.002
	EMM ± SE	0.46 ± 0.01	0.50 ± 0.02	0.54 ± 0.02	0.54 ± 0.03		
Stroop	***Mean ± SD***	0.32 ± 0.12	0.32 ± 0.12	0.32 ± 0.12	0.34 ± 0.12	2.70 (0.04)	0.001
	EMM ± SE	0.32 ± 0.00	0.32 ± 0.00	0.32 ± 0.00	0.34 ± 0.01		
CRT	***Mean ± SD***	2.91 ± 0.10	2.91 ± 0.10	2.92 ± 0.11	2.92 ± 0.10	2.02 (0.11)	0.001
	EMM ± SE	2.91 ± 0.00	2.91 ± 0.00	2.92 ± 0.00	2.92 ± 0.00		
Chair rise	***Mean ± SD***	3.62 ± 0.49	3.68 ± 0.51	3.71 ± 0.55	3.86 ± 0.57	31.86 (<0.001)	0.01 *
	EMM ± SE	3.62 ± 0.01	3.68 ± 0.01	3.71 ± 0.01	3.83 ± 0.02		
PASE	***Mean ± SD***	148.41 ± 74.77	140 ± 73.17	133.60 ± 74.26	103.88 ± 70.04	50.92 (<0.001)	0.02 *
	EMM ± SE	147.09 ± 1.28	140.64 ± 1.56	134.30 ± 2.04	107.34 ± 3.04		
LSI	***Mean ± SD***	86.30 ± 17.11	85.30 ± 17.47	82.36 ± 18.70	77.99 ± 21.20	26.62 (<0.001)	0.01 *
	EMM ± SE	85.81 ± 0.30	85.34 ± 0.37	82.66 ± 0.49	79.75 ± 0.72		
Count of conditions with	***Mean ± SD***	0.32 ± 0.51	0.36 ± 0.54	0.42 ± 0.59	0.43 ± 0.58	11.18 (<0.001)	0.01 *

reported other treatment use	***EMM ± SE***	0.32 ± 0.01	0.36 ± 0.01	0.41 ± 0.02	0.41 ± 0.02		
White blood cell count	***Mean ± SD***	0.81 ± 0.11	0.82 ± 0.11	0.82 ± 0.12	0.85 ± 0.11	16.43 (<0.001)	0.01 *
	EMM ± SE	0.81 ± 0.00	0.82 ± 0.00	0.82 ± 0.00	0.84 ± 0.01		
Albumin	***Mean ± SD***	39.97 ± 2.69	39.72 ± 2.74	39.66 ± 2.80	39.38 ± 2.90	5.60 (<0.001)	0.002
	EMM ± SE	39.92 ± 0.05	39.72 ± 0.06	39.74 ± 0.08	39.47 ± 0.12		
Cholesterol	***Mean ± SD***	5.15 ± 1.11	5.15 ± 1.13	5.15 ± 1.15	5.05 ± 1.26	2 (0.11)	0.001
	EMM ± SE	5.18 ± 0.02	5.11 ± 0.02	5.12 ± 0.03	5.09 ± 0.05		
Extraversion	***Mean ± SD***	4.33 ± 1.79	4.35 ± 1.77	4.39 ± 1.88	4.34 ± 1.88	0.07 (0.98)	0.00
	EMM ± SE	4.35 ± 0.03	4.34 ± 0.04	4.34 ± 0.05	4.38 ± 0.08		
Openness	***Mean ± SD***	5.36 ± 1.40	5.43 ±1.36	5.51 ± 1.40	5.35 ± 1.51	1.75 (0.15)	0.001
	EMM ± SE	5.37 ± 0.03	5.43 ± 0.03	5.47 ± 0.04	5.39 ± 0.06		
MULTIVARIATE TEST (PILLAI'S TRACE): F (39, 21,123) = 10.74, p < 0.001							

Notes. * = small effect size (≥ 0.01 to < 0.06) based on partial η^2. MPMT shows inverse score because of data transformation. The mean ± SD describes the variables without adjusting for the covariates. EMM ± SE shows the means and standard errors after adjusting for the covariates in the model. Reporting both shows the difference in the means after accounting for the covariates.
SD = Standard Deviation; EMM = Estimated Marginal Means; SE = Standard Error; MPMT = Miami Prospective Memory Test; CRT = Choice Reaction Time; PASE = Physical Activity Scale for the Elderly; LSI = Life Space Index

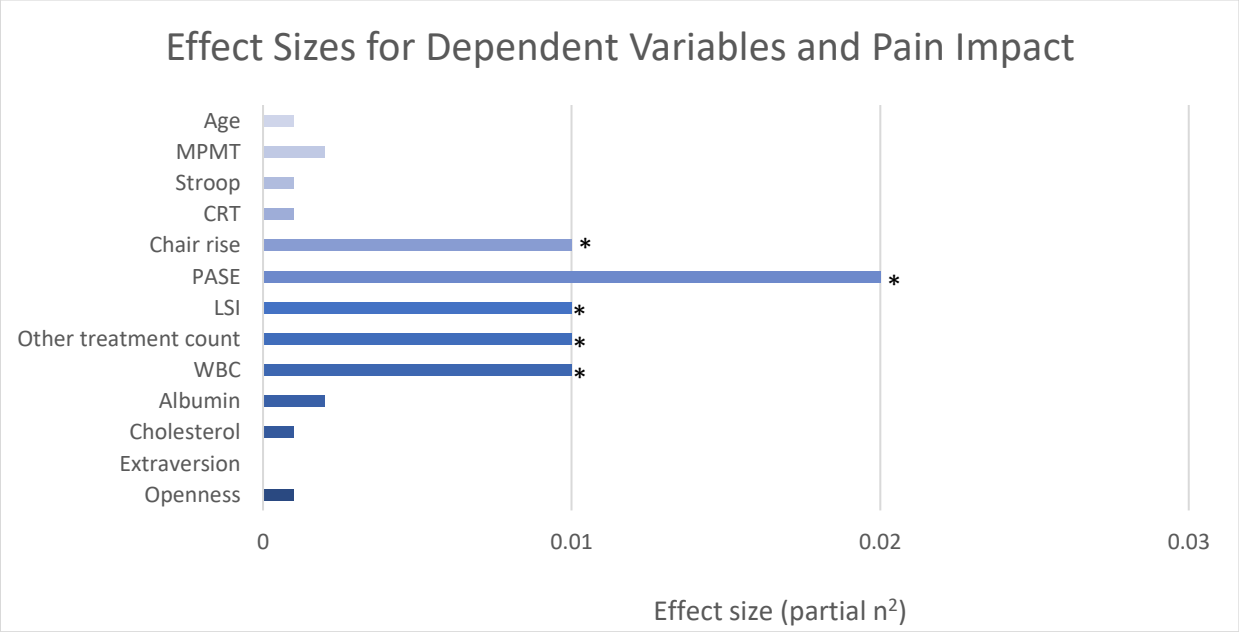

Figure 10. Effect sizes (partial n^2) from MANCOVA for pain impact and dependent variables.

Notes. * = small effect size (≥ 0.01 to < 0.06) based on partial η^2.
MPMT = Miami Prospective Memory Test; CRT = Choice Reaction Time; PASE = Physical Activity Scale for the Elderly; LSI = Life Space Index; WBC = White Blood Cell count

Remaining Categorical Variables (Tables 25 and 26)

Falls. There was a significant association between the pain impact groups and falls, [χ^2 (9) = 27.59, p = 0.001] (refer to Table 25). After a Bonferroni adjustment, the following cells significantly contributed to the overall χ^2 statistic: those who reported "no" activities prevented by pain and "no falls" (observed count was more than expected; p < 0.003); those who reported "no" activities prevented by pain and "falls that resulted in injury that required medical attention" (observed count was less than expected; p < 0.003); those who reported "no" activities prevented by pain and "falls that resulted in injury that required medical attention and hospitalization" (observed count was less than expected; p = 0.001). Cramer's V, however, suggested that a small effect size was not reached (Cramer's V = 0.03).

Table 25. χ^2 of pain impact and falls.

	Total (n = 10 335)	**None (n = 4 377)**	**A few (n = 3 087)**	**Some (n = 1 881)**	**Most (n = 990)**	**X^2**	**df**	**p**	**Cramer's V**
No falls	9 680 (93.66%)	4 156 (94.95%) [a]	2 874 (93.10%)	1 738 (92.40%)	912 (92.12%)				
No serious injury/medical attention	256 (2.48%)	95 (2.17%)	77 (2.49%)	55 (2.92%)	29 (2.93%)				
Injury with medical attention	321 (3.11%)	107 (2.44%) [b]	107 (3.47%)	70 (3.72%)	37 (3.74%)	27.59	9	0.001	0.03
Injury with medical attention and hospitalization	78 (0.75%)	19 (0.43%) [b]	29 (0.94%)	18 (0.96%)	12 (1.21%)				

Notes. [a] = observed count is significantly more than expected count (p < 0.003). [b] = observed count is significantly less than expected count (p < 0.003).

Social Participation. There was a significant association between the pain impact groups and social participation, [χ^2 (12) = 105.34, p < 0.00] (refer to Table 26). After a Bonferroni adjustment, the following significantly contribute to the overall χ^2 statistic: those who reported "a few" activities prevented by pain and participated in social activities "at least once a year" (observed count was less than expected; p = 0.001); those who reported "most" activities were

prevented by pain and "did not participate" in social activities (observed count was more than expected; $p < 0.003$); those who reported "most" activities were prevented by pain and participated in social activities "at least once a year" (observed count was more than expected; $p < 0.003$); those who reported "most" activities were prevented by pain and participated in social activities "at least once a month" (observed count was more than expected; $p < 0.003$); those who reported "most" activities were prevented by pain and participated in social activities "at least once a week" (observed count was less than expected; $p < 0.003$). Cramer's V, however, suggested that a small effect size was not reached (Cramer's V = 0.06).

Table 26. χ^2 of pain impact and social participation.

	Total (n = 10 323)	**None (n = 4 374)**	**A few (n = 3 083)**	**Some (n = 1 876)**	**Most (n = 990)**	**X^2**	**df**	**p**	**Cramer's V**
Did not participate	25 (0.24%)	10 (0.23%)	3 (0.10%)	4 (0.21%)	8 (0.81%) [a]	105.34	12	<0.001	0.06
Participated at least once a year	193 (1.87%)	79 (1.81%)	37 (1.20%) [b]	31 (1.65%)	46 (4.65%) [a]				
Participated at least once a month	1 422 (13.78%)	577 (13.19%)	379 (12.29%)	277 (14.77%)	189 (19.09%) [a]				
Participated at least once a week	6 976 (67.58%)	2 958 (67.63%)	2 141 (69.45%)	1 267 (67.54%)	610 (5.91%) [b]				
Participated at least once a day	1 707 (16.54%)	750 (17.15%)	523 (16.96%)	297 (15.83%)	137 (13.84%)				

Notes. [a] = observed count is significantly more than expected count ($p < 0.003$). [b] = observed count is significantly less than expected count ($p < 0.003$).

CHAPTER SIX: DISCUSSION

In 2018, Gagliese et al. (2018) proposed the biopsychosocial model of pain and aging which described pain across the adult lifespan as the dynamic interaction of variables across the biopsychosocial spectrum. To our knowledge, this is the first study to test the biopsychosocial model of pain and aging in a large sample of community-dwelling middle-aged and older adults by simultaneously examining sociodemographic, cognitive, physical, and biopsychosocial variables.

Table 27 summarizes the significant variables for each pain outcome, by statistical test used, so that similarities and differences can be observed across the outcomes. The findings support a biopsychosocial conceptualization of pain presence, intensity, and impact in older people and suggest directions for refinement of the model. Age was significant in bivariate analysis for pain presence and intensity but not in multivariate analysis, indicating that age-relevant variables were included in the models. Sociodemographic, biological and physical, cognitive and motor, and psychological and social variables were associated with pain presence and intensity. Sociodemographic, biological and physical, and psychological and social variables were associated with pain impact. Before discussing the findings, it is important to note that while variables were placed into domains, these are arbitrary (Gagliese et al., 2018; Melzack & Casey, 1968) since the variables may be related and may overlap across domains. It is also important to note that the cross-sectional design of the study prevents causation to be determined. The next sections will discuss the pain outcomes and significant variables.

Table 27. Summary of results for each pain outcome.

	Pain Presence	**Pain Intensity**	**Pain Impact**
Summary of results from regressions			

Age			
Sex			
Men	– o –		↑
Women	↑	– o –	– o –
Education			
Less than secondary school	– o –	↑	
Secondary school	↑	↑	
Some post-secondary			
Post-secondary degree/diploma		– o –	– o –
Ethnicity			
Canadian	– o –	↑	↓
European	↑		↓
Indigenous			
Other	↑	– o –	– o –
Income			
< $20 000	– o –	↑	
≥ $20 000 but < $50 000	↑	↑	↓
≥ $50 000 but < $100 000	↑	↑	
≥ $100 000 but < $150 000	↑		
≥ $150 000		– o –	– o –
Marital Status			
Single	– o –		
Married or common-law	↓		
Widowed	↑		
Divorced/separated		– o –	– o –
Language			
English	– o –		↑
French			↓
Other		– o –	– o –
Biophysical factor	↑	↑	↑
Cognitive-motor factor	↓	↓	
Psychosocial factor	↓	↓	↓
Summary of results from MANCOVAs and χ^2			
Chair rise test	↑	↑	↑
PASE		↓	↓
LSI			↓
Count of conditions with reported other treatment use	↑		↑
White blood cell count			↑
Individual comorbidities			
Back problems or pain	x	x	x
Hypertension	x		
Osteoarthritis	x	x	x
Mental health conditions	x	x	x
Urinary incontinence or urinary tract infection	x		
Diabetes			x
Heart disease (including congestive heart failure, myocardial infarction, or angina)		x	
Migraine	x		
Chronic obstructive pulmonary disorder			x
Peripheral vascular disease		x	

Bowel disorder (including Crohn's disease, ulcerative colitis, or irritable bowel syndrome) or incontinence	**x**		
Other physical or mental condition (including other arthritis or infections)	**x**		**x**

Notes. **– o –** = reference category. Green ↑ = more likely. Red ↓ = less likely. Blue ↑ = more time or higher scores. Blue ↓ = less time or lower scores. **x** = significant variables with a small effect size.
PASE = Physical Activity Scale for the Elderly; LSI = Life Space Index.

Pain Characteristics

Previous studies have shown that 20% to 80% of middle-aged community-dwelling adults report persistent pain (Gibson & Lussier, 2012), and 33% of older adults live with chronic pain (Health Canada, 2019). Although the type of pain was not specified within the current study, the prevalence of pain (i.e., 36% people reporting pain) is comparable to these previous studies. Regarding pain intensity and impact, approximately moderate pain intensity and impact levels have been previously found in older Swedish adults (Larsson, Hansson, Sundquist, & Jakobsson, 2017), which is also consistent with the report of pain intensity and impact within the current study. Taken together, these data suggest our sample is comparable and representative of other large epidemiological studies of pain in middle-aged and older people.

Excluded participants were older, less educated, were of other ethnicities, had lower incomes, were completely retired, not married or in a common-law relationship, and spoke other languages compared to included participants. Although the demographics of those who were excluded are likely to report pain or poorer health outcomes (Bradbeer, Helme, Yong, Kendig, & Gibson, 2003; Choi & DiNitto, 2016; Feldman, Dong, Katz, Donnell-Fink, & Losina, 2015; Gibson & Lussier, 2012), it is typical of other studies to have similar demographics of included and excluded participants as seen in the current study (Gagliese et al., 2009; Gauthier et al., 2009; Mah et al., 2018). The CLSA also minimized bias within the sample by comparing the demographics with other population based data (Raina et al., 2008).

Biopsychosocial Model of Pain and Aging

The current study supports the biopsychosocial model of pain and aging (Gagliese et al., 2018) and offers four revised models (see Figure 11 for variables shared across all outcomes and Figures 12 to 14 for a summary of each outcome). The findings support pain presence, intensity, and impact as overlapping constructs which also have variables unique to each of them, spanning across all reviewed dimensions. Interestingly, when the variables were analysed within the PCA, they grouped together into "Biophysical" and "Psychosocial" factors, reflecting a biopsychosocial structure. As expected, age was not significant in the multivariate models for pain presence and intensity, indicating that age-relevant variables were included in the models and supporting its role as a proxy. The sociodemographic dimension emerged in every model, along with the biological and physical and psychological and social dimensions. Interestingly, the cognitive and motor dimension only emerged in the pain presence and intensity models, but not pain impact.

Taken together, the refined models confirm that pain and aging are complex and cannot be confined to a single dimension, supporting Melzack and Casey (1968) who stated that pain has multiple unique underlying factors. The models also outlined the nonuniform relationships between the variables and pain outcomes (see Table 27 for a summary of statistical relationships to each pain outcome). Considering multiple pain outcomes separately, then, provides more insightful findings compared to a single outcome. The next sections will discuss the variables that were shared across all pain outcomes and those that were unique between pain outcomes.

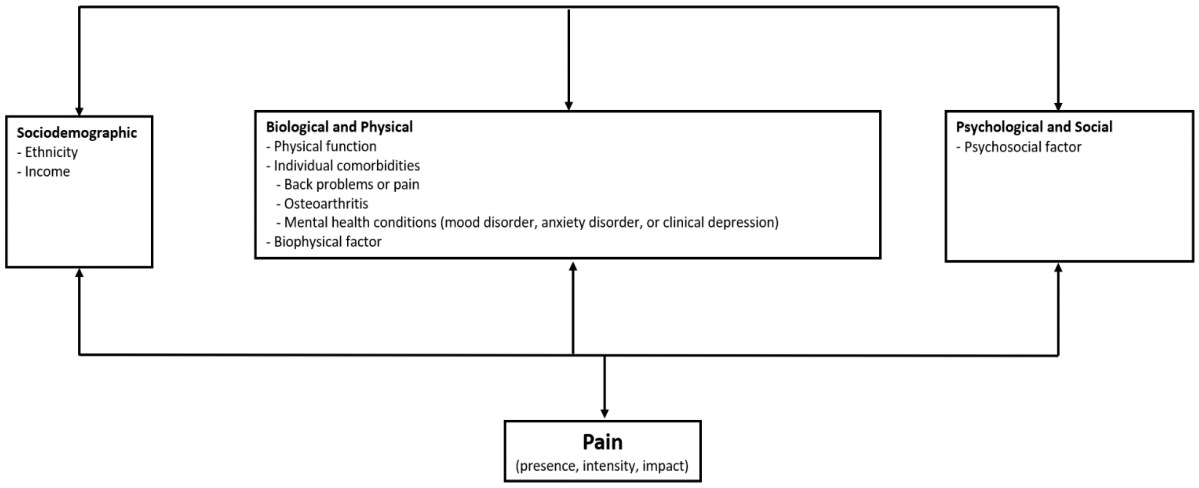

Figure 11. Revised biopsychosocial model of pain and aging for pain presence, intensity, and impact.

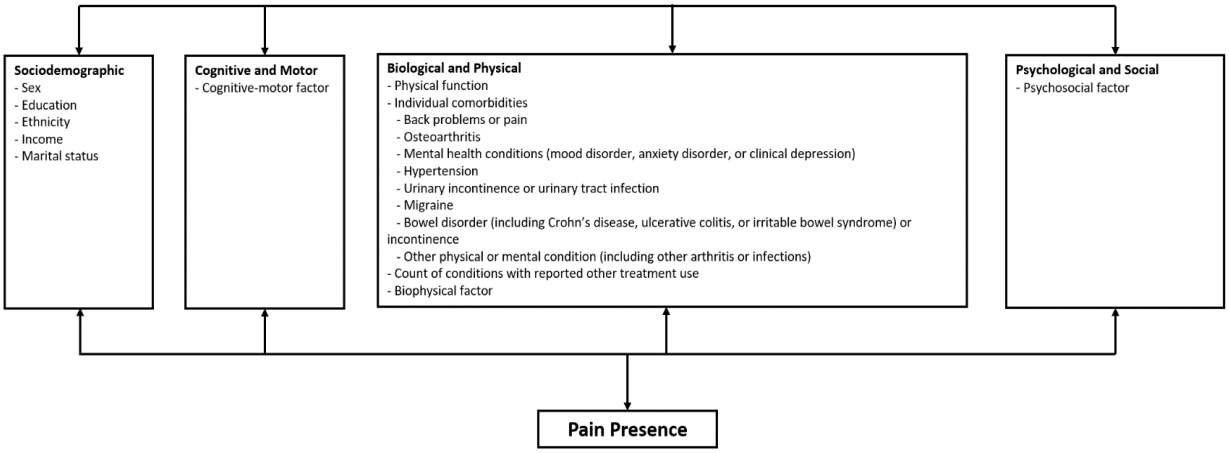

Figure 12. Revised biopsychosocial model of pain and aging for pain presence.

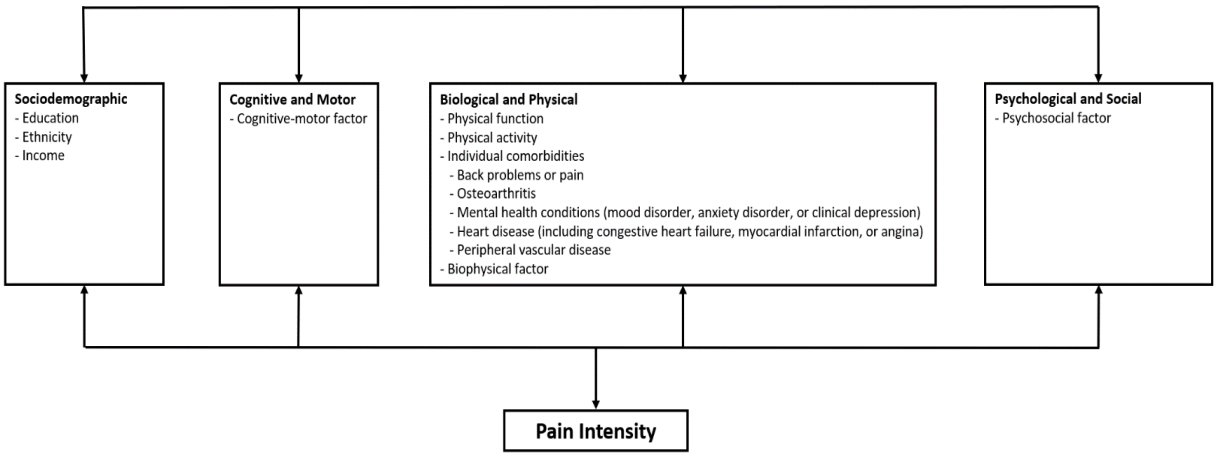

Figure 13. Revised biopsychosocial model of pain and aging for pain intensity.

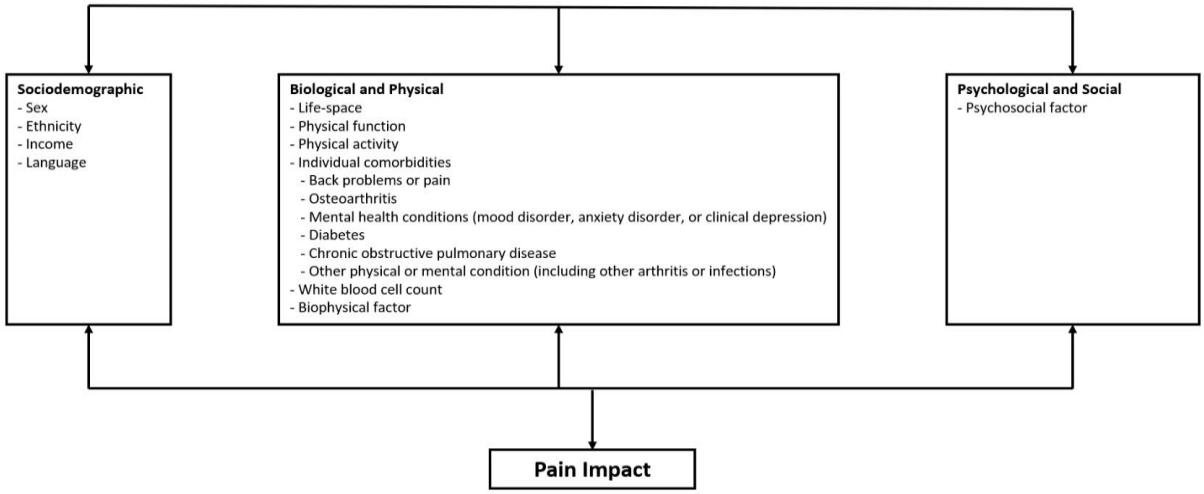

Figure 14. Revised biopsychosocial model of pain and aging for pain impact.

Shared Variables Across Outcomes

Significant variables that were shared across pain presence, intensity, and impact were ethnicity, income, the chair rise test, Comorbidities (Back Problems or Pain; Osteoarthritis;

Mental Health Conditions), and the "Biophysical" and "Psychosocial" factors. Each are discussed in detail below and are integrated together at the end of the section.

Sociodemographic Variables

Ethnicity. This study found that pain was associated with European or other ethnicities more than Canadian, which is somewhat consistent with previous literature (Green, Baker, Smith, & Sato, 2003). When considering the finding on other ethnicities, Green et al. (2003) found that people of other ethnicities may not consistently adhere to health care advice to manage their pain, potentially perceiving poor control over it. Rather than solely attributing nonadherence to individual-level factors, it is important to recognize that nonadherence is related to adverse social determinants of health (e.g., food insecurity, housing instability) which might make it more difficult for people of other ethnicities to adhere to health care advice (Wilder et al., 2021). When considering the finding on European ethnicity, Thompson et al. (2019) explain that poverty is associated with psychosocial stressors that increase the risk for poor health outcomes such as pain. Perhaps if people of European ethnicities in the current study live below the poverty line, it could explain why they are more likely to report pain compared to Canadians.

In the current study, higher pain intensity was associated with Canadian ethnicity more than other ethnicities which is inconsistent with other studies (Janevic, McLaughlin, Heapy, Thacker, & Piette, 2017; Park, Engstrom, Tappen, & Ouslander, 2015; Portenoy, Ugarte, Fuller, & Haas, 2004; Reyes-Gibby, Aday, Todd, Cleeland, & Anderson, 2007; K. A. Thompson et al., 2019). The inconsistency might be due to the differences in pain measures used, with only one of the cited studies using the same pain intensity measure as the present study (Reyes-Gibby et al., 2007). Another reason for the inconsistency might be differences in pain management between

ethnicities, with people of other ethnicities (i.e., black) likely to engage in methods such as praying or attending church (Park et al., 2015), which might alleviate pain. However, passive coping methods such as praying may not be considered as useful as active coping methods (Tait & Chibnall, 2014). Future studies should build upon the present findings and its association to passive and active pain coping methods.

The current study found higher pain impact was associated with other ethnicities more than Canadian or European, which is in line with other studies (Barry, Glenn, Hoff, & Potenza, 2017; Reyes-Gibby et al., 2007). Ethnic minorities are likely to receive inadequate medical treatment and have increased stressors associated with racism and discrimination (Anderson, Green, & Payne, 2009; Barry et al., 2017; C. L. Edwards, Fillingim, & Keefe, 2001; R. R. Edwards, Moric, Husfeldt, Buvanendran, & Ivankovich, 2005; Tait & Chibnall, 2014), which are associated with higher pain impact (Anderson et al., 2009). Ethnic minorities may also wait till symptoms become more severe compared to ethnic majorities before seeking treatment (R. R. Edwards et al., 2005), possibly explaining why more of their activities are impacted by pain.

Income. The present study found that pain was associated with higher income levels more than lower income levels. Previous studies suggest that people of higher income levels work in "white-collar" positions (i.e., management roles) and be granted less sick leave compared to those in "blue-collar" positions (i.e., manual labour) (Mittendorfer-Rutz & Dorner, 2018). Therefore, it is possible that rest from pain is less likely in people of higher income levels. Meanwhile, increased medical visits might risk job loss (De Sola, Salazar, Dueñas, Ojeda, & Failde, 2016), possibly encouraging people of lower income levels to underreport pain to maintain job security.

In the present study, higher pain intensity was associated with lower income levels more than higher income levels. People that require more medical consultations due to pain have a high risk of job loss since they seek numerous treatments to relieve their pain, taking time away from work (De Sola et al., 2016) possibly resulting in less income. There might also be increased barriers for people with low income (i.e., transportation difficulties and financial costs) to treat pain (Newman, Kapoor, & Thorn, 2018; Wang, Huang, & Zhou, 2019), potentially resulting in increased pain over time. Additionally, financial worry has previously been associated with increased pain intensity (Rios & Zautra, 2011). Although financial worry was not examined in the current study, it might contribute to the findings which future studies can build upon by including it in the analysis.

In the present study, higher pain impact was associated with higher income levels more than lower income levels. If people of lower income who work in manual labour positions were vocal that their activities were prevented by pain, they might be afraid of losing work (Mittendorfer-Rutz & Dorner, 2018), possibly resulting in underreporting the impact of pain. Since approximately half of the sample in the present study is not retired, their work environment might affect the report of pain impact. Future studies should build upon the present findings by analysing occupation.

Biological and Physical Variables

Chair Rise Test. This study found that pain, and higher intensity and impact of pain were associated with worse performance on the chair rise test, supporting evidence from previous studies examining the chair rise test with pain presence (C. Hicks et al., 2020; G. E. Hicks, Sions, & Velasco, 2018) and intensity (Sipko, Glibowski, Barczyk-Pawelec, & Kuczyński, 2016) and in

a study examining balance and pain impact (Stubbs, Schofield, & Patchay, 2014). Pain is associated with increased functional limitations and mobility problems (Sardina et al., 2021; Vancampfort et al., 2017), which might explain the poor performance on the chair rise test in the current study. Specifically, people may modify their activities to prevent more pain (King, Kendzerska, Waugh, & Hawker, 2018; G. H. Lo et al., 2015). Another possible explanation for the present findings relates to psychological attributes. Tomita et al. (2015), for example, found the fear of falling was associated with worse performance on the chair rise test in community-dwelling older women. Additionally, older adults with pain who are less confident in their balance abilities might be worried about the consequences of falling and engage in fewer activities to prevent falls (Sipko et al., 2016; Stubbs, Schofield, et al., 2014; Stubbs, Schofield, Patchay, & Leveille, 2016). Future studies should build upon the current findings by also examining fear of falling and balance confidence.

Comorbidities. *Back Problems or Pain; Osteoarthritis; and Mental Health Conditions (Mood Disorder, Anxiety Disorder, or Clinical Depression)* are associated with all pain outcomes in the present study, whether through symptomology or prognosis (Dominick et al., 2012a; Longe & Gale, 2006; Merck Manual, n.d.; Vancampfort et al., 2017). Specifically, back pain is common in older adults (Moley, 2020) and is associated with increased sedentary behaviour (Vancampfort et al., 2017). One of the main symptoms of osteoarthritis is pain, which may worsen or be triggered by activity (Longe & Gale, 2006), possibly explaining its associations to pain presence and intensity. People with osteoarthritis might also avoid activities such as stair climbing, bending, or lifting heavy objects, which might explain its association with pain impact. The stated mental health conditions might perpetuate or be perpetuated by pain and physical limitations (Barnhill,

2020; Coryell, 2020b, 2020a; Longe & Gale, 2006), playing an important role in reduced pleasure in performing previously enjoyable activities (Barnhill, 2020; Coryell, 2020b, 2020a).

"Biophysical" factor. This study found that pain and a higher intensity and impact of pain were associated with increased scores on the "Biophysical" factor. As previously described, increased scores on the "Biophysical" factor indicate lower grip strength, shorter height, and increased body fat percentage, Comorbidity Count, and Count of Conditions with Reported Medication Use. Taken together, the increased scores on the "Biophysical" factor indicate decreased biophysical health. Based on the items of the "Biopsychosocial" factor, the findings of the present study are consistent with previous literature (Dominick, Blyth, & Nicholas, 2012b; Hermsen et al., 2018; Khezrian, McNeil, Myint, & Murray, 2019; Leong et al., 2007).

There are several possible explanations for the present findings. With age, there are increases in fat mass (Batsis & Villareal, 2018), comorbidities, and medication use (Gulbech Ording & Toft Sørensen, 2013; Held et al., 2016; Patel et al., 2017; A. W. Taylor et al., 2010). An increase in comorbidities is associated with functional decline, which is related to reduced grip strength (Bohannon, 2019; Yorke et al., 2017). Specifically, as comorbidities increase, there is a step-like decrease in grip strength (Bohannon, 2019; Yorke et al., 2017). This might be due to similarities in the physiological systems used for grip strength and those that are impacted or impact on comorbidities (Cheung, Nguyen, Au, Tan, & Kung, 2013). An increased comorbidity count has also previously been associated with more pain (Dominick et al., 2012b; Leong et al., 2007). Comorbidities might contribute to reduced involvement in activities due to health-related disabilities (Hermsen et al., 2018), while medication use can impair physical function (Gnjidic et al., 2012; Khezrian et al., 2019) which is associated with limitations in performing activities

(Ryan et al., 2018). Previous literature has also shown a positive relationship between height loss and back pain (Endo et al., 2019), partly explaining the present findings.

While this study supports the inclusion of a "Biophysical" factor into the biopsychosocial model of pain and aging, this is the first study to do so. Future studies are warranted to examine the longitudinal effects of the "Biophysical" factor as the population ages, including the addition of items into the factor.

Psychological and Social Variables

"Psychosocial" factor. The current study found that no pain and a lower intensity and impact of pain were associated with increased scores on the "Psychosocial" factor. As previously described, increased scores on the "Psychosocial" factor indicate decreased scores on the CES-D10, K10, and PC-PTSD, and increased scores on the SWLS, Emotional Stability, Conscientiousness, Agreeableness, and MOS-SSS. Based on the items of the "Psychosocial" factor, the findings of the present study support previous studies that have found poor psychological health in people with pain (Akram & Malik, 2019; Cotchett et al., 2016; Elbinoune et al., 2016; Giummarra et al., 2017; Riggs et al., 2018), associations between personality traits and pain presence and intensity (Bucourt et al., 2017; Sutin et al., 2019), and the protective nature of social support on mental health, thereby influencing pain (Raichle, Hanley, Jensen, & Cardenas, 2007).

There are some possible explanations for the findings. Poor psychological health, such as depression, is associated with greater physical suffering (Fitzgerald et al., 2015) and functional limitations (Dhanju et al., 2019). Poor psychological health might also be associated with activity avoidance (Cotchett et al., 2016). For instance, those with poor psychological health, particularly

PTSD, report higher levels of depression and pain intensity and impact which might be since the pain reminds the individual of trauma, triggering activity avoidance (Giummarra et al., 2017). High levels of social support can help to cope with stress (Zeng, Sun, Yang, & Fu, 2016), promote acceptance of pain and better quality of life (Finlay et al., 2018), and increase the resilience to pain (J. E. Lee, Kahana, & Kahana, 2016), possibly explaining its relation to the pain outcomes. This is the first study to support the inclusion of the "Psychosocial" factor into the biopsychosocial model of pain and aging. Further research is warranted to confirm the present findings and understand the longitudinal relationships of the psychosocial dimension in pain and aging.

In summary, ethnicity, income, the chair rise test, Back Problems or Pain, Osteoarthritis, Mental Health Conditions (Mood Disorder, Anxiety Disorder, or Clinical Depression), "Biophysical", and "Psychosocial" factors were associated with all pain outcomes (Figure 11). Within the sociodemographic dimension, studies have shown that ethnic minorities may have lower income levels and, overall, lower socioeconomic status which is associated with pain (Tait & Chibnall, 2014). Within the biological and physical dimension, a person may limit their physical mobility to effectively perform tasks, such as the chair rise test, in order to prevent more pain from health conditions (i.e., osteoarthritis or back problems) (King et al., 2018; G. H. Lo et al., 2015). Back problems may perpetuate or be perpetuated by increased body fat percentage (an item of the "Biophysical" factor) (Hussain et al., 2017). Comorbidities and medication use (both items of the "Biophysical" factor) may interfere with physical mobility (Gnjidic et al., 2012; Hermsen et al., 2018; Khezrian et al., 2019).

When considering the integration of variables across the dimensions, the sociodemographic variables might be associated with discrimination and poverty, which in turn are associated with poor psychological health including stress and social isolation (C. L. Edwards et al., 2001; Raphael, 2000, 2002; Raphael et al., 2001; Tait & Chibnall, 2014). Poor psychological health is associated with reduced activity participation and physical mobility, health conditions, and possibly job loss or lower income (Cotchett et al., 2016; De Sola et al., 2016; Fitzgerald et al., 2015; Giummarra et al., 2017). Poor biological and physical health might be associated with increased leave from work, poorer mental health, and more activity restriction (De Sola et al., 2016; Hermsen et al., 2018; Resnick et al., 2018; Ryan et al., 2018; Vancampfort et al., 2017). Taken together, the integration of variables found in the current study align with the gate control theory and its expansion (Melzack & Casey, 1968; Melzack & Wall, 1965), lifespan developmental perspectives (Dunn, 2010; Walco et al., 2016), and specifically the biopsychosocial model of pain and aging (Gagliese et al., 2018). Namely, the nonuniform relationships of the variables across the pain outcomes supports the multidimensionality of pain.

Unique Variables Between Outcomes

Age was not retained in multivariate models for both pain presence and intensity. Significant variables that were unique between pain outcomes were sex, education, marital status, language, the “Cognitive-motor” factor, physical activity, life-space, white blood cell count, Comorbidities (Hypertension; Urinary Incontinence or Urinary Tract Infection; Bowel Disorder or Incontinence; Heart Disease; Peripheral Vascular Disease; Diabetes; Chronic Obstructive Pulmonary Disease; and Other Physical or Mental Conditions), and the Count of Conditions with Other Treatment Usage. Each are discussed in detail below and together at the end of the section.

Sociodemographic Variables

Age. Consistent with findings from previous studies (Larsson et al., 2017; Zimmer & Zajacova, 2018) in bivariate analyses, age was positively associated with pain presence and intensity. However, in multivariate analyses, age was no longer a significant correlate. This supports the biopsychosocial model of pain and aging; namely, age-related variables were included in the models (Dunn, 2010; Gagliese, 2009; Walco et al., 2016). Nonetheless, the current findings might be explained by the restricted age-range in the sample. However, the large sample size should have mitigated against this due to increased statistical power (Field, 2009). Future research should investigate the relationship of age with the same or additional variables and its associations with pain using longitudinal data and other statistical tests such as parallel and serial mediation models (Hayes, 2013). Also, investigating younger age groups in comparison with middle-aged and older people will allow for insightful findings across the lifespan.

Sex. This study found that women were more likely to report pain than men, supporting previous studies where women reported more pain than men in the vertebral column (Wranker, Rennemark, & Berglund, 2016), non-localised back pain (Coggon et al., 2017), neuropathic pain (Cardinez et al., 2018), and post-surgical pain (Zheng et al., 2017). Previous studies also suggest that women might be more susceptible than men to chronic pain conditions (Gagliese & Fillingim, 2003; Mogil, 2012) and societal views encourage pain expression in women more than men (Gagliese & Fillingim, 2003; Mattos Feijó et al., 2018), possibly explaining the current findings.

In the current study, higher pain impact was associated with men more than women, supporting evidence from previous studies (Rovner et al., 2017). Rovner et al. (2017) found that besides participating in activities more than men, women also accepted their pain more and had less fear of movement. Conversely, men were more afraid of movement possibly due to the fear of re-injury. Societal roles might play a role for pain impact as women spend more time performing household activities (Bingefors & Isacson, 2004) and manage their pain better than men (Casetta et al., 2009), possibly resulting in less pain impact.

Education. This study found that pain was associated with a secondary school education more than less than a secondary school education, contradicting results from previous studies (Elsayed et al., 2019; Feldman et al., 2015); however, in the previous studies, specific patient populations were investigated such as those undergoing total knee arthroplasty (Feldman et al., 2015) or decompression surgery for lumbar spinal stenosis (Elsayed et al., 2019) whereas the current study was not restricted to specific disease characteristics. Another explanation relates to health literacy; specifically, higher education is related to increased health literacy (Tait & Chibnall, 2014). People with low education might live in environments with less access to health-promoting resources (Adler & Newman, 2002) and may be at a disadvantage when attempting to increase health literacy (Roth & Geisser, 2002). Perhaps this lack of access to health resources and reduced understanding about pain in the less educated population explains why more highly educated people were more likely to report pain in the present study.

In the current study, higher pain intensity was associated with less than a secondary school education or a secondary school education more than a post-secondary degree or diploma, supporting evidence from previous studies (H. J. Kim et al., 2014; Van Der Leeuw et al., 2016).

Higher education levels are associated with health-promoting behaviours (Adler & Newman, 2002; Feldman et al., 2015), adherence to treatments (Geyer, Hemström, Peter, & Vågerö, 2006), and improvements in pain (Olson et al., 2011), while lower education levels are associated with low income levels (Olson et al., 2011) which have been previously found to be associated with pain (Rios & Zautra, 2011). Low education levels have also been associated with pain catastrophizing which encourages the mindset of thinking the pain is much worse that it might be (Roth & Geisser, 2002), impairs how one copes with pain (H. J. Kim et al., 2014), and increases the risk for poor long-term behavioural and emotional adjustment (R. R. Edwards et al., 2006). People who catastrophize might need increased resources to understand their pain (R. R. Edwards et al., 2006). Pain catastrophizing may also change throughout the lifespan, with Ruscheweyh et al. (2011) finding a more affective relation to pain (i.e., anger, anxiety, sadness) in younger adults but a more sensory experience of pain (i.e., increased pain intensity) in older adults. However, since pain catastrophizing was not examined within the present study, this explanation remains speculative. Future studies should include measures of pain catastrophizing.

A review article examining the associations between education and back pain suggests that people with a low education level are more likely to work in physically demanding jobs, have poorer sick-leave benefits, and fear losing work which may result in them returning to work before an injury is healed (Dionne et al., 2001). The lifespan developmental approach also suggests there are gains and losses experienced with increasing age (Baltes, 1997; Baltes, Staudinger, & Lindenberger, 1999), which might include accumulation of risk from previous jobs. Although approximately half of the present sample is retired, it might be possible that their previous jobs were physically demanding, potentially contributing to their current pain. Future

studies can build on the present findings by investigating current and past occupation and their relationships to education and pain.

Marital Status. This study found that pain was associated with married/common-law relationships less than single people, consistent with previous studies that have found married people attend to their pain sooner than single people (Atzema et al., 2011) and unmarried people have less engagement in positive health behaviours (e.g., not seeking medical care) which may be associated with increased pain (Reese, Somers, Keefe, Mosley-Williams, & Lumley, 2010). Marriage may allow for emotional support between spouses and is associated with better psychological health (e.g., less depression and stress, and higher self-esteem) in the spouse with pain (Rana et al., 2016; Reese et al., 2010). Specifically, the social support exchanged between spouses might help the spouse with pain to tolerate or accept it more, thereby lessening its effects (Rana et al., 2016; Reese et al., 2010).

The current study found that pain was associated with people who were widowed more than single people, consistent with previous studies that found widowed people report pain (Bradbeer et al., 2003) and have poor health outcomes associated with pain (Eriksson, Somer, & Lauri, 2001; Ferrario, Cardillo, Vicario, Balzarini, & Zotti, 2004; Li, Liang, Toler, & Gu, 2005). Specifically, widowed people might experience distress, depression, physical limitations (Gilbar & Ben-Zur, 2002), loneliness (Bradbeer et al., 2003), and concern over managing finances and household tasks on their own (Eriksson et al., 2001). Health-promoting behaviours might also decline because of the changes the widowed spouse has to undergo (e.g., decreased physical activity) (Eriksson et al., 2001), which may be amplified if they were heavily dependent on their spouse for emotional or social support (Gilbar & Dagan, 1995; Li et al., 2005). The death of the

spouse, then, may have a negative impact on the surviving spouse's mental health (i.e., increased risk of depression) (Li et al., 2005).

Single people may be socially isolated, which can negatively contribute to a person's pain and coping (Karayannis et al., 2019). For example, living alone may be associated with less adherence to taking medications and less attention to new or worsening symptoms from existing or new health conditions, which may enhance pain (Kaplan & Berkman, 2021). Additionally, people who are socially isolated may have a greater sense of loneliness and think their pain is worse compared to those who are less socially isolated (Karayannis et al., 2019). Future studies can build upon the present findings by investigating measures of loneliness in the analysis.

Studies have suggested that high marital satisfaction can be help the patient adjust to their pain and improve their mental health (Burns et al., 2018; Huang, Jones, Bennett, Nagayama Hall, & Lyons, 2018). Specifically, married couples with low marital satisfaction are at risk for psychological disability and pain compared to couples with higher satisfaction (Reese et al., 2010). When considering widowhood and pain, the pre-bereavement period is associated with the mental health of the surviving spouse during the bereavement period (Jonasson et al., 2009; ValdimarsdÓttir, Helgason, Adolfsson, Steineck, & Helgason, 2002). For instance, if a spouse experienced pain months before their death, the widowed spouse may experience poor health outcomes (i.e., sleep problems) years after the death of the spouse (Jonasson et al., 2009), which might impact on the report of pain. It is important for future studies to examine others affected by end of life care (e.g., the spouse), as well as physical symptoms and distress at the end of life (Hales et al., 2014; Hales, Gagliese, Nissim, Zimmermann, & Rodin, 2012). Considering that ours is the first study to support marital status as a variable within the biopsychosocial model of

pain and aging, future studies should examine it more in-depth by including measures of marital satisfaction and the pre-bereavement period in the analysis.

Language. This study found that higher pain impact was associated with people who could converse in English more and people who could converse in French less than other languages. A possible explanation for the differences might be due to difficulty in expressing pain. Specifically, in the social communication model of pain, Craig (2009) suggests that pain is complex and difficult to express through language as it might not precisely encompass the subjective experience of pain. Instead, nonverbal expressions (e.g., facial expressions and body posture) might be used to provide more insight into a person's report of pain. Future studies should build upon the present findings by including nonverbal cues of pain in the analysis.

Cognitive and Motor Variables

"Cognitive-motor" factor. In the present study, no pain was associated with increased scores on the "Cognitive-motor" factor. As previously described, increased scores on the "Cognitive-motor" factor indicate higher scores on the RAVLT, animal naming test, COWAT, and the MAT, and increased performance on the TUG test, standing balance test, and the 4-m walk test. Based on the items of the "Cognitive-motor" factor, the present findings are in line with previous literature as poor performance in executive function (K. S. Baker, Gibson, Georgiou-Karistianis, Roth, & Giummarra, 2016; Masiliūnas, Vitkutė, Stankevičius, Matijošaitis, & Petrikonis, 2017; Murata et al., 2017), memory (K. S. Baker et al., 2016; Oosterman et al., 2011; Simon et al., 2016), gait (Bindawas, 2016), balance (da Silva et al., 2015; Kuo, Huang, Chiang, Lee, & Tsai, 2015), and tasks involving combinations of these variables (Hamacher, Rudolf, Lohmann, &

Schega, 2016) have been associated with pain. This study also found that those with increased scores on the "Cognitive-motor" factor were less likely to report a high intensity of pain. Previous studies are in line with the present results as increased pain intensity has been associated with impaired executive functioning (Karp et al., 2006), memory (Jacobsen et al., 2019), gait (Sawa et al., 2017), balance (Norheim, Samani, Bønløkke, Omland, & Madeleine, 2020), and tasks involving combinations of these variables (Morone, Abebe, Morrow, & Weiner, 2014; Weiner, Rudy, Morrow, Slaboda, & Lieber, 2006).

Due to the cross-sectional design of the study, causality cannot be inferred. Hence, it might be possible that pain influences cognitive-motor health rather than vice versa. As explained by previous literature, memory (Oosterman et al., 2011) and executive function are often impaired because of pain (Boselie, Vancleef, & Peters, 2018; Karp et al., 2006) which might be due to the attentional demands required by pain (Galvez-Sánchez et al., 2018; Oosterman et al., 2012, 2011; Van Der Leeuw et al., 2016). With increasing pain intensities, older adults may not be able to slow pain signals in higher order cognitive processes since their attention is diverted to the pain (Karp et al., 2006; Oosterman et al., 2011).

When considering the motor components of the "Cognitive-motor" factor, previous studies have shown that gait speed is slower in the presence of pain (S. W. Lee et al., 2020; Sawa et al., 2017), which might be due to the distraction of pain (Sawa et al., 2017). Gait speed might also change with increased pain intensities as a protective strategy of preventing more pain (Barzilay et al., 2016), while reductions in pain might improve gait speed in older adults (J. L. Taylor, Parker, Szanton, & Thorpe, 2018). Increased pain is associated with impairments in balance (da Silva et al., 2015), while older adults might be less confident in their ability to perform balance tasks if they have pain (Stubbs et al., 2016).

Dual task performance, which is the combination of cognitive and motor domains to perform a task (Hamacher et al., 2016), might partly explain the findings as well. In older adults, the disruptive nature of pain on cognitive functioning might make it difficult to multitask. Gait changes due to dual tasking might be higher in the presence of pain, while decreased pain intensity is associated with increases in dual task performance in older people with knee osteoarthritis (Hamacher et al., 2016). In another study by Ogawa et al. (2019), results showed that community-dwelling older adults with pain performed poorly when simultaneously tasked with a cognitive challenge and tested on gait speed. Interestingly, when people with a higher intensity of pain were tested on gait speed, without a cognitive challenge, they performed worse than those with lower pain intensities or those with the added cognitive challenge (Ogawa et al., 2019). This corroborates previous findings of higher pain intensities interfering with attentional demands, thereby also being associated with decreased cognitive-motor health. However, since dual-task performance was not investigated in the present sample, the explanations remain speculative. Future studies should build upon the present findings by investigating dual-task performance within the model.

Biological and Physical Variables

PASE. This study found that higher pain intensity was associated with worse physical activity scores, supporting previous literature in middle-aged and older adults with arthritis (de Groot, Bussmann, Stam, & Verhaar, 2008; Herbolsheimer et al., 2016; Shih, Hootman, Kruger, & Helmick, 2006). A possible explanation relates to biopsychosocial variables such as functional limitations (Shih et al., 2006), lower mental health (de Groot et al., 2008), reduced social contact, and the pain itself (Baert, Gorus, Mets, & Bautmans, 2015). Other variables that may also play a role include the fear of falling (Baert et al., 2015), uncertainty of the role of physical activity, and

the fear of increased pain (Herbolsheimer et al., 2016). However, since the influence of the latter factors (i.e., fear of falling and of increased pain) were not investigated in this study, further research might build upon the present findings by testing these additional variables.

The current study found that higher pain impact was associated with worse physical activity scores, which has been previously supported (Duncan, Van Dillen, Garbutt, Earhart, & Perlmutter, 2019). The findings also corroborate those of Murphy et al. (2016) who suggest that people with low pain impact continue to engage in activities, despite the presence of pain, since physical activity may serve as a distraction. Instead, those with high pain impact might restrict their physical activities to avoid more pain (Hendry, Williams, Markland, Wilkinson, & Maddison, 2006; Murphy et al., 2016). The authors explain that anticipating pain might play a negative role when engaging in activities for people with high pain impact (Murphy et al., 2016). Additionally, less physical activity might be associated with increased sedentary behaviour thereby increasing pain and disability (Herbolsheimer et al., 2016).

LSI. This study found higher pain impact was associated with worse life-space scores. As previously described, life-space indexes a person's physical and social mobility, general health, and ability to live independently (P. S. Baker et al., 2003; Byles et al., 2015). Lower life-space scores have been previously associated with motor difficulty (Barnes et al., 2007; Suzuki et al., 2014), social isolation (Iyer et al., 2018), and reduced opportunities to participate in productive and valuable activities (Byles et al., 2015). This might explain why worse life-space scores are associated with more activity limitation.

Another explanation for the present finding is that older people with pain are likely to restrict or alter their physical or social activities to prevent more pain (G. H. Lo et al., 2015; Mackichan,

Adamson, & Gooberman-Hill, 2013). They might view self-restriction of physical or social activity as a necessary process of pain and aging (Mackichan et al., 2013) or may not realize that their painful condition (e.g., osteoarthritis) leads to the modification of their activities to prevent further pain (G. H. Lo et al., 2015).

White Blood Cell Count. The present study found that higher pain impact was associated with increased white blood cell counts. This variable has not been extensively studied in the past in relation to pain impact, while accounting for numerous biopsychosocial variables. Nonetheless, the differences in white blood cell count by pain impact group might be explained by associated comorbidities, which prevent participation in activities because of health-related disabilities (Hermsen et al., 2018). For example, white blood cell count increases with infection and inflammatory diseases, which are associated with pain (Longe & Gale, 2006). The comorbidities that were associated with pain impact (discussed below) are those whose symptomology includes inflammation. White blood cell count might also increase because of physical or emotional stress (Longe & Gale, 2006), which may have been experienced by the participants in this study as seen through worse scores on the Psychosocial factor in those with a high pain impact.

Comorbidities. *Hypertension; Urinary Incontinence or Urinary Tract Infection; Migraine; and Bowel Disorder or Incontinence* are all associated with potentially painful symptoms (Longe & Gale, 2006) and are common in older adults (Cook & Sobeski, 2013; Katz & Feldstein, 2008; Longe & Gale, 2006; Rowe & Juthani-Mehta, 2013; Shrestha & Taleban, 2019), possibly explaining why they differ between pain presence groups.

Heart Disease (including Congestive Heart Failure, Myocardial Infarction, or Angina) and Peripheral Vascular Disease differed between pain intensity groups. Understanding the etiology of these comorbidities provides insight into their significance with pain intensity. In congestive heart failure, the decreased blood supply pumped by the heart might result in edema (Longe & Gale, 2006), which is associated with increased pain (A. D. Thompson & Shea, 2020). In myocardial infarction and angina, clogged arteries result in the blockage of blood to the heart, which might be aggravated with stress and exertion (Longe & Gale, 2006). Angina is associated with increased chest pain, and in hospital settings, people with myocardial infarction are required to report changes in the intensity of pain to nurses or other health-care professionals (Longe & Gale, 2006), highlighting the importance of pain intensity in the presentation of these conditions. In peripheral vascular disease, the occlusion of a blood vessel (usually in the lower extremities) limits oxygen and nutrition available for the tissues; this is aggravated by exercise (e.g., walking) as there is already limited circulation within the body (John Hopkins Medicine, n.d.; Teo, 2019). It may then lead to an increased intensity of muscle cramping, resulting in pain intensity changes (John Hopkins Medicine, n.d.; Teo, 2019), potentially explaining why this condition differs between pain intensity groups.

Diabetes and Chronic Obstructive Pulmonary Disease differed between pain impact groups. Diabetes occurs when the glucose in the blood cannot be used by the cells in the body (Longe & Gale, 2006). It can cause health complications such as peripheral neuropathy which may lead to amputation of an extremity because of reduced sensitivity of nerve endings (Longe & Gale, 2006). It is a common condition in older adults and in those who are overweight or sedentary (Longe & Gale, 2006), possibly explaining why it differed between pain impact groups. Chronic obstructive pulmonary disease is an airflow limitation caused by an inflammatory response to

inhaled toxins (Wise, 2020). Its occurrence increases with age, and the associated inflammation increases as the disease progresses (Wise, 2020). Chronic obstructive pulmonary disease might also lead to functional decline which may be brought about by the shortness of breath when performing activities such as dressing, bathing, or eating (Wise, 2020), possibly resulting in more activity prevention.

Other Physical or Mental Conditions (including Other Arthritis or Infections) differed between pain presence and impact groups. This might be since arthritis is associated with painful inflammation of the joints, while infections may be associated with painful symptoms (Longe & Gale, 2006). Since the Other Conditions within this comorbidity were not specified, speculations may not be made about their relationships with pain presence or impact.

Conditions with Reported Other Treatments Count. In the present study, pain and higher pain impact was associated with a higher Count of Using Other Treatments for conditions (i.e., Hypertension; Depression; Stroke or Mini-Stroke; Parkinson's Disease). Most of the conditions that participants received other treatment for were those associated with diagnostically painful symptoms (Longe & Gale, 2006), with another study supporting the associations between pain and Parkinson's disease as well (Buhmann et al., 2017). Depression and Parkinson's disease have also previously been associated with high pain impact (Allen, Wong, Canning, & Moloney, 2016; Duncan et al., 2019; Przekop, Haviland, Oda, & Morton, 2015; Smith, Becker, Roberts, Walker, & Szanton, 2016), while hypertension and stroke have been associated with poor physical function (Xu et al., 2016) including motor impairment (Tang, Lau, Mok, Ungvari, & Wong, 2015). The underlying conditions that participants sought other treatment for, then, might be the reason for increased treatments in high pain impact groups. Another possible explanation

might be that having more activities prevented by pain acts as a facilitator to engage in health-promoting behaviours (Hendry et al., 2006) which might include seeking treatment for their conditions. When educated about pain management techniques, Kung et al. (2000) found older community-dwelling adults were likely to participate in more activities and have reductions in pain.

Although it is understood that those seeking other treatments are doing so to relieve the pain associated with their conditions (Wolever et al., 2015), speculations cannot be made about the Other Treatments Used since they were not specified within this study. Future studies should build upon the current findings by investigating the types of treatments used.

In summary, pain presence (Figure 12) was not significantly associated with age in the multivariate model, but was associated with sex, education, marital status, the "Cognitive-motor" factor, Hypertension, Urinary Incontinence or Urinary Tract Infection, Migraines, Bowel Disorder or Incontinence, Other Physical or Mental Conditions, and Count of Conditions with Other Treatment Usage. Pain intensity (Figure 13) was also not significantly associated with age in multivariate models, but was associated with education, the "Cognitive-motor" factor, physical activity, Heart Disease, and Peripheral Vascular Disease. Pain impact (Figure 14) was associated with sex, language, life-space, physical activity, Diabetes, Chronic Obstructive Pulmonary Disease, Other Physical or Mental Condition, and white blood cell count. In addition, the shared variables (i.e., ethnicity, income, Back Problems or Pain, Osteoarthritis, Mental Health Conditions, physical function, "Biophysical" factor, and "Psychosocial" factor) as previously described were associated with all pain outcomes.

The variables (e.g., age, sex, comorbidity, depression, anxiety, education, memory, and executive function) proposed in the biopsychosocial model of pain and aging (Gagliese et al., 2018) were included in the current study and were all associated with at least one pain outcome. In Miaskowski et al.'s (2020) biopsychosocial model of chronic pain for older adults, it has been proposed that variables such as sex, comorbidities, depression, anxiety, ethnicity, and physical and cognitive function should be simultaneously examined in relation to multiple pain outcomes including intensity and impact, which were all addressed within the current study and were found to be significant with at least one pain outcome. In Weiner et al.'s (2019) study, a biopsychosocial profile was created for older people with chronic low back pain and results showed that pain was multifaceted with various central and peripheral nervous system contributors. The uniqueness of variables between pain outcomes in the current study, and the presence of overlap between a combination of two outcomes, supports the variability of pain and collectively corroborates the previous studies. By examining multiple pain outcomes, valuable insights were gained that may have been missed if only one pain outcome was examined. for example, if pain impact was not included as an outcome, life-space, a new variable in the study of pain, would not have emerged as an important component. Additionally, neglecting pain presence and intensity as outcomes would have missed the important contribution of the cognitive and motor dimension.

Strengths and Limitations

There were several strengths in this study to be highlighted. The large sample size provided strong statistical power. This is also the first study, to our knowledge, that investigated over fifty variables from the sociodemographic, cognitive, physical, and biopsychosocial dimensions and

their relationships to three pain outcomes in community-dwelling middle-aged and older adults through a multivariate analysis design. Most of the statistical tests used controlled for confounders, allowing for an inclusive understanding of the relationships between the variables and pain outcomes. By using a multivariate design with a large sample, an important strength was its hypothesis generating capacity for future studies to build upon, such as examining variables related to marital satisfaction, the fear of falling, and non-pharmacological treatments.

There were several limitations in this study to be acknowledged. The cross-sectional design of the study prevents causation to be determined but allows for a model to be developed using baseline data from the CLSA. Future studies can use longitudinal waves of data from the CLSA, which uses the same sample, variables, and potentially including more detailed variables (e.g., drug identification numbers). Although verbal descriptor scales are valid and reliable assessments of pain in older adults, the pain questions may not have comprehensively captured the pain experience like a multidimensional pain measure might have. For example, more than half of the sample reported a Condition with Potentially Painful Symptoms, yet less than half of the sample reported the presence of pain. Additionally, the pain measures were collected approximately 18-months after the collection of some data. However, these limitations were unavoidable due to variable selection and the study design used by the CLSA. To mitigate the latter limitation, future studies may limit the variables included in the analysis to only those collected during the MCQ. Another limitation relates to medications; due to the timeline of data release from the CLSA, the drug identification numbers for medications were not included in the present study. However, future studies may use drug identification numbers in the analysis as they have been released by the CLSA. Lastly, sample weights were not used in this study due to errors with the weights provided by the CLSA in the original dataset; the refined weights were

released after the analysis was conducted and, thus, were not used in the current study. Future studies should utilize these weights to generalize the results to the broader Canadian population.

Implications and Future Directions

This study demonstrated that pain presence, intensity, and impact had commonalities and differences in sociodemographic, biological and physical, cognitive and motor, and psychological and social variables, supporting Gagliese et al.'s (2018) biopsychosocial model of pain and aging and offering revised models (see Figures 11 to 14). These findings have important implications for pain management and treatment. Rather than solely using a biomedical approach, the variability of pain demonstrated in the current study encourages physicians and other health care professionals to treat patients with pain through a holistic lens which, in addition to biomedical factors, also focuses on demographic, cognitive, psychological, and social factors. The uniqueness of variables between pain outcomes also emphasizes the importance of examining pain through multiple outcomes to create a comprehensive profile.

Another important implication of this study relates to age. The lack of significance of this variable in multivariate analysis for pain presence and intensity suggests that age-relevant variables were included in the models, supporting the role of age as a proxy to biopsychosocial variables and their relationships to pain. Future studies might build upon this finding by using more complex statistical tests such as parallel and serial mediation models (Hayes, 2013), as well as longitudinally investigating the relationships between age and other variables to gain more sophisticated insights over time. Additionally, these findings imply that people age in different ways (Dunn, 2010) and it is necessary to examine variables unique to an individual when assessing their pain (Gagliese et al., 2018).

While there were many variables included in the models, there were still others that were left out (e.g., falls and social participation). Previous research has found these variables to be important when examining pain and age. Therefore, these variables may serve as candidate correlates in future studies. Different aspects of these measures might be analysed as well. For example, when assessing falls, perhaps a measure about the fear of falling can be included in the analysis. When examining social participation, perhaps future studies can examine informal versus formal activity participation and its relationship to pain.

Another important finding relates to the contributions of the sociodemographic dimension in the models. This dimension has often been neglected in the past with research (Health Canada, 2019; Raphael & Bryant, 2000) advocating for the importance of this dimension when understanding health. This study supports its inclusion in this model, as there was at least one significant sociodemographic variable for each pain outcome. Social determinants of health, which include the sociodemographic variables discussed in the current study, are important determinants in pain and aging (Karran, Grant, & Moseley, 2020; Pooler & Srinivasan, 2018). It is important for future studies to understand this dimension of pain in older adults by investigating sociodemographic variables on their own, and instead of only as covariates or for use in descriptive statistics.

Since this is the first study to test the biopsychosocial model of pain and aging through a cross-sectional study design, future studies can build upon the present findings and continue to revise the model using longitudinal data from the CLSA. The current sample only included cognitively-intact participants due to the baseline exclusion criteria; however, the longitudinal data collection waves of the CLSA do not exclude cognitively impaired participants (Raina et al., 2008), allowing for the model to be examine predictors before disease (e.g., dementia) diagnosis.

Through continuous revisions of the model, deeper insights of pain in older adults can be fostered which can inform the community and health care professionals, as well as pain management programs.

CHAPTER SEVEN: CONCLUSION

In conclusion, the current findings support the biopsychosocial model of pain and aging and offer revised models. While there were similarities across each pain outcome (presence, intensity, and impact), there were also differences between the outcomes, supporting the importance of examining multiple pain outcomes to understand pain in middle-aged and older adults. Importantly, age was significant in bivariate analysis but not significant in multivariate analysis for pain presence and intensity, suggesting that age-related variables were included in multivariate models. The findings of this study provide a baseline framework for future research to revise, through longitudinal data and the inclusion of additional variables. The findings also demonstrate the importance of using a multidimensional approach when creating pain management strategies.

REFERENCES

Adamo, D. E., Anderson, T., Koochaki, M., & Fritz, N. E. (2020). Declines in grip strength may indicate early changes in cognition in healthy middle-aged adults. *PLoS ONE*, *15*(4), 1–11. https://doi.org/10.1371/journal.pone.0232021

Adler, N. E., & Newman, K. (2002). Socioeconomic disparities in health: Pathways and policies. *Health Affairs*, *21*(2), 60–76. https://doi.org/10.1377/hlthaff.21.2.60

Ahmadi-Abhari, S., Luben, R. N., Wareham, N. J., & Khaw, K.-T. (2013). Seventeen year risk of all-cause and cause-specific mortality associated with C-reactive protein, fibrinogen and leukocyte count in men and women: The EPIC-Norfolk study. *European Journal of Epidemiology*, *28*(7), 541–550. https://doi.org/10.1007/s10654-013-9819-6

Akintoye, O. O., Oniyide, A. A., & Owoyele, B. V. (2018). A study of pain threshold, interleukins and NLR in diabetic polyneuropathy in a selected Nigerian population. *Nigerian Journal of Physiological Sciences*, *33*(2), 151–157. https://doi.org/10.4314/NJPS.V33I2

Akram, M. J., & Malik, A. N. (2019). Frequency of chronic neuropathic pain and its association with depression in the elderly in Pakistan. *The Journal of the Pakistan Medical Association*, *69*(12), 1907–1909. https://doi.org/10.5455/JPMA.302642229.

Alcock, L., O'Brien, T. D., & Vanicek, N. (2015). Age-related changes in physical functioning: Correlates between objective and self-reported outcomes. *Physiotherapy*, *101*(2), 204–213. https://doi.org/10.1016/j.physio.2014.09.001

Allen, N. E., Wong, C. M., Canning, C. G., & Moloney, N. (2016). The association between Parkinson's disease motor impairments and pain. *Pain Medicine*, *17*(3), 456–462. https://doi.org/10.1111/pme.12898

Altintas, H. K., & Aslan, G. K. (2019). Incidence of falls among community-dwelling older adults in Turkey and its relationship with pain and insomnia. *International Journal of Nursing Practice*, *25*(5), 1–9. https://doi.org/10.1111/ijn.12766

American Psychiatric Association. (2020). What is depression? Retrieved June 6, 2021, from https://www.psychiatry.org/patients-families/depression/what-is-depression

American Psychological Association. (n.d.). Anxiety. Retrieved June 6, 2021, from https://www.apa.org/topics/anxiety

American Psychological Association. (2020a). APA dictionary of psychology: Psychological distress. Retrieved June 6, 2021, from https://dictionary.apa.org/psychological-distress

American Psychological Association. (2020b). APA dictionary of psychology: Stress. Retrieved June 6, 2021, from https://dictionary.apa.org/stress

Anderson, K. O., Green, C. R., & Payne, R. (2009). Racial and ethnic disparities in pain: Causes and consequences of unequal care. *The Journal of Pain*, *10*(12), 1187–1204. https://doi.org/10.1016/j.jpain.2009.10.002

Andresen, E. M., Malmgren, J. A., Carter, W. B., & Patrick, D. L. (1994). Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *American Journal of Preventive Medicine*, *10*(2), 77–84.

Ang, S., & Chen, T.-Y. (2019). Going online to stay connected: Online social participation buffers the relationship between pain and depression. *Journal of Gerontology. Series B, Psychological Sciences and Social Sciences*, *74*(6), 1020–1031. https://doi.org/10.1093/geronb/gby109

Ansai, J. H., de Andrade, L. P., Nakagawa, T. H., Vale, F. A. C., Caetano, M. J. D., Lord, S. R.,

& Rebelatto, J. R. (2017). Cognitive correlates of timed up and go subtasks in older people with preserved cognition, mild cognitive impairment, and Alzheimer's disease. *American Journal of Physical Medicine and Rehabilitation*, *96*(10), 700–705. https://doi.org/10.1097/PHM.0000000000000722

Ansai, J. H., de Andrade, L. P., Rossi, P. G., Almeida, M. L., Vale, F. A. C., & Rebelatto, J. R. (2018). Association between gait and dual task with cognitive domains in older people with cognitive impairment. *Journal of Motor Behavior*, *50*(4), 409–415. https://doi.org/10.1080/00222895.2017.1363702

Arrindell, W. A., Meeuwesen, L., & Huyse, F. J. (1991). The Satisfaction with Life Scale (SWLS): Psychometric properties in a non-psychiatric medical outpatients sample. *Personality and Individual Differences*, *12*(2), 117–123. https://doi.org/10.1016/0191-8869(91)90094-R

Atzema, C. L., Austin, P. C., Huynh, T., Hassan, A., Chiu, M., Wang, J. T., & Tu, J. V. (2011). Effect of marriage on duration of chest pain associated with acute myocardial infarction before seeking care. *Canadian Medical Association Journal*, *183*(13), 1482–1491. https://doi.org/10.1503/cmaj.110170

Auyeung, T. ., Lee, J. S. W., Leung, J., Kwok, T., Leung, P. ., & Woo, J. (2010). Survival in older men may benefit from being slightly overweight and centrally obese - a 5-year follow-up study in 4,000 older adults using DXA. *Journals of Gerontology: Medical Sciences*, *65A*(1), 99–104. https://doi.org/10.1093/gerona/glp099

Auyeung, T. W., Kwok, T., Lee, J., Leung, P. C., Leung, J., & Woo, J. (2008). Functional decline in cognitive impairment - the relationship between physical and cognitive function. *Neuroepidemiology*, *31*(3), 167–173. https://doi.org/10.1159/000154929

Awale, A., Hagedorn, T. J., Dufour, A. B., Menz, H. B., Casey, V. A., & Hannan, M. T. (2017). Foot function, foot pain, and falls in older adults: The Framingham foot study. *Gerontology*, *63*(4), 318–324. https://doi.org/10.1159/000475710

Baert, V., Gorus, E., Mets, T., & Bautmans, I. (2015). Motivators and barriers for physical activity in older adults with osteoporosis. *Journal of Geriatric Physical Therapy*, *38*(3), 105–114. https://doi.org/10.1519/JPT.0000000000000035

Baker, K. S., Gibson, S., Georgiou-Karistianis, N., Roth, R. M., & Giummarra, M. J. (2016). Everyday executive functioning in chronic pain: Specific deficits in working memory and emotion control, predicted by mood, medications, and pain interference. *Clinical Journal of Pain*, *32*(8), 673–680. https://doi.org/10.1097/AJP.0000000000000313

Baker, P. S., Bodner, E. V., & Allman, R. M. (2003). Measuring life-space mobility in community-dwelling older adults. *Journal of the American Geriatrics Society*, *51*(11), 1610–1614.

Baltes, P. B. (1997). On the incomplete architecture of human ontogeny: Selection, optimization, and compensation as foundation of developmental theory. *American Psychologist*, *52*(4), 366–380. https://doi.org/10.1037/0003-066X.52.4.366

Baltes, P. B., Staudinger, U. M., & Lindenberger, U. (1999). Lifespan psychology: Theory and application to intellectual functioning. *Annual Review of Psychology*, *50*, 471–507. https://doi.org/10.1146/annurev.psych.50.1.471

Barnes, L. L., Wilson, R. S., Bienias, J. L., Mendes De Leon, C. F., Kim, H. J. N., Buchman, A. S., & Bennett, D. A. (2007). Correlates of life space in a volunteer cohort of older adults. *Experimental Aging Research*, *33*(1), 77–93. https://doi.org/10.1080/03610730601006420

Barnhill, J. W. (2020). Overview of anxiety disorders. Retrieved February 10, 2021, from Merck

Manual Professional Version website: https://www.merckmanuals.com/professional/psychiatric-disorders/anxiety-and-stressor-related-disorders/overview-of-anxiety-disorders?query=anxiety

Barry, D. T., Glenn, C. P., Hoff, R. A., & Potenza, M. (2017). Pain interference, psychopathology, and general medical conditions among black and white adults in the US general population. *Journal of Addiction Medicine*, *11*(2), 98–105. https://doi.org/10.1097/ADM.0000000000000281

Bartley, E. J., & Fillingim, R. B. (2013). Sex differences in pain: A brief review of clinical and experimental findings. *British Journal of Anaesthesia*, *111*(1), 52–58. https://doi.org/10.1093/bja/aet127

Barzilay, Y., Segal, G., Lotan, R., Regev, G., Beer, Y., Lonner, B. S., … Elbaz, A. (2016). Patients with chronic non-specific low back pain who reported reduction in pain and improvement in function also demonstrated an improvement in gait pattern. *European Spine Journal*, *25*(9), 2761–2766. https://doi.org/10.1007/s00586-015-4004-0

Batsis, J. A., & Villareal, D. T. (2018). Sarcopenic obesity in older adults: Aetiology, epidemiology and treatment strategies. *Nature Reviews Endocrinology*, *14*(9), 513–537. https://doi.org/10.1038/s41574-018-0062-9

BC Guidelines. (2017). *Gait speed (4-metre)*. Retrieved from https://www2.gov.bc.ca/assets/gov/health/practitioner-pro/bc-guidelines/frailty-gaitspeed.pdf

Béland, F., Julien, D., Bier, N., Desrosiers, J., Kergoat, M. J., & Demers, L. (2018). Association between cognitive function and life-space mobility in older adults: Results from the FRéLE longitudinal study. *BMC Geriatrics*, *18*(1), 1–15. https://doi.org/10.1186/s12877-018-0908-y

Bherer, L., Erickson, K. I., & Liu-Ambrose, T. (2013). A review of the effects of physical activity and exercise on cognitive and brain functions in older adults. *Journal of Aging Research*, 1–8. https://doi.org/10.1155/2013/657508

Billick, S. B., Siedenburg, E., Burgert, W., & Bruni-Solhkhah, S. M. (2001). Validation of the mental alternation test with the mini-mental state examination in geriatric psychiatric inpatients and normal controls. *Comprehensive Psychiatry*, *42*(3), 202–205. https://doi.org/10.1053/comp.2001.23146

Bindawas, S. M. (2016). Relationship between frequent knee pain, obesity, and gait speed in older adults: Data from the osteoarthritis initiative. *Clinical Interventions in Aging*, *11*, 237–244. https://doi.org/10.2147/CIA.S100546

Bingefors, K., & Isacson, D. (2004). Epidemiology, co-morbidity, and impact on health-related quality of life of self-reported headache and musculoskeletal pain - a gender perspective. *European Journal of Pain*, *8*(5), 435–450. https://doi.org/10.1016/j.ejpain.2004.01.005

Blyth, F. M., Rochat, S., Cumming, R. G., Creasey, H., Handelsman, D. J., Le Couteur, D. G., … Waite, L. M. (2008). Pain, frailty and comorbidity on older men: The CHAMP study. *Pain*, *140*(1), 224–230. https://doi.org/10.1016/j.pain.2008.08.011

Bohannon, R. W. (1995). Sit-to-stand test for measuring performance of lower extremity muscles. *Perceptual and Motor Skills*, *80*, 163–166.

Bohannon, R. W. (2006). Reference values for the timed up and go test: A descriptive meta-analysis. *Journal of Geriatric Physical Therapy*, *29*(2), 64–68.

Bohannon, R. W. (2019). Grip strength: An indispensable biomarker for older adults. *Clinical Interventions in Aging*, *14*, 1681–1691. https://doi.org/10.2147/CIA.S194543

Bohannon, R. W., Larkin, P. A., Cook, A. C., Gear, J., & Singer, J. (1984). Decrease in timed balance test scores with aging. *Physical Therapy*, *64*(7), 1067–1070.
Bohannon, R. W., & Leary, K. M. (1995). Standing balance and function over the course of acute rehabilitation. *Archives of Physical Medicine and Rehabilitation*, *76*(11), 994–996.
Borsheski, R., & Johnson, Q. L. (2014). Pain management in the geriatric population. *Missouri Medicine*, *111*(6), 508–511.
Boselie, J. J. L. M., Vancleef, L. M. G., & Peters, M. L. (2018). Filling the glass: Effects of a positive psychology intervention on executive task performance in chronic pain patients. *European Journal of Pain (United Kingdom)*, *22*(7), 1268–1280. https://doi.org/10.1002/ejp.1214
Boyle, P. A., Buchman, A. S., Barnes, L. L., James, B. D., & Bennett, D. A. (2010). Association between life space and risk of mortality in advanced age. *Journal of the American Geriatrics Society*, *58*(10), 1925–1930. https://doi.org/10.1111/j.1532-5415.2010.03058.x
Bozkurt, H., Arac, D., & Cigdem, B. (2019). Effect of preoperative uric acid level and neutrophil / lymphocyte ratio on preoperative and postoperative visual analogue pain scores in patients with lumbar disc herniation: A cross-sectional study. *Turkish Neurosurgery*, *29*(5), 705–709. https://doi.org/10.5137/1019-5149.JTN.25897-19.2
Brach, J. S., Vanswearingen, J. M., Newman, A. B., & Kriska, A. M. (2002). Identifying early decline of physical function in community-dwelling older women: Performance-based and self-report measures. *Physical Therapy*, *82*(4), 320–328. https://doi.org/10.1093/ptj/82.4.320
Bradbeer, M., Helme, R. D., Yong, H. H., Kendig, H. L., & Gibson, S. J. (2003). Widowhood and other demographic associations of pain in independent older people. *Clinical Journal of Pain*, *19*(4), 247–254. https://doi.org/10.1097/00002508-200307000-00008
Bucourt, E., Martaillé, V., Mulleman, D., Goupille, P., Joncker-Vannier, I., Huttenberger, B., … Courtois, R. (2017). Comparison of the big five personality traits in fibromyalgia and other rheumatic diseases. *Joint Bone Spine*, *84*(2), 203–207. https://doi.org/10.1016/j.jbspin.2016.03.006
Buhmann, C., Wrobel, N., Grashorn, W., Fruendt, O., Wesemann, K., Diedrich, S., & Bingel, U. (2017). Pain in Parkinson disease: A cross-sectional survey of its prevalence, specifics, and therapy. *Journal of Neurology*, *264*(4), 758–769. https://doi.org/10.1007/s00415-017-8426-y
Bunk, S., Emch, M., Koch, K., Lautenbacher, S., Zuidema, S., & Kunz, M. (2020). Pain processing in older adults and its association with prefrontal characteristics. *Brain Sciences*, *10*(8). https://doi.org/10.3390/brainsci10080477
Burns, J. W., Post, K. M., Smith, D. A., Porter, L. S., Buvanendran, A., Fras, A. M., & Keefe, F. J. (2018). Spouse criticism and hostility during marital interaction: Effects on pain intensity and behaviors among individuals with chronic low back pain. *Pain*, *159*(1), 25–32. https://doi.org/10.1097/j.pain.0000000000001037
Buss, A., Wolf-Oostermann, K., & Strupeit, S. (2017). Life-space mobility of older adults living in the community - a cross-sectional study. *ARC Journal of Nursing and Healthcare*, *3*(4), 15–21. https://doi.org/10.20431/2455-4324.0304004
Butler, M., Retzlaff, P., & Vanderploeg, R. (1991). Neuropsychological test usage. *Professional Psychology: Research and Practice*, *22*(6), 510–512.
Byles, J. E., Leigh, L., Vo, K., Forder, P., & Curryer, C. (2015). Life space and mental health: A study of older community-dwelling persons in Australia. *Aging & Mental Health*, *19*(2),

98–106. https://doi.org/10.1080/13607863.2014.917607
Callisaya, M. L., Blizzard, C. L., Wood, A. G., Thrift, A. G., Wardill, T., & Srikanth, V. K. (2015). Longitudinal relationships between cognitive decline and gait slowing: The Tasmanian study of cognition and gait. *Journals of Gerontology: Medical Sciences*, *70*(10), 1226–1232. https://doi.org/10.1093/gerona/glv066
Campion, E. W., DeLabry, L. O., & Glynn, R. J. (1988). The effect of age on serum albumin in healthy males: Report from the normative aging study. *Journals of Gerontology: Medical Sciences*, *43*(1), 18–20. https://doi.org/10.1093/geronj/43.1.M18
Canadian Institutes of Health Research. (2020). What is gender? What is sex? Retrieved June 6, 2021, from https://cihr-irsc.gc.ca/e/48642.html
Cardinez, N., Lovblom, L. E., Bai, J. W., Lewis, E., Abraham, A., Scarr, D., … Perkins, B. A. (2018). Sex differences in neuropathic pain in longstanding diabetes: Results from the Canadian Study of Longevity in Type 1 Diabetes. *Journal of Diabetes and Its Complications*, *32*(7), 660–664. https://doi.org/10.1016/j.jdiacomp.2018.05.001
Casetta, I., Riise, T., Wamme Nortvedt, M., Economou, N. T., De Gennaro, R., Fazio, P., … Granieri, E. (2009). Gender differences in health-related quality of life in multiple sclerosis. *Multiple Sclerosis*, *15*(11), 1339–1346. https://doi.org/10.1177/1352458509107016
Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports*, *100*(2), 126–131. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/3920711%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC1424733
Cecchi, F., Molino-Lova, R., Di Iorio, A., Conti, A. A., Mannoni, A., Lauretani, F., … Ferrucci, L. (2009). Measures of physical performance capture the excess disability associated with hip pain or knee pain in older persons. *Journals of Gerontology: Medical Sciences*, *64A*(12), 1316–1324. https://doi.org/10.1093/gerona/glp125
Cederbom, S., & Arkkukangas, M. (2019). Impact of the fall prevention otago exercise programme on pain among community-dwelling older adults: A short-and long-term follow-up study. *Clinical Interventions in Aging*, *14*, 721–726. https://doi.org/10.2147/CIA.S200188
Cesari, M., Onder, G., Zamboni, V., Manini, T., Shorr, R. I., Russo, A., … Landi, F. (2008). Physical function and self-rated health status as predictors of mortality: Results from longitudinal analysis in the ilSIRENTE study. *BMC Geriatrics*, *8*(34). https://doi.org/10.1186/1471-2318-8-34
Chalé-Rush, A., Guralnik, J. M., Walkup, M. P., Miller, M. E., Jack Rejeski, W., Katula, J. A., … Fielding, R. A. (2010). Relationship between physical functioning and physical activity in the Lifestyle Interventions and Independence for Elders Pilot (LIFE-P). *Journal of the American Geriatrics Society*, *58*(10), 1918–1924. https://doi.org/10.1111/j.1532-5415.2010.03008.x.Relationship
Chang, M.-C., Chen, P.-F., & Lung, F.-W. (2017). Personality disparity in chronic regional and widespread pain. *Psychiatry Research*, *254*, 284–289. https://doi.org/10.1016/j.psychres.2017.04.059
Cheung, C. L., Nguyen, U.-S. D. T., Au, E., Tan, K. C. B., & Kung, A. W. C. (2013). Association of handgrip strength with chronic diseases and multimorbidity: A cross-sectional study. *Age*, *35*(3), 929–941. https://doi.org/10.1007/s11357-012-9385-y
Chiao, C., & Hsiao, C. (2017). Comparison of personality traits and successful aging in older

Taiwanese. *Geriatrics and Gerontology International*, *17*(11), 2239–2246. https://doi.org/10.1111/ggi.13019
Chiou, J. H., Liu, L. K., Lee, W. J., Peng, L. N., & Chen, L. K. (2018). What factors mediate the inter-relationship between frailty and pain in cognitively and functionally sound older adults? A prospective longitudinal ageing cohort study in Taiwan. *BMJ Open*, *8*(2). https://doi.org/10.1136/bmjopen-2017-018716
Choi, N. G., & DiNitto, D. M. (2016). Correlates of worry about health care costs among older adults. *Journal of Applied Gerontology*, *37*(6), 763–782. https://doi.org/10.1177/0733464816650803
Clouston, S. A. P., Brewster, P., Kuh, D., Richards, M., Cooper, R., Hardy, R., … Hofer, S. M. (2013). The dynamic relationship between physical function and cognition in longitudinal aging cohorts. *Epidemiologic Reviews*, *35*(1), 33–50. https://doi.org/10.1093/epirev/mxs004
CLSA. (2014a). *Chair rise test*. Retrieved from https://www.clsa-elcv.ca/doc/533
CLSA. (2014b). *Measuring standing balance*. Retrieved from https://www.clsa-elcv.ca/doc/532
CLSA. (2014c). *Timed (4-metre) walk test*. Retrieved from https://www.clsa-elcv.ca/doc/530
CLSA. (2014d). *Timed get up and go test*. Retrieved from https://www.clsa-elcv.ca/doc/531
CLSA. (2015a). *Biospecimen post collection processing*. Retrieved from https://www.clsa-elcv.ca/doc/503
CLSA. (2015b). *Collection of blood by venipuncture*. Retrieved from https://www.clsa-elcv.ca/doc/501
CLSA. (2015c). *Collection of random urine specimens*. Retrieved from https://www.clsa-elcv.ca/doc/502
CLSA. (2015d). *Data collection site questionnaires (comprehensive)*.
CLSA. (2015e). *Maintaining contact questionnaire (tracking and comprehensive)*.
CLSA. (2016a). *Hand grip strength*. Retrieved from https://www.clsa-elcv.ca/doc/537
CLSA. (2016b). *Standing height and weight measurement*. Retrieved from https://www.clsa-elcv.ca/doc/1112
CLSA. (2017). *CLSA technical document: Sampling and computation of response rates and sample weights for the tracking (telephone interview) participants and comprehensive participants*. Retrieved from https://www.clsa-elcv.ca/doc/1041
CLSA. (2018a). *CLSA access agreement*. Retrieved from https://www.clsa-elcv.ca/doc/2841
CLSA. (2018b). *Derived variable-Life Space Index (LSI) (comprehensive assessment)*. Retrieved from https://www.clsa-elcv.ca/doc/2785
CLSA. (2018c). *In-home questionnaire (baseline - comprehensive)*.
Coggon, D., Ntani, G., Walker-Bone, K., Palmer, K. T., Felli, V. E., Harari, R., … Salazar Vega, E. J. (2017). Epidemiological differences between localised and non-localised low back pain. *Spine (Phila Pa 1976)*, *42*(10), 740–747. https://doi.org/10.1097/BRS.0000000000001956
Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (Second). Lawrence Erlbaum Associates.
Colcombe, S., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychological Science*, *14*(2), 125–130.
Cook, K., & Sobeski, L. M. (2013). Urinary incontinence in the older adult. *PSAP 2013: Special Populations*, 3–20.
Coryell, W. (2020a). Depressive disorders. Retrieved February 10, 2021, from Merck Manual Professional Version website: https://www.merckmanuals.com/professional/psychiatric-

disorders/mood-disorders/depressive-disorders?query=clinical depression
Coryell, W. (2020b). Overview of mood disorders. Retrieved February 10, 2021, from Merck Manual Professional Version website: https://www.merckmanuals.com/professional/psychiatric-disorders/mood-disorders/overview-of-mood-disorders?query=mood disorder
Cotchett, M., Munteanu, S. E., & Landorf, K. B. (2016). Depression, anxiety, and stress in people with and without plantar heel pain. *Foot and Ankle International*, *37*(8), 816–821. https://doi.org/10.1177/1071100716646630
Craig, K. D. (2009). The social communication model of pain. *Canadian Psychology*, *50*(1), 22–32. https://doi.org/10.1037/a0014772
Creamer, P., Lethbridge-Cejku, M., Costa, P., Tobin, J. D., Herbst, J. H., & Hochberg, M. C. (1999). The relationship of anxiety and depression with self-reported knee pain in the community: Data from the Baltimore Longitudinal Study of Aging. *Arthritis Care & Research: The Official Journal of the Arthritis Health Professionals Association*, *12*(1), 3–7. https://doi.org/10.1002/1529-0131(199902)12:1<3::aid-art2>3.0.co;2-k
Crowe, M., Jordan, J., Gillon, D., McCall, C., Frampton, C., & Jamieson, H. (2017). The prevalence of pain and its relationship to falls, fatigue and depression in a cohort of older people living in the community. *Journal of Advanced Nursing*, *73*(11), 2642–2651. https://doi.org/10.1111/jan.13328
da Silva, R. A., Vieira, E. R., Carvalho, C. E., Oliveira, M. R., Amorim, C. F., & Neto, E. N. (2015). Age-related differences on low back pain and postural control during one-leg stance: A case–control study. *European Spine Journal*, *25*(4), 1251–1257. https://doi.org/10.1007/s00586-015-4255-9
Dance, A. (2019). The pain gap. *Nature*, *567*, 448–450.
de Groot, I. B., Bussmann, J. B., Stam, H. J., & Verhaar, J. A. N. (2008). Actual everyday physical activity in patients with end-stage hip or knee osteoarthritis compared with healthy controls. *Osteoarthritis and Cartilage*, *16*, 436–442. https://doi.org/10.1016/j.joca.2007.08.010
de Luca, K. E., Parkinson, L., Haldeman, S., Byles, J. E., & Blyth, F. (2017). The relationship between spinal pain and comorbidity: A cross-sectional analysis of 579 community-dwelling, older Australian women. *Journal of Manipulative and Physiological Therapeutics*, *40*(7), 459–466. https://doi.org/10.1016/j.jmpt.2017.06.004
De Sola, H., Salazar, A., Dueñas, M., Ojeda, B., & Failde, I. (2016). Nationwide cross-sectional study of the impact of chronic pain on an individual's employment: Relationship with the family and the social support. *BMJ Open*, *6*, 1–12. https://doi.org/10.1136/bmjopen-2016-012246
Defrin, R., Eli, I., & Pud, D. (2011). Interactions among sex, ethnicity, religion, and gender role expectations of pain. *Gender Medicine*, *8*(3), 172–183. https://doi.org/10.1016/j.genm.2011.04.001
Demnitz, N., Hogan, D. B., Dawes, H., Johansen-Berg, H., Ebmeier, K. P., Poulin, M. J., & Sexton, C. E. (2018). Cognition and mobility show a global association in middle- and late-adulthood: Analyses from the Canadian Longitudinal Study on Aging. *Gait and Posture*, *64*, 238–243. https://doi.org/10.1016/j.gaitpost.2018.06.116
DePew, Z. S., Garofoli, A. C., Novotny, P. J., & Benzo, R. P. (2012). Screening for severe physical inactivity in chronic obstructive pulmonary disease: The value of simple measures and the validation of two physical activity questionnaires. *Chronic Respiratory Disease*,

10(1), 19–27. https://doi.org/10.1177/1479972312464243
Dhanju, S., Kennedy, S. H., Abbey, S., Katz, J., Weinrib, A., Clarke, H., … Ladha, K. (2019). The impact of comorbid pain and depression in the United States: Results from a nationally representative survey. *Scandinavian Journal of Pain*, *19*(2), 319–325. https://doi.org/10.1515/sjpain-2018-0323
Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, *49*(1), 71–75.
Dionne, C. E., Von Korff, M., Koepsell, T. D., Deyo, R. A., Barlow, W. E., & Checkoway, H. (2001). Formal education and back pain: A review. *Journal of Epidemiology and Community Health*, *55*(7), 455–468. https://doi.org/10.1136/jech.55.7.455
Dominick, C. H., Blyth, F. M., & Nicholas, M. K. (2012a). Unpacking the burden: Understanding the relationships between chronic pain and comorbidity in the general population. *Pain*, *153*(2), 293–304. https://doi.org/10.1016/j.pain.2011.09.018
Dominick, C. H., Blyth, F. M., & Nicholas, M. K. (2012b). Unpacking the burden: Understanding the relationships between chronic pain and comorbidity in the general population. *Pain*, *153*(2), 293–304. https://doi.org/10.1016/j.pain.2011.09.018
Donges, C. E., & Duffield, R. (2012). Effects of resistance or aerobic exercise training on total and regional body composition in sedentary overweight middle-aged adults. *Applied Physiology, Nutrition and Metabolism*, *37*(3), 499–509. https://doi.org/10.1139/H2012-006
Douglas, H., Georgiou, A., & Westbrook, J. (2017). Social participation as an indicator of successful aging: An overview of concepts and their associations with health. *Australian Health Review*, *41*(4), 455–462. https://doi.org/10.1071/AH16038
Duncan, R. P., Van Dillen, L. R., Garbutt, J. M., Earhart, G. M., & Perlmutter, J. S. (2019). Low back pain--related disability in Parkinson disease: Impact on functional mobility, physical activity, and quality of life. *Physical Therapy*, *99*(10), 1346–1353. https://doi.org/10.1093/ptj/pzz094
Dunn, K. M. (2010). Extending conceptual frameworks: Life course epidemiology for the study of back pain. *BMC Musculoskeletal Disorders*, *11*(23).
Eccleston, C., & Crombez, G. (1999). Pain demands attention: A cognitive-affective model of the interruptive function of pain. *Psychological Bulletin*, *125*(3), 356–366. https://doi.org/10.1037/0033-2909.125.3.356
Edholm, P., Nilsson, A., & Kadi, F. (2019). Physical function in older adults: Impacts of past and present physical activity behaviors. *Scandinavian Journal of Medicine and Science in Sports*, *29*(3), 415–421. https://doi.org/10.1111/sms.13350
Edwards, C. L., Fillingim, R. B., & Keefe, F. (2001). Race, ethnicity and pain. *Pain*, *94*(2), 133–137. https://doi.org/10.1016/S0304-3959(01)00408-0
Edwards, R. R., Goble, L., Kwan, A., Kudel, I., McGuire, L., Heinberg, L., … Haythornthwaite, J. (2006). Catastrophizing, pain, and social adjustment in scleroderma: Relationships with educational level. *Clinical Journal of Pain*, *22*(7), 639–646. https://doi.org/10.1097/01.ajp.0000210918.26159.94
Edwards, R. R., Moric, M., Husfeldt, B., Buvanendran, A., & Ivankovich, O. (2005). Ethnic similarities and differences in the chronic pain experience: A comparison of African American, Hispanic, and white patients. *Pain Medicine*, *6*(1), 88–98.
Ehsanbakhsh, A. R., Akhbari, H., Iraee, M. B., Toosi, F. S., Khorashadizadeh, N., Rezvani, M. R., & Naseh, G. (2011). The prevalence of undetected vertebral fracture in patients with back pain by dual-energy X-ray absorptiometry (DXA) of the lateral thoracic and lumbar

spine. *Asian Spine Journal*, *5*(3), 139–145. https://doi.org/10.4184/asj.2011.5.3.139
Ek, S., Rizzuto, D., Fratiglioni, L., Johnell, K., Xu, W., & Welmer, A. K. (2018). Risk profiles for injurious falls in people over 60: A population-based cohort study. *Journals of Gerontology - Medical Sciences*, *73*(2), 233–239. https://doi.org/10.1093/gerona/glx115
Elbinoune, I., Amine, B., Shyen, S., Gueddari, S., Abouqal, R., & Hajjaj-Hassouni, N. (2016). Chronic neck pain and anxiety-depression: Prevalence and associated risk factors. *Pan African Medical Journal*, *24*, 1–8. https://doi.org/10.11604/pamj.2016.24.89.8831
Elsayed, G. A., Dupépé, E. B., Erwood, M. S., Davis, M. C., McClugage, S. G., Szerlip, P., … Hadley, M. N. (2019). Education level as a prognostic indicator at 12 months following decompression surgery for symptomatic lumbar spinal stenosis. *Journal of Neurosurgery: Spine*, *30*(1), 60–68. https://doi.org/10.3171/2018.6.SPINE18226
Endo, T., Abe, T., Akai, K., Kijima, T., Takeda, M., Yamasaki, M., … Yano, S. (2019). Height loss but not body composition is related to low back pain in community-dwelling elderlies: Shimane CoHRE study. *BMC Musculoskeletal Disorders*, *20*(1), 1–7. https://doi.org/10.1186/s12891-019-2580-6
Eriksson, E., Somer, S., & Lauri, S. (2001). How relatives adjust after the death of a patient with cancer in hospice. *Cancer Nursing*, *24*(6), 436–445. https://doi.org/10.1097/00002820-200112000-00004
Feldman, C. H., Dong, Y., Katz, J. N., Donnell-Fink, L. A., & Losina, E. (2015). Association between socioeconomic status and pain, function and pain catastrophizing at presentation for total knee arthroplasty. *BMC Musculoskeletal Disorders*, *16*(1), 1–10. https://doi.org/10.1186/s12891-015-0475-8
Ferrari, A., Baraldi, C., Licata, M., & Rustichelli, C. (2018). Polypharmacy among headache patients: A cross-sectional study. *CNS Drugs*, *32*(6), 567–578. https://doi.org/10.1007/s40263-018-0522-8
Ferrario, S. R., Cardillo, V., Vicario, F., Balzarini, E., & Zotti, A. M. (2004). Advanced cancer at home: Caregiving and bereavement. *Palliative Medicine*, *18*(2), 129–136. https://doi.org/10.1191/0269216304pm870oa
Field, A. (2009). *Discovering statistics using SPSS: (and sex and drugs and rock "n" roll)* (Third). SAGE Publications Ltd.
Fillingim, R. B., King, C. K., Ribeiro-dasilva, M. C., Rahim-Williams, B., & Riley III, J. L. (2009). Sex, gender, and pain: A review of recent clinical and experimental findings. *Journal of Pain*, *10*(5), 447–485. https://doi.org/10.1016/j.jpain.2008.12.001
Finlay, K. A., Peacock, S., & Elander, J. (2018). Developing successful social support: An interpretative phenomenological analysis of mechanisms and processes in a chronic pain support group. *Psychology and Health*, *33*(7), 846–871. https://doi.org/10.1080/08870446.2017.1421188
Fitzgerald, P., Lo, C., Li, M., Gagliese, L., Zimmermann, C., & Rodin, G. (2015). The relationship between depression and physical symptom burden in advanced cancer. *BMJ Supportive and Palliative Care*, *5*(4), 381–388. https://doi.org/10.1136/bmjspcare-2012-000380
Fitzpatrick, A. L., Buchanan, C. K., Nahin, R. L., DeKosky, S. T., Atkinson, H. H., Carlson, M. C., & Williamson, J. D. (2007). Associations of gait speed and other measures of physical function with cognition in a healthy cohort of elderly persons. *Journals of Gerontology: Medical Sciences*, *62A*(11), 1244–1251. https://doi.org/10.1093/gerona/62.11.1244
Fowler, S. L., Rasinski, H. M., Geers, A. L., Helfer, S. G., & France, C. R. (2011). Concept

priming and pain: An experimental approach to understanding gender roles in sex-related pain differences. *Journal of Behavioral Medicine*, *34*(2), 139–147. https://doi.org/10.1007/s10865-010-9291-7

Frazier, S. C. (2005). Health outcomes and polypharmacy in elderly individuals: An integrated literature review. *Journal of Gerontological Nursing*, *31*(9), 4–11. https://doi.org/10.3928/0098-9134-20050901-04

Gagliese, L. (2009). Pain and aging: The emergence of a new subfield of pain research. *Journal of Pain*, *10*(4), 343–353. https://doi.org/10.1016/j.jpain.2008.10.013

Gagliese, L., & Farrell, M. J. (2005). The neurobiology of aging, nociception, and pain: An integration of animal and human experimental evidence. In *Progress in Pain Research and Management* (Vol. 35, pp. 25–44). Seattle: IASP Press.

Gagliese, L., & Fillingim, R. B. (2003). Age and sex interactions in the experience of pain. *The International Journal Fo Sex Differences in the Study of Health*, *1*(2), 1–8.

Gagliese, L., Gauthier, L. R., Macpherson, A. K., Jovellanos, M., & Chan, V. W. S. (2008). Correlates of postoperative pain and intravenous patient-controlled analgesia use in younger and older surgical patients. *Pain Medicine*, *9*(3), 299–314. https://doi.org/10.1111/j.1526-4637.2008.00426.x

Gagliese, L., Gauthier, L. R., Narain, N., & Freedman, T. (2018, December 20). Pain, aging and dementia: Towards a biopsychosocial model. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, Vol. 87, pp. 207–215. https://doi.org/10.1016/j.pnpbp.2017.09.022

Gagliese, L., Gauthier, L. R., & Rodin, G. (2007). Cancer pain and depression: A systematic review of age-related patterns. *Pain Research and Management*, *12*(3), 205–211. https://doi.org/10.1155/2007/150126

Gagliese, L., Jovellanos, M., Zimmermann, C., Shobbrook, C., Warr, D., & Rodin, G. (2009). Age-related patterns in adaptation to cancer pain: A mixed-methods study. *Pain Medicine*, *10*(6), 1050–1061. https://doi.org/10.1111/j.1526-4637.2009.00649.x

Gagliese, L., & Katz, J. (2003). Age differences in postoperative pain are scale dependent: A comparison of measures of pain intensity and quality in younger and older surgical patients. *Pain*, *103*(1–2), 11–20. https://doi.org/10.1016/S0304-3959(02)00327-5

Gagliese, L., Katz, L., Gibson, M., Clark, A. J., Lussier, D., Gordon, A., & Salter, M. W. (2012). A brief educational intervention about pain and aging for older members of the community and health care workers. *Journal of Pain*, *13*(9), 849–856. https://doi.org/10.1016/j.jpain.2012.05.009

Gagliese, L., & Melzack, R. (1997). Age differences in the quality of chronic pain: A preliminary study. *Pain Research and Management*, *2*(3), 157–162.

Gagliese, L., & Melzack, R. (2003). Age-related differences in the qualities but not the intensity of chronic pain. *Pain*, *104*(3), 597–608. https://doi.org/10.1016/S0304-3959(03)00117-9

Gagliese, L., Weizblit, N., Ellis, W., & Chan, V. (2005). The measurement of postoperative pain: A comparison of intensity scales in younger and older surgical patients. *Pain*, *117*(3), 412–420. https://doi.org/10.1016/j.pain.2005.07.004

Galvez-Sánchez, C. M., Ladrón de Guevara, C. M., Montoro, C. I., Fernández-Serrano, M. J., Duschek, S., & Reyes del Paso, G. (2018). Cognitive deficits in fibromyalgia syndrome are associated with pain responses to low intensity pressure stimulation. *PLoS ONE*, *13*(8), 1–12. https://doi.org/10.1371/journal.pone.0201488

Garcia-Pinillos, F., Cozar-Barba, M., Munoz-Jimenez, M., Soto-Hermoso, V., & Latorre-Roman, P. (2016). Gait speed in older people: An easy test for detecting cognitive impairment,

functional independence, and health state. *Psychogeriatrics*, *16*(3), 165–171. https://doi.org/10.1111/psyg.12133
Garin, N., Koyanagi, A., Chatterji, S., Tyrovolas, S., Olaya, B., Leonardi, M., … Haro, J. M. (2016). Global multimorbidity patterns: A cross-sectional, population-based, multi-country study. *Journals of Gerontology: Medical Sciences*, *71*(2), 205–214. https://doi.org/10.1093/gerona/glv128
Gatchel, R. J., Bo Peng, Y., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin*, *133*(4), 581–624. https://doi.org/10.1037/0033-2909.133.4.581
Gatchel, R. J., Howard, K. J., & Kishino, N. D. (2010). The biopsychosocial approach to pain management. *PPM Communications*, 1–28.
Gauthier, L. R., Dworkin, R. H., Warr, D., Riddell, R. P., Lawrence Librach, S., Moore, M., … Gagliese, L. (2018). Age-related patterns in cancer pain and its psychosocial impact: Investigating the role of variability in physical and mental health quality of life. *Pain Medicine*, *19*, 658–676. https://doi.org/10.1093/pm/pnx002
Gauthier, L. R., & Gagliese, L. (2011). Assessment of pain in older persons. In *Handbook of pain assessment* (3rd ed., pp. 242–259). New York, NY: The Guilford Press.
Gauthier, L. R., Rodin, G., Zimmermann, C., Warr, D., Moore, M., Shepherd, F., & Gagliese, L. (2009). Acceptance of pain : A study in patients with advanced cancer. *Pain*, *143*(1–2), 147–154. https://doi.org/10.1016/j.pain.2009.02.009
Geneen, L. J., Moore, R. A., Clarke, C., Martin, D., Colvin, L. A., & Smith, B. H. (2017). Physical activity and exercise for chronic pain in adults: An overview of Cochrane Reviews. *Cochrane Database of Systematic Reviews*, (4), 1–75. https://doi.org/10.1002/14651858.CD011279.pub3
Geyer, S., Hemström, Ö., Peter, R., & Vågerö, D. (2006). Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. *Journal of Epidemiology and Community Health*, *60*(9), 804–810. https://doi.org/10.1136/jech.2005.041319
Gibson, S. J., & Lussier, D. (2012). Prevalence and relevance of pain in older persons. *Pain Medicine*, *13*(Suppl. 2), S23–S26. https://doi.org/10.1111/j.1526-4637.2012.01349.x
Gilbar, O., & Ben-Zur, H. (2002). Bereavement of spouse caregivers of cancer patients. *American Journal of Orthopsychiatry*, *72*(3), 422–432. https://doi.org/10.1037//0002-9432.72.3.422
Gilbar, O., & Dagan, A. (1995). Coping with loss: Differences between widows and widowers of deceased cancer patients. *OMEGA - Journal of Death and Dying*, *31*(3), 207–220. https://doi.org/10.2190/wk8u-l30c-dkqr-0w6v
Giummarra, M. J., Casey, S. L., Devlin, A., Ioannou, L. J., Gibson, S. J., Georgiou-Karistianis, N., … Ponsford, J. (2017). Co-occurrence of posttraumatic stress symptoms, pain, and disability 12 months after traumatic injury. *Pain Reports*, *2*(5), 1–12. https://doi.org/10.1097/PR9.0000000000000622
Glass, N. A., Torner, J. C., Frey Law, L. A., Wang, K., Yang, T., Nevitt, M. C., … Segal, N. A. (2013). The relationship between quadriceps muscle weakness and worsening of knee pain in the MOST cohort: A 5-year longitudinal study. *Osteoarthritis and Cartilage*, *21*(9), 1154–1159. https://doi.org/10.1016/j.joca.2013.05.016
Glickman, S. G., Marn, C. S., Supiano, M. A., & Dengel, D. R. (2004). Validity and reliability of dual-energy X-ray absorptiometry for the assessment of abdominal adiposity. *Journal of*

Applied Physiology, *97*(2), 509–514. https://doi.org/10.1152/japplphysiol.01234.2003
Gnjidic, D., Hilmer, S. N., Blyth, F. M., Naganathan, V., Waite, L., Seibel, M. J., … Le Couteur, D. G. (2012). Polypharmacy cutoff and outcomes: Five or more medicines were used to identify community-dwelling older men at risk of different adverse outcomes. *Journal of Clinical Epidemiology*, *65*(9), 989–995. https://doi.org/10.1016/j.jclinepi.2012.02.018
Gosling, S. D., Rentfrow, P. J., & Swann Jr, W. B. (2003). A very brief measure of the big-five personality domains. *Journal of Research in Personality*, *37*(6), 504–528. https://doi.org/10.1016/S0092-6566(03)00046-1
Green, C. R., Baker, T. A., Smith, E. M., & Sato, Y. (2003). The effect of race in older adults presenting for chronic pain management: A comparative study of black and white Americans. *Journal of Pain*, *4*(2), 82–90. https://doi.org/10.1054/jpai.2003.8
Green, C. R., & Hart-Johnson, T. (2010). Cancer pain: An age-based analysis. *Pain Medicine*, *11*, 1525–1536.
Gulbech Ording, A., & Toft Sørensen, H. (2013). Concepts of comorbidities, multiple morbidities, complications, and their clinical epidemiologic analogs. *Clinical Epidemiology*, *5*(1), 199–203. https://doi.org/10.2147/CLEP.S45305
Hadjistavropoulos, T., Craig, K. D., Duck, S., Cano, A., Jackson, P. L., Mogil, J. S., … Fitzgerald, T. D. (2011). A biopsychosocial formulation of pain communication. *Psychological Bulletin*, *137*(6), 910–939. https://doi.org/10.1037/a0023876
Hales, S., Chiu, A., Husain, A., Braun, M., Rydall, A., Gagliese, L., … Rodin, G. (2014). The quality of dying and death in cancer and its relationship to palliative care and place of death. *Journal of Pain and Symptom Management*, *48*(5), 839–851. https://doi.org/10.1016/j.jpainsymman.2013.12.240
Hales, S., Gagliese, L., Nissim, R., Zimmermann, C., & Rodin, G. (2012). Understanding bereaved caregiver evaluations of the quality of dying and death: An application of cognitive interviewing methodology to the quality of dying and death questionnaire. *Journal of Pain and Symptom Management*, *43*(2), 195–204. https://doi.org/10.1016/j.jpainsymman.2011.03.018
Hamacher, D., Rudolf, M., Lohmann, C., & Schega, L. (2016). Pain severity reduction in subjects with knee osteoarthritis decreases motor-cognitive dual-task costs. *Clinical Biomechanics*, *39*, 62–64. https://doi.org/10.1016/j.clinbiomech.2016.09.009
Han, H. S., Lee, J. Y., Kang, S. B., & Chang, C. B. (2016). The relationship between the presence of depressive symptoms and the severity of self-reported knee pain in the middle aged and elderly. *Knee Surgery, Sports Traumatology, Arthroscopy*, *24*(5), 1634–1642. https://doi.org/10.1007/s00167-015-3628-2
Hand, C., Law, M., McColl, M. A., Hanna, S., & Elliott, S. (2014). An examination of social support influences on participation for older adults with chronic health conditions. *Disability and Rehabilitation*, *36*(17), 1439–1444. https://doi.org/10.3109/09638288.2013.845258
Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: The Guilford Press.
Health Canada. (2019). *Chronic pain in Canada: Laying a foundation for action: A report by the Canadian pain task force, June 2019.* Retrieved from http://epe.lac-bac.gc.ca/100/201/301/weekly_acquisitions_list-ef/2019/19-35/publications.gc.ca/collections/collection_2019/sc-hc/H134-5-2019-eng.pdf%0Ahttps://www.canada.ca/content/dam/hc-sc/documents/corporate/about-health-

canada/public-engagement/extern
Heerema, E., & Chaves, C. (2020). The verbal fluency test for dementia screening. Retrieved September 1, 2021, from https://www.verywellhealth.com/verbal-fluency-test-and-how-it-screens-for-dementia-98629
Held, F. P., Blyth, F., Gnjidic, D., Hirani, V., Naganathan, V., Waite, L. M., … Le Couteur, D. G. (2016). Association rules analysis of comorbidity and multimorbidity: The concord health and aging in men project. *Journals of Gerontology: Medical Sciences*, *71*(5), 625–631. https://doi.org/10.1093/gerona/glv181
Hendry, M., Williams, N. H., Markland, D., Wilkinson, C., & Maddison, P. (2006). Why should we exercise when our knees hurt? A qualitative study of primary care patients with osteoarthritis of the knee. *Family Practice*, *23*(5), 558–567. https://doi.org/10.1093/fampra/cml022
Herbolsheimer, F., Schaap, L. A., Edwards, M. H., Maggi, S., Otero, Á., Timmermans, E. J., … Peter, R. (2016). Physical activity patterns among older adults with and without knee osteoarthritis in six European countries. *Arthritis Care and Research*, *68*(2), 228–236. https://doi.org/10.1002/acr.22669
Hermsen, L. A. H., Hoogendijk, E. O., van der Wouden, J. C., Smalbrugge, M., Leone, S. S., van der Horst, H. E., & Dekker, J. (2018). Self-perceived care needs in older adults with joint pain and comorbidity. *Aging Clinical and Experimental Research*, *30*(5), 449–455. https://doi.org/10.1007/s40520-017-0795-7
Heyer, E. J., Sharma, R., Winfree, C. J., Mocco, J., Donald, J., Mccormick, P. A., … Conolly Jr, E. S. (2000). Severe pain confounds neuropsychological test performance. *Journal of Clinical and Experimental Neuropsychology*, *22*(5), 633–639. https://doi.org/10.1076/1380-3395(200010)22:5;1-9;FT633
Hicks, C., Levinger, P., Menant, J. C., Lord, S. R., Sachdev, P. S., Brodaty, H., & Sturnieks, D. L. (2020). Reduced strength, poor balance and concern about falls mediate the relationship between knee pain and fall risk in older people. *BMC Geriatrics*, *20*(1), 1–8. https://doi.org/10.1186/s12877-020-1487-2
Hicks, G. E., Sions, J. M., & Velasco, T. O. (2018). Hip symptoms, physical performance, and health status in older adults with chronic low back pain: A preliminary investigation. *Archives of Physical Medicine and Rehabilitation*, *99*(7), 1273–1278. https://doi.org/10.1016/j.apmr.2017.10.006
Hill, C. L., Gill, T., Taylor, A. W., Daly, A., Grande, E. D., & Adams, R. J. (2007). Psychological factors and quality of life in arthritis: A population-based study. *Clinical Rheumatology*, *26*(7), 1049–1054. https://doi.org/10.1007/s10067-006-0439-3
Hirano, K., Imagama, S., Hasegawa, Y., Ito, Z., Muramoto, A., & Ishiguro, N. (2014). Impact of low back pain, knee pain, and timed up-and-go test on quality of life in community-living people. *Journal of Orthopaedic Science*, *19*(1), 164–171. https://doi.org/10.1007/s00776-013-0476-0
Horgas, A. L. (2017). Pain management in older adults. *Nursing Clinics of North America*, *52*(4), e1–e7. https://doi.org/10.1016/j.cnur.2017.08.001
Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression* (Second). Hoboken, NJ: John Wiley & Sons Inc.
Huang, E. R., Jones, K. D., Bennett, R. M., Nagayama Hall, G. C., & Lyons, K. S. (2018). The role of spousal relationships in fibromyalgia patients' quality of life. *Psychology, Health and Medicine*, *23*(8), 987–995. https://doi.org/10.1080/13548506.2018.1444183

Hussain, S. M., Urquhart, D. M., Wang, Y., Shaw, J. E., Magliano, D. J., Wluka, A. E., & Cicuttini, F. M. (2017). Fat mass and fat distribution are associated with low back pain intensity and disability: Results from a cohort study. *Arthritis Research and Therapy*, *19*(1), 1–10. https://doi.org/10.1186/s13075-017-1242-z

IBM. (2019). Comparing column proportions. Retrieved October 9, 2020, from https://www.ibm.com/docs/en/spss-statistics/26.0.0?topic=statistics-comparing-column-proportions

Iyer, A. S., Wells, J. M., Bhatt, S. P., Kirkpatrick, D. P., Sawyer, P., Brown, C. J., … Dransfield, M. T. (2018). Life-space mobility and clinical outcomes in COPD. *International Journal of COPD*, *13*, 2731–2738. https://doi.org/10.2147/COPD.S170887

Jackson, C. A., Jones, M., Tooth, L., Mishra, G. D., Byles, J., & Dobson, A. (2015). Multimorbidity patterns are differentially associated with functional ability and decline in a longitudinal cohort of older women. *Age and Ageing*, *44*(5), 810–816. https://doi.org/10.1093/ageing/afv095

Jacobsen, H. B., Stubhaug, A., Schirmer, H., Inge Landrø, N., Wilsgaard, T., Mathiesen, E., & Nielsen, C. S. (2019). Neuropsychological functions of verbal recall and psychomotor speed significantly affect pain tolerance. *European Journal of Pain (United Kingdom)*, *23*(9), 1608–1618. https://doi.org/10.1002/ejp.1437

James, B. D., Boyle, P. A., Buchman, A. S., Barnes, L. L., & Bennett, D. A. (2011). Life space and risk of Alzheimer disease, mild cognitive impairment, and cognitive decline in old age. *American Journal of Geriatric Psychiatry*, *19*(11), 961–969. https://doi.org/10.1097/JGP.0b013e318211c219

Janevic, M. R., McLaughlin, S. J., Heapy, A. A., Thacker, C., & Piette, J. D. (2017). Racial and socioeconomic disparities in disabling chronic pain: Findings from the health and retirment study. *The Journal of Pain*, *18*(12), 1459–1467. https://doi.org/10.1016/j.jpain.2017.07.005

John, A. F. (2016). *Age-related differences in accuracy of retrospective pain reporting*. Cornell University.

John Hopkins Medicine. (n.d.). Peripheral vascular disease. Retrieved January 29, 2021, from https://www.hopkinsmedicine.org/health/conditions-and-diseases/peripheral-vascular-disease

Johnson, J. K., Lui, L. Y., & Yaffe, K. (2007). Executive function, more than global cognition, predicts functional decline and mortality in elderly women. *Journal of Gerontology: Medical Sciences*, *62A*(10), 1134–1141. https://doi.org/10.1093/gerona/62.10.1134

Johnson, J., Rodriguez, M. A., & Al Snih, S. (2020). Life-space mobility in the elderly: Current perspectives. *Clinical Interventions in Aging*, *15*, 1665–1674. https://doi.org/10.2147/CIA.S196944

Jonasson, J. M., Hauksdóttir, A., Valdimarsdóttir, U., Fürst, C. J., Onelöv, E., & Steineck, G. (2009). Unrelieved symptoms of female cancer patients during their last months of life and long-term psychological morbidity in their widowers: A nationwide population-based study. *European Journal of Cancer*, *45*(10), 1839–1845. https://doi.org/10.1016/j.ejca.2009.02.008

Kaplan, D. P., & Berkman, B. J. (2021). Older adults living alone. Retrieved November 29, 2021, from Merck Manual Professional Version website: https://www.merckmanuals.com/en-ca/professional/geriatrics/social-issues-in-older-adults/older-adults-living-alone

Karayannis, N. V., Baumann, I., Sturgeon, J. A., Melloh, M., & Mackey, S. C. (2019). The

impact of social isolation on pain interference: A longitudinal study. *Annals of Behavioral Medicine*, *53*(1), 65–74. https://doi.org/10.1093/abm/kay017

Karp, J. F., Reynolds III, C. F., Butters, M., Dew, M. A., Mazumdar, S., Begley, A. E., … Weiner, D. K. (2006). Correlates of neuropsychological impairment in older adult pain clinic patients. *Pain Medicine*, *7*(5), 444–452. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3624763/pdf/nihms412728.pdf

Karran, E. L., Grant, A. R., & Moseley, G. L. (2020). Low back pain and the social determinants of health: A systematic review and narrative synthesis. *Pain*, *161*(11), 2476–2493. https://doi.org/10.1097/j.pain.0000000000001944

Karssemeijer, E. G. A., Aaronson, J. A., Bossers, W. J. R., Donders, R., Olde Rikkert, M. G. M., & Kessels, R. P. C. (2019). The quest for synergy between physical exercise and cognitive stimulation via exergaming in people with dementia: A randomized controlled trial. *Alzheimer's Research & Therapy*, *11*(3). https://doi.org/10.1186/s13195-018-0454-z

Katz, S., & Feldstein, R. (2008). Inflammatory bowel disease of the elderly: A wake-up call. *Gastroenterology & Hepatology*, *4*(5), 337–347.

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S.-L. T., … Zaslavsky, A. M. (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine*, *32*(6), 959–976. https://doi.org/10.1017\S0033291702006074

Kessler, R. C., Barker, P. R., Colpe, L. J., Epstein, J. F., Gfroerer, J. C., Hiripi, E., … Zaslavsky, A. M. (2003). Screening for serious mental illness in the general population. *Archive of General Psychiatry*, *60*, 184–189.

Kessler, R. C., Foster, C., Webster, P. S., & House, J. S. (1992). The relationship between age and depressive symptoms in two national surveys. *Psychology and Aging*, *7*(1), 119–126. https://doi.org/10.1037/0882-7974.7.1.119

Khezrian, M., McNeil, C. J., Myint, P. K., & Murray, A. D. (2019). The association between polypharmacy and late life deficits in cognitive, physical and emotional capability: A cohort study. *International Journal of Clinical Pharmacy*, *41*(1), 251–257. https://doi.org/10.1007/s11096-018-0761-2

Kim, H.-Y. (2013). Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry & Endodontics*, *38*(1), 52. https://doi.org/10.5395/rde.2013.38.1.52

Kim, H. J., Kim, S. C., Kang, K. T., Chang, B. S., Lee, C. K., & Yeom, J. S. (2014). Influence of educational attainment on pain intensity and disability in patients with lumbar spinal stenosis: Mediation effect of pain catastrophizing. *Spine*, *39*(10), E637-644. https://doi.org/10.1097/BRS.0000000000000267

King, L. K., Kendzerska, T., Waugh, E. J., & Hawker, G. A. (2018). The impact of osteoarthritis on difficulty walking: A population-based study. *Arthritis Care and Research*, *70*(1), 71–79. https://doi.org/10.1002/acr.23250

Kitayuguchi, J., Kamada, M., Inoue, S., Kamioka, H., Abe, T., Okada, S., & Mutoh, Y. (2017). Association of low back and knee pain with falls in Japanese community-dwelling older adults: A 3-year prospective cohort study. *Geriatrics and Gerontology International*, *17*(6), 875–884. https://doi.org/10.1111/ggi.12799

Krok, J. L., & Baker, T. A. (2014). The influence of personality on reported pain and self-efficacy for pain management in older cancer patients. *Journal of Health Psychology*, *19*(10), 1261–1270. https://doi.org/10.1177/1359105313488976

Kuh, D., Bassey, E. J., Butterworth, S., Hardy, R., & Wadsworth, M. E. J. (2005). Grip strength, postural control, and functional leg power in a representative cohort of British men and women: Associations with physical activity, health status, and socioeconomic conditions. *Journal of Gerontology: Medical Sciences*, *60A*(2), 224–231.

Kung, F., Gibson, S. J., & Helme, R. D. (2000). A community-based program that provides free choice of intervention for older people with chronic pain. *Journal of Pain*, *1*(4), 293–308. https://doi.org/10.1054/jpai.2000.16178

Kuo, Y. L., Huang, K. Y., Chiang, P. T., Lee, P. Y., & Tsai, Y. J. (2015). Steadiness of spinal regions during single-leg standing in older adults with and without chronic low back pain. *PLoS ONE*, *10*(5), 1–12. https://doi.org/10.1371/journal.pone.0128318

Kurita, G. P., De Mattos Pimenta, C. A., Braga, P. E., Frich, L., Jørgensen, M. M., Nielsen, P. R., … Sjøgren, P. (2012). Cognitive function in patients with chronic pain treated with opioids: Characteristics and associated factors. *Acta Anaesthesiologica Scandinavica*, *56*(10), 1257–1266. https://doi.org/10.1111/j.1399-6576.2012.02760.x

Laerd Statistics. (2018). Ordinal regression using SPSS statistics. Retrieved October 9, 2020, from https://statistics.laerd.com/spss-tutorials/ordinal-regression-using-spss-statistics.php#:~:text=For example%2C you could use,age%22 and %22income%22.

Langford, D. J., Theodore, B. R., Balsiger, D., Tran, C., Doorenbos, A. Z., Tauben, D. J., & Sullivan, M. D. (2018). Number and type of post-traumatic stress disorder (PTSD) symptom domains are associated with patient-reported outcomes in patients with chronic pain. *Journal of Pain*, *19*(5), 506–514. https://doi.org/10.1016/j.jpain.2017.12.262

Larsson, C., Hansson, E. E., Sundquist, K., & Jakobsson, U. (2017). Chronic pain in older adults: prevalence, incidence, and risk factors. *Scandinavian Journal of Rheumatology*, *46*(4), 317–325. https://doi.org/10.1080/03009742.2016.1218543

Lee, J. E., Kahana, B., & Kahana, E. (2016). Social support and cognitive functioning as resources for elderly persons with chronic arthritis pain. *Aging and Mental Health*, *20*(4), 370–379. https://doi.org/10.1080/13607863.2015.1013920

Lee, J., Jang, S. N., & Cho, S. I. (2018). The trajectories of the number of pain sites and their associated factors in older adults: Results from the Korean Longitudinal Study of Ageing. *Gerontology*, *64*(6), 532–540. https://doi.org/10.1159/000490051

Lee, S. W., Patel, J., Napatkamon, A., Aguilla, E., Hill, J., & Bartels, M. N. (2020). Effect of comorbid chronic low back pain on patient-reported outcome and gait parameters in patients with symptomatic knee osteoarthritis. *American Journal of Physical Medicine and Rehabilitation*, *99*(12), 1184–1188. https://doi.org/10.1097/PHM.0000000000001492

Leong, I. Y., Farrell, M. J., Helme, R. D., & Gibson, S. J. (2007). The relationship between medical comorbidity and self-rated pain, mood disturbance, and function in older people with chronic pain. *Journals of Gerontology: Medical Sciences*, *62A*(5), 550–555. https://doi.org/10.1093/gerona/62.5.550

Li, L., Liang, J., Toler, A., & Gu, S. (2005). Widowhood and depressive symptoms among older Chinese: Do gender and source of support make a difference? *Social Science & Medicine*, *60*(3), 637–647. https://doi.org/10.1016/j.socscimed.2004.06.014

Lo, C., Zimmermann, C., Rydall, A., Walsh, A., Jones, J. M., Moore, M. J., … Rodin, G. (2010). Longitudinal study of depressive symptoms in patients with metastatic gastrointestinal and lung cancer. *Journal of Clinical Oncology*, *28*(18), 3084–3089. https://doi.org/10.1200/JCO.2009.26.9712

Lo, G. H., Mcalindon, T. E., Hawker, G. A., Driban, J. B., Price, L. L., Song, J., … Dunlop, D.

D. (2015). Symptom assessment in knee osteoarthritis needs to account for physical activity level. *Arthritis & Rheumatology*, *67*(11), 2897–2904. https://doi.org/10.1002/art.39271
Loftis, C. (2016). Mental flexibility. In *Encyclopedia of Clinical Neuropsychology*. https://doi.org/10.1007/978-3-319-56782-2
Loke, S. C., Abdullah, S. S., Chai, S. T., Hamid, T. A., & Yahaya, N. (2011). Assessment of factors influencing morale in the elderly. *PLoS ONE*, *6*(1), 1–8. https://doi.org/10.1371/journal.pone.0016490
Longe, J. L., & Gale, T. (2006). *The Gale Encyclopedia of Nursing & Allied Health* (2nd Editio; J. . Longe, Ed.). Detroit, Mich: Thomson Gale.
MacDonald, P. L., & Gardner, R. C. (2000). Type I error rate comparisons of post hoc procedures for I J chi-square tables. *Educational and Psychological Measurement*, *60*(5), 735–754. https://doi.org/10.1177/00131640021970871
Mackey, D. C., Cauley, J. A., Barrett-Connor, E., Schousboe, J. T., Cawthon, P. M., & Cummings, S. R. (2014). Life-space mobility and mortality in older men: A prospective cohort study. *Journal of the American Geriatrics Society*, *62*(7), 1288–1296. https://doi.org/10.1111/jgs.12892
Mackey, D. C., Lui, L.-Y., Cawthon, P. M., Ensrud, K., Yaffe, K., & Cummings, S. R. (2016). Life-space mobility and mortality in older women: Prospective results from the study of osteoporotic fractures. *Journal of the American Geriatrics Society*, *64*(11), 2226–2234. https://doi.org/10.1111/jgs.14474
Mackichan, F., Adamson, J., & Gooberman-Hill, R. (2013). "Living within your limits": Activity restriction in older people experiencing chronic pain. *Age and Ageing*, *42*(6), 702–708. https://doi.org/10.1093/ageing/aft119
Mah, K., Tran, K. T., Gauthier, L. R., Rodin, G., Zimmermann, C., Warr, D., … Gagliese, L. (2018). Do correlates of pain-related stoicism and cautiosness differ in younger and older people with advanced cancer? *The Journal of Pain*, *19*(3), 301–316. https://doi.org/10.1016/j.jpain.2017.11.002
Maldonato, N. M., Sperandeo, R., Caiazzo, G., Cioffi, V., Cozzolino, P., De Santo, R. M., … Scognamiglio, C. (2018). Keep moving without hurting: The interaction between physical activity and pain in determining cognitive function at the population level. *PLoS ONE*, *13*(6). https://doi.org/10.1371/journal.pone.0197745
Marshall, L. M., Litwack-Harrison, S., Cawthon, P. M., Kado, D. M., Deyo, R. A., Makris, U. E., … Nevitt, M. C. (2016). A prospective study of back pain and risk of falls among older community-dwelling women. *Journals of Gerontology - Medical Sciences*, *71*(9), 1177–1183. https://doi.org/10.1093/gerona/glv225
Marshall, L. M., Litwack-Harrison, S., Makris, U. E., Kado, D. M., Cawthon, P. M., Deyo, R. A., … Nevitt, M. C. (2017). A prospective study of back pain and risk of falls among older community-dwelling men. *Journals of Gerontology: Me*, *72*(9), 1264–1269. https://doi.org/10.1093/gerona/glw227
Masiliūnas, R., Vitkutė, D., Stankevičius, E., Matijošaitis, V., & Petrikonis, K. (2017). Response inhibition, set shifting, and complex executive function in patients with chronic lower back pain. *Medicina*, *53*(1), 26–33. https://doi.org/10.1016/j.medici.2016.12.001
Mattos Feijó, L., Tarman, G. Z., Fontaine, C., Harrison, R., Johnstone, T., & Salomons, T. (2018). Sex-specific effects of gender identification on pain study recruitment. *Journal of Pain*, *19*(2), 178–185. https://doi.org/10.1016/j.jpain.2017.09.009
McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its

applications. *Journal of Personality*, *60*(2), 175–215. https://doi.org/10.1111/j.1467-6494.1992.tb00970.x
Mcphee, J. S., French, D. P., Jackson, D., Nazroo, J., Pendleton, N., & Degens, H. (2016). Physical activity in older age: Perspectives for healthy ageing and frailty. *Biogerontology*, *17*(3), 567–580. https://doi.org/10.1007/s10522-016-9641-0
McWilliams, L. A., Cox, B. J., & Enns, M. W. (2003). Mood and anxiety disorders associated with chronic pain: An examination in a nationally representative sample. *Pain*, *106*(1–2), 127–133. https://doi.org/10.1016/S0304-3959(03)00301-4
Melzack, R., & Casey, K. L. (1968). Sensory, motivational, and central control determinants of pain. In *The Skin Senses* (pp. 423–439).
Melzack, R., & Katz, J. (2013). Pain. *Wiley Interdisciplinary Reviews: Cognitive Science*, *4*(1), 1–15. https://doi.org/10.1002/wcs.1201
Melzack, R., & Wall, P. D. (1965). Pain mechanisms: A new theory. *Science*, *150*(3699), 971–979. https://doi.org/10.1126/science.150.3699.971
Melzack, R., & Wall, P. D. (1996). *Challenge of pain: A modern medical classic* (2nd editio). Penguin Group.
Merck Manual. (n.d.). Merck manual professional version. Retrieved February 10, 2021, from https://www.merckmanuals.com/professional
Miaskowski, C., Blyth, F., Nicosia, F., Haan, M., Keefe, F., Smith, A., & Ritchie, C. (2020). A biopsychosocial model of chronic pain for older adults. *Pain Medicine*, *21*(9), 1793–1805. https://doi.org/10.1093/PM/PNZ329
Mittendorfer-Rutz, E., & Dorner, T. E. (2018). Socio-economic factors associated with the 1-year prevalence of severe pain and pain-related sickness absence in the Austrian population. *Wiener Klinische Wochenschrift: The Central European Journal of Medicine*, *130*(1–2), 4–13. https://doi.org/10.1007/s00508-017-1222-y
Mogil, J. S. (2012). Sex differences in pain and pain inhibition: Multiple explanations of a controversial phenomenon. *Nature Reviews Neuroscience*, *13*(12), 859–866. Retrieved from http://dx.doi.org/10.1038/nrn3360
Moley, P. J. (2020). Evaluation of neck and back pain. Retrieved January 25, 2021, from Merck Manual Professional Version website: https://www.merckmanuals.com/professional/musculoskeletal-and-connective-tissue-disorders/neck-and-back-pain/evaluation-of-neck-and-back-pain?query=back pain
Morone, N. E., Abebe, K. Z., Morrow, L. A., & Weiner, D. K. (2014). Pain and decreased cognitive function negatively impact physical functioning in older adults with knee osteoarthritis. *Pain Medicine (United States)*, *15*(9), 1481–1487. https://doi.org/10.1111/pme.12483
Motl, R. W., McAuley, E., Snook, E. M., & Gliottoni, R. C. (2009). Physical activity and quality of life in multiple sclerosis: Intermediary roles of disability, fatigue, mood, pain, self-efficacy and social support. *Psychology, Health and Medicine*, *14*(1), 111–124. https://doi.org/10.1080/13548500802241902
Munch, T., Harrison, S. L., Barrett-Connor, E., Lane, N. E., Nevitt, M. C., Schousboe, J. T., … Cawthon, P. M. (2015). Pain and falls and fractures in community-dwelling older men. *Age and Ageing*, *44*(6), 973–979. https://doi.org/10.1093/ageing/afv125
Murata, S., Sawa, R., Nakatsu, N., Saito, T., Sugimoto, T., Nakamura, R., … Ono, R. (2017). Association between chronic musculoskeletal pain and executive function in community-dwelling older adults. *European Journal of Pain (United Kingdom)*, *21*(10), 1717–1722.

https://doi.org/10.1002/ejp.1083
Murman, D. L. (2015). The impact of age on cognition. *Seminars in Hearing*, *36*(1), 111–121. https://doi.org/10.1055/s-0035-1555115
Murphy, S. L., Schepens Niemiec, S. L., Lyden, A. K., & Kratz, A. L. (2016). Pain, fatigue, and physical activity in osteoarthritis: The moderating effects of pain- and fatigue-related activity interference. *Archives of Physical Medicine and Rehabilitation*, *97*(9 Suppl), S201–S209. https://doi.org/10.1016/j.apmr.2015.05.025
Nawai, A., Leveille, S. G., Shmerling, R. H., van der Leeuw, G., & Bean, J. F. (2017). Pain severity and pharmacologic pain management among community-living older adults: The MOBILIZE Boston study. *Aging Clinical and Experimental Research*, *29*(6), 1139–1147. https://doi.org/10.1007/s40520-016-0700-9
Neogi, T., Nevitt, M. C., Yang, M., Curtis, J. R., Torner, J., & Felson, D. T. (2010). Consistency of knee pain: Correlates and association with function. *Osteoarthritis and Cartilage*, *18*(10), 1250–1255. https://doi.org/10.1016/j.joca.2010.08.001
NERI. (1991). *Physical Activity Scale for the Elderly: Administration and scoring instruction manual*.
Newman, A. K., Kapoor, S., & Thorn, B. E. (2018). Health care utilization for chronic pain in low-income settings. *Pain Medicine*, *19*(12), 2387–2397. https://doi.org/10.1093/pm/pny119
Noguchi, N., Blyth, F. M., Waite, L. M., Naganathan, V., Cumming, R. G., Handelsman, D. J., … Le Couteur, D. G. (2016). Prevalence of the geriatric syndromes and frailty in older men living in the community: The Concord health and ageing in men project. *Australasian Journal on Ageing*, *35*(4), 255–261. https://doi.org/10.1111/ajag.12310
Norheim, K. L., Samani, A., Bønløkke, J. H., Omland, Ø., & Madeleine, P. (2020). On the role of ageing and musculoskeletal pain on dynamic balance in manual workers. *Journal of Electromyography and Kinesiology*, *50*. https://doi.org/10.1016/j.jelekin.2019.102374
O'Reilly, S. C., Muir, K. R., & Doherty, M. (1999). Effectiveness of home exercise on pain and disability from osteoarthritis of the knee: A randomised controlled trial. *Annals of the Rheumatic Diseases*, *58*(1), 15–19. https://doi.org/10.1136/ard.58.1.15
Ogawa, E. F., Shi, L., Bean, J. F., Hausdorff, J. M., Dong, Z., Manor, B., … Leveille, S. G. (2019). Chronic pain characteristics and gait in older adults: The MOBILIZE Boston study II. *Archives of Physical Medicine and Rehabilitation*, *101*(3), 418–425. https://doi.org/10.1016/j.apmr.2019.09.010
Oliveira, D. S., Mendonça, L. V. F., Sampaio, R. S. M., Dias De Castro-Lopes, J. M. P., & De Azevedo, L. F. R. (2018). The impact of anxiety and depression on the outcomes of chronic low back pain multidisciplinary pain management-a multicenter prospective cohort study in pain clinics with one-year follow-up. *Pain Medicine*, *20*(4), 736–746. https://doi.org/10.1093/pm/pny128
Olson, P. R., Lurie, J. D., Frymoyer, J., Walsh, T., Zhao, W., Morgan, T. S., … Weinstein, J. N. (2011). Lumbar disc herniation in the spine patient outcomes research trial: Does educational attainment impact outcome? *Spine*, *36*(26), 2324–2332. https://doi.org/10.1097/BRS.0b013e31820bfb9a
Oosterman, J. M., Derksen, L. C., Van Wijck, A. . M., Kessels, R. P. C., & Veldhuijzen, D. S. (2012). Executive and attentional functions in chronic pain: Does performance decrease with increasing task load? *Pain Research and Management*, *17*(3), 159–165. https://doi.org/10.1155/2012/962786

Oosterman, J. M., Derksen, L. C., Van Wijck, A. J. M., Veldhuijzen, D. S., & Kessels, R. P. C. (2011). Memory functions in chronic pain: Examining contributions of attention and age to test performance. *Clinical Journal of Pain*, *27*(1), 70–75. https://doi.org/10.1097/AJP.0b013e3181f15cf5

Oosterman, J. M., Gibson, S. J., Pulles, W. L. J. A., & Veldhuijzen, D. S. (2013). On the moderating role of age in the relationship between pain and cognition. *European Journal of Pain (United Kingdom)*, *17*(5), 735–741. https://doi.org/10.1002/j.1532-2149.2012.00235.x

Orhurhu, V., Olusunmade, M., Akinola, Y., Urits, I., Orhurhu, M. S., Viswanath, O., … Gill, J. (2019). Depression trends in patients with chronic pain: An analysis of the nationwide inpatient sample. *Pain Physician*, *22*(5), E487–E494.

Outcalt, S. D., Kroenke, K., Krebs, E. E., Chumbler, N. R., Wu, J., Yu, Z., & Bair, M. J. (2015). Chronic pain and comorbid mental health conditions: Independent associations of posttraumatic stress disorder and depression with pain, disability, and quality of life. *Journal of Behavioral Medicine*, *38*(3), 535–543. https://doi.org/10.1007/s10865-015-9628-3

Paladini, A., Fusco, M., Coaccioli, S., Skaper, S. D., & Varrassi, G. (2015). Chronic pain in the elderly: The case for new therapeutic strategies. *Pain Physician*, *18*(5), E863–E876.

Park, J., Engstrom, G., Tappen, R., & Ouslander, J. (2015). Health-related quality of life and pain intensity among ethnically diverse community-dwelling older adults. *Pain Management Nursing*, *16*(5), 733–742. https://doi.org/10.1016/j.pmn.2015.04.002

Park, J., Newman, D., Engstrom, G., Hammar, L. M., & Swall, A. (2017). The moderating and covarying effects of social support and pain intensity on depressive symptomology among racially and ethnically diverse older adults. *Pain Management*, *7*(1), 19–32. https://doi.org/10.2217/pmt-2016-0027

Patel, K. V., Guralnik, J. M., Phelan, E. A., Gell, N. M., Wallace, R. B., Sullivan, M. D., & Turk, D. C. (2017). Symptom burden among community-dwelling older adults in the United States. *Journal of the American Geriatrics Society*, *67*(2), 223–231. https://doi.org/10.1111/jgs.15673

Patterson, J. (2011). Verbal fluency. In *Encyclopedia of Clinical Neuropsychology*. https://doi.org/10.1007/978.0-387-79948-3_1423

Pavot, W., & Diener, E. (2013). The satisfaction with life scale (SWL). Retrieved September 15, 2021, from Measurement Instrument Database for the Social Science website: www.midss.ie

Peel, C., Baker, P. S., Roth, D. L., Brown, C. J., Bodner, E. V., & Allman, R. M. (2005). Assessing mobility in older adults: The UAB study of aging life-space assessment. *Physical Therapy*, *85*(10), 1008–1019.

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry*, *18*, 189–193.

Piva, S. R., Almeida, G. J. M., & Wasko, M. C. M. (2010). Association of physical function and physical activity in women with rheumatoid arthritis. *Arthritis Care & Research (Hoboken)*, *62*(8), 1144–1151. https://doi.org/10.1002/acr.20177

Pooler, J., & Srinivasan, M. (2018). *Issue brief: Social determinants of health and the aging population*. Retrieved from https://impaqint.com/sites/default/files/issue-briefs/Issue Brief_SDOHandAgingPopulation_0.pdf

Portenoy, R. K., Ugarte, C., Fuller, I., & Haas, G. (2004). Population-based survey of pain in the

United States: Differences among white, African American, and Hispanic subjects. *Journal of Pain*, *5*(6), 317–328. https://doi.org/10.1016/j.jpain.2004.05.005
Prins, A., Ouimette, P., Kimerling, R., Cameron, R. P., Hugelshofer, D. S., Shaw-Hegwer, J., … Sheikh, J. L. (2003). The primary care PTSD Screen (PC-PTSD): Development and operating characteristics. *Primary Care Psychiatry*, *9*(1), 9–14. https://doi.org/10.1185/135525703125002360
Prkachin, K. M., & Craig, K. D. (1995). Expressing pain: The communication and interpretation of facial pain signals. *Journal of Nonverbal Behavior*, *19*(4), 191–205.
Prkachin, K. M., Solomon, P. E., & Ross, J. (2007). Underestimation of pain by health-care providers: Towards a model of the process of inferring pain in others. In *Canadian Journal of Nursing Research* (Vol. 39).
Przekop, P., Haviland, M. G., Oda, K., & Morton, K. R. (2015). Prevalence and correlates of pain interference in older adults: Why treating the whole body and mind is necessary. *Journal of Bodywork and Movement Therapies*, *19*(2), 217–225. https://doi.org/10.1016/j.jbmt.2014.04.011
Pulles, W. L. J. A., & Oosterman, J. M. (2011). The role of neuropsychological performance in the relationship between chronic pain and functional physical impairment. *Pain Medicine*, *12*(12), 1769–1776. https://doi.org/10.1111/j.1526-4637.2011.01266.x
Raichle, K. A., Hanley, M., Jensen, M. P., & Cardenas, D. D. (2007). Cognitions, coping and social environment predict adjustment to pain in spinal cord injury. *The Journal of Pain*, *8*(9), 718–729.
Raina, P. S., Bonnett, B., Waltner-Toews, D., Woodward, C., & Abernathy, T. (1999). How reliable are selected scales from population-based health surveys? An analysis among seniors. *Canadian Journal of Public Health*, *90*(1), 60–64.
Raina, P. S., Wolfson, C., & Kirkland, S. A. (2008). *Canadian Longitudinal Study on Aging (CLSA) protocol*. Retrieved from https://clsa-elcv.ca/doc.511
Raina, P. S., Wolfson, C., Kirkland, S. A., & Griffith, L. E. (2018). *The Canadian Longitudinal Study on Aging (CLSA) report on healthy aging in Canada*. Retrieved from https://www.clsa-elcv.ca/doc/2639
Raina, P. S., Wolfson, C., Kirkland, S. A., Griffith, L. E., Oremus, M., Patterson, C., … Brazil, K. (2009). The Canadian Longitudinal Study on Aging (CLSA). *Canadian Journal on Aging*, *28*(3), 221–229. https://doi.org/10.1017/S0714980809990055
Ramage-Morin, P. L. (2008). Chronic pain in Canadian seniors. In *Health Reports* (Vol. 19). Retrieved from http://www.statcan.ca
Rana, A. Q., Qureshi, A. R. M., Mumtaz, A., Abdullah, I., Jesudasan, A., Hafez, K. K., & Rana, M. A. (2016). Associations of pain and depression with marital status in patients diagnosed with Parkinson's disease. *Acta Neurologica Scandinavica*, *133*(4), 276–280. https://doi.org/10.1111/ane.12454
Rantakokko, M., Iwarsson, S., Slaug, B., & Nilsson, M. (2019). Life-space mobility in Parkinson's disease: Associations with motor and non-motor symptoms. *Journals of Gerontology: Medical Sciences*, *74A*(4), 507–512. https://doi.org/10.1093/gerona/gly074
Raphael, D. (2000). Health inequalities in Canada: Current discourses and implications for public health action. *Critical Public Health*, *10*(2), 193–216. https://doi.org/10.1080/713658246
Raphael, D. (2002). Addressing health inequalities in Canada. *Leadership in Health Services*, *15*(2), 1–8. https://doi.org/10.1108/13660750210427240

Raphael, D., & Bryant, T. (2000). Putting the population into population health. *Canadian Journal of Public Health*, *91*(1), 9–12. https://doi.org/10.1007/bf03404245

Raphael, D., Renwick, R., Brown, I., Phillips, S., Sehdev, H., & Steinmetz, B. (2001). Community quality of life in low-income neighborhoods: Findings from two contrasting communities in Toronto, Canada. *Journal of the Community Development Society*, *32*(2), 310–333. https://doi.org/10.1080/15575330109489684

Reese, J. B., Somers, T. J., Keefe, F. J., Mosley-Williams, A., & Lumley, M. A. (2010). Pain and functioning of rheumatoid arthritis patients based on marital status: Is a distressed marriage preferable to no marriage? *The Journal of Pain*, *11*(10), 958–964. https://doi.org/10.1016/j.jpain.2010.01.003

Regorz, A. (2020). How to interpret a collinearity diagnostics table in SPSS. Retrieved October 9, 2020, from http://www.regorz-statistik.de/en/collinearity_diagnostics_table_SPSS.html

Reid, M. C., Bennett, D. A., Chen, W. G., Eldadah, B. A., Farrar, J. T., Ferrell, B., … Zacharoff, K. L. (2011). Improving the pharmacologic management of pain in older adults: Identifying the research gaps and methods to address them. *Pain Medicine*, *12*(9), 1336–1357. https://doi.org/10.1111/j.1526-4637.2011.01211.x.

Reid, M. C., Eccleston, C., & Pillemer, K. (2015). Management of chronic pain in older adults. *BMJ*, *350*, 1–10. https://doi.org/10.1136/bmj.h532

Resnick, B., Galik, E., Boltz, M., Vigne, E., Holmes, S., Fix, S., & Zhu, S. (2018). Physical activity and function in assisted living residents. *Western Journal of Nursing Research*, *40*(12), 1734–1748. https://doi.org/10.1177/0193945918764448

Reuben, D., Seeman, T. E., Keeler, E., Hayes, R. P., Bowman, L., Sewall, A., … Guralnik, J. M. (2004). Refining the categorization of physical functional status: The added value of combining self-reported and performance-based measures. *Journal of Gerontology: Medical Sciences*, *59A*(10), 1056–1061. https://doi.org/10.1093/gerona/59.10.m1056

Reuben, D., Valle, L., Hays, R., & Siu, A. (1995). Measuring physical function in community-dwelling older persons: A comparison of self-administered, interviewer-administered, and performance-based measures. *Journal of the American Geriatrics Society*, *43*, 17–23.

Reyes-Gibby, C. C., Aday, L. A., Todd, K. H., Cleeland, C. S., & Anderson, K. O. (2007). Pain in aging community-dwelling adults in the United States: Non-Hispanic whites, non-Hispanic blacks, and Hispanics. *The Journal of Pain*, *8*(1), 75–84. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2688697/pdf/nihms-110443.pdf

Riggs, A., Breuer, B., Patel, V., Harounian, J., Chen, J., Dhingra, L., … Knotkova, H. (2018). Pain-related distress among patients referred to a community-based palliative care program. *Palliative and Supportive Care*, *17*(3), 338–344. https://doi.org/10.1017/S1478951518000251

Rios, R., & Zautra, A. J. (2011). Socioeconomic disparities in pain: The role of economic hardship and daily financial worry. *Health Psychology*, *30*(1), 58–66. https://doi.org/10.1037/a0022025

Roberts, K. C., Rao, D. P., Bennett, T. L., Loukine, L., & Hayaraman, G. C. (2015). Prevalence and patterns of chronic disease multimorbidity and associated determinants in Canada. *Health Promotion and Chronic Disease Prevention in Canada*, *35*(6), 87–94.

Rosano, C., Simonsick, E. M., Harris, T. B., Kritchevsky, S. B., Brach, J., Visser, M., … Newman, A. B. (2005). Association between physical and cognitive function in healthy elderly: The health, aging and body composition study. *Neuroepidemiology*, *24*(1–2), 8–14. https://doi.org/10.1159/000081043

Rosenthal, R. (2008). Conducting judgment studies: Some methodological issues. In *The new handbook of methods in nonverbal behavior research* (pp. 199–234). New York, NY: Oxford university press.

Rosso, A. L., Taylor, J. A., Tabb, L. P., & Michael, Y. L. (2013). Mobility, disability, and social engagement in older adults. *Journal of Aging and Health*, *25*(4), 617–637. https://doi.org/10.1177/0898264313482489

Roth, R. S., & Geisser, M. E. (2002). Educational achievement and chronic pain disability: Mediating role of pain-related cognitions. *Clinical Journal of Pain*, *18*(5), 286–296. https://doi.org/10.1097/00002508-200209000-00003

Rouch, I., Edjolo, A., Laurent, B., Pongan, E., Dartigues, J. F., & Amieva, H. (2021). Association between chronic pain and long-term cognitive decline in a population-based cohort of elderly participants. *Pain*, *162*(2), 552–560. https://doi.org/10.1097/j.pain.0000000000002047

Rovner, G. S., Sunnerhagen, K. S., Björkdahl, A., Gerdle, B., Börsbo, B., Johansson, F., & Gillanders, D. (2017). Chronic pain and sex-differences; women accept and move, while men feel blue. *PLoS ONE*, *12*(4), 1–12. https://doi.org/10.1371/journal.pone.0175737

Rowe, T. A., & Juthani-Mehta, M. (2013). Urinary tract infection in older adults. *Journal of Aging and Health*, *9*(5).

Ruscheweyh, R., Nees, F., Marziniak, M., Evers, S., Flor, H., & Knecht, S. (2011). Pain catastrophizing and pain-related emotions: Influence of age and type of pain. *The Clinical Journal of Pain*, *27*(7), 578–586. https://doi.org/10.1097/ajp.0b013e31820fde1b

Ryan, A., Murphy, C., Boland, F., Galvin, R., Stats, D., & Smith, S. M. (2018). What is the impact of physical activity and physical function on the development of multimorbidity in older adults over time? A population-based cohort study. *Journals of Gerontology: Medical Sciences*, *73B*(11), 1538–1544. https://doi.org/10.1093/gerona/glx251

Ryan, A., Wallace, E., O'Hara, P., & Smith, S. M. (2015). Multimorbidity and functional decline in community-dwelling adults: A systematic review. *Health and Quality of Life Outcomes*, *13*(1). https://doi.org/10.1186/s12955-015-0355-9

Sallinen, J., Stenholm, S., Rantanen, T., Heliovaara, M., Sainio, P., & Koskinen, S. (2010). Hand-grip strength cut-points to screen older persons at risk for mobility limitation. *Journal of the American Geriatrics Society*, *58*(9), 1721–1726. https://doi.org/10.1111/j.1532-5415.2010.03035.x

Sardina, A. L., Gamalda, A. A., Andel, R., Johnson, S., Baker, T. A., Thorpe, R. J., … Zonderman, A. B. (2021). Cross-sectional examination of musculoskeletal pain and physical function in a racially and socioeconomically diverse sample of adults. *Journal of Gerontology: Medical Sciences*, *76*(2), 368–377. https://doi.org/10.1093/gerona/glaa251

Savvas, S. M., & Gibson, S. J. (2016). Overview of pain management in older adults. *Clinics in Geriatric Medicine*, *32*(4), 635–650. https://doi.org/10.1016/j.cger.2016.06.005

Sawa, R., Doi, T., Misu, S., Saito, T., Sugimoto, T., Murata, S., … Ono, R. (2017). The severity and number of musculoskeletal pain associated with gait in community-dwelling elderly individuals. *Gait and Posture*, *54*, 242–247. https://doi.org/10.1016/j.gaitpost.2017.03.013

Schuit, A. J., Schouten, E. G., Westerterp, K. R., & Saris, W. H. (1997). Validity of the Physical Activity Scale for the Elderly (PASE): According to energy expenditure assessed by the doubly labeled water method. *Journal of Clinical Epidemiology*, *50*(5), 541–546.

Scott, E. L., Kroenke, K., Wu, J., & Yu, Z. (2016). Beneficial effects of improvement in depression, pain catastrophizing, and anxiety on pain outcomes: A 12-month longitudinal

analysis. *Journal of Pain*, *17*(2), 215–222. https://doi.org/10.1016/j.jpain.2015.10.011
Scudds, R. J., & Østbye, T. (2001). Pain and pain-related interference with function in older Canadians: The Canadian study of health and aging. *Disability and Rehabilitation*, *23*(15), 654–664. https://doi.org/10.1080/09638280110043942
Sherbourne, C. D., & Stewart, A. L. (1991). The MOS social support survey. *Social Science & Medicine*, *32*(6), 705–714.
Shih, M., Hootman, J. ., Kruger, J., & Helmick, C. . (2006). Physical activity in men and women with arthritis: National health interview survey, 2002. *American Journal of Preventive Medicine*, *30*(5), 385–393. https://doi.org/10.1016/j.amepre.2005.12.005
Shimada, H., Sawyer, P., Harada, K., Kaneya, S., Nihei, K., Asakawa, Y., … Ishizaki, T. (2010). Predictive validity of the classification schema for functional mobility tests in instrumental activities of daily living decline among older adults. *Archives of Physical Medicine and Rehabilitation*, *91*(2), 241–246. https://doi.org/10.1016/j.apmr.2009.10.027
Shrestha, M. P., & Taleban, S. (2019). Management of ulcerative colitis in the elderly. *Drugs and Aging*, *36*(1), 13–27. https://doi.org/10.1007/s40266-018-0611-x
Shum, D. H. K., & Fleming, J. (2011). Prospective memory. In *Encyclopedia of Clinical Neuropsychology*. https://doi.org/10.1007/978-0-387-79948-3_1144
Shumway-Cook, A., Brauer, S., & Woollacott, M. (2000). Predicting the probability for falls in community-dwelling older adults using the timed up and go test. *Physical Therapy*, *80*(9), 896–903.
Siddall, P. J., & Cousins, M. J. (2004). Persistent pain as a disease entity: Implications for clinical management. *Anesthesia and Analgesia*, *99*(2), 510–520. https://doi.org/10.1213/01.ANE.0000133383.17666.3A
Simard, M., Rouleau, I., Kadlec, H., Taler, V., Tuokko, H., Voll, S., … Raina, P. (2018). Miami prospective memory test in the Canadian longitudinal study on aging. *Clinical Neuropsychologist*, *33*(1), 137–165. https://doi.org/10.1080/13854046.2018.1435824
Simon, C. B., Lentz, T. A., Bishop, M. D., Riley, J. L., Fillingim, R. B., & George, S. Z. (2016). Comparative associations of working memory and pain catastrophizing with chronic low back pain intensity. *Physical Therapy*, *96*(7), 1049–1056. https://doi.org/10.2522/ptj.20150335
Sipko, T., Glibowski, E., Barczyk-Pawelec, K., & Kuczyński, M. (2016). The effect of chronic pain intensity on sit-to-stand strategy in patients with herniated lumbar disks. *Journal of Manipulative and Physiological Therapeutics*, *39*(3), 169–175. https://doi.org/10.1016/j.jmpt.2016.02.014
Sjøgren, P., Thomsen, A. B., & Olsen, A. K. (2000). Impaired neuropsychological performance in chronic nonmalignant pain patients receiving long-term oral opioid therapy. *Journal of Pain and Symptom Management*, *19*(2), 100–108. https://doi.org/10.1016/S0885-3924(99)00143-8
Smith, P. D., Becker, K., Roberts, L., Walker, J., & Szanton, S. L. (2016). Associations among pain, depression, and functional limitation in low-income, home-dwelling older adults: An analysis of baseline data from CAPABLE. *Geriatric Nursing*, *37*(5), 348–352. https://doi.org/10.1016/j.gerinurse.2016.04.016
Solhaug, H. I., Romuld, E. B., Romild, U., & Stordal, E. (2012). Increased prevalence of depression in cohorts of the elderly: An 11-year follow-up in the general population-the HUNT study. *International Psychogeriatrics*, *24*(1), 151–158. https://doi.org/10.1017/S1041610211001141

Sorge, R. E., & Totsch, S. K. (2017). Sex differences in pain. *Journal of Neuroscience Research*, *95*(6), 1271–1281. https://doi.org/10.1002/jnr.23841

Spagnuolo, D. L., Jürgensen, S. P., Iwama, Â. M., & Dourado, V. Z. (2010). Walking for the assessment of balance in healthy subjects older than 40 years. *Gerontology*, *56*(5), 467–473. https://doi.org/10.1159/000275686

Specht, J., Egloff, B., & Schmukle, S. C. (2011). Stability and change of personality across the life course: The impact of age and major life events on mean-level and rank-order stability of the big five. *Journal of Personality and Social Psychology*, *101*(4), 862–882. https://doi.org/10.1037/a002

Spector, A., & Orrell, M. (2010, September). Using a biopsychosocial model of dementia as a tool to guide clinical practice. *International Psychogeriatrics*, Vol. 22, pp. 957–965. https://doi.org/10.1017/S1041610210000840

Stalvey, B. T., Owsley, C., Sloane, M. E., & Ball, K. (1999). The life space questionnaire: A measure of the extent of mobility of older adults. *The Journal of Applied Gerontology*, *18*(4), 460–478.

Statistics Canada. (2019). *Population projections for Canada (2018 to 2068), provinces and territories (2018 to 2043)*. Retrieved from http://www.statcan.gc.ca/pub/91-520-x/2010001/tablesectlist-listetableauxsect-eng.htm

Stubbs, B., Binnekade, T., Eggermont, L., Sepehry, A. A., Patchay, S., & Schofield, P. (2014). Pain and the risk for falls in community-dwelling older adults: Systematic review and meta-analysis. *Archives of Physical Medicine and Rehabilitation*, *95*(1), 175–187. https://doi.org/10.1016/j.apmr.2013.08.241

Stubbs, B., Schofield, P., & Patchay, S. (2014). Mobility limitations and fall-related factors contribute to the reduced health-related quality of life in older adults with chronic musculoskeletal pain. *Pain Practice*, *16*(1), 80–89. https://doi.org/10.1111/papr.12264

Stubbs, B., Schofield, P., Patchay, S., & Leveille, S. (2016). Musculoskeletal pain characteristics associated with lower balance confidence in community-dwelling older adults. *Physiotherapy*, *102*(2), 152–158. https://doi.org/10.1016/j.physio.2015.03.3721

Sutin, A. R., Stephan, Y., Luchetti, M., & Terracciano, A. (2019). The prospective association between personality traits and persistent pain and opioid medication use. *Journal of Psychosomatic Research*, *123*. https://doi.org/10.1016/j.jpsychores.2019.04.019

Suzuki, T., Kitaike, T., & Ikezaki, S. (2014). Life-space mobility and social support in elderly adults with orthopaedic disorders. *International Journal of Nursing Practice*, *20*(S1), 32–38. https://doi.org/10.1111/ijn.12248

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (Sixth). Pearson Education Inc.

Tait, R. C., & Chibnall, J. T. (2014). Racial/ethnic disparities in the assessment and treatment of pain. *American Psychologist*, *69*(2), 131–141. https://doi.org/10.1037/a0035204

Tang, W. K., Lau, C. G., Mok, V., Ungvari, G. S., & Wong, K. S. (2015). The impact of pain on health-related quality of life 3 months after stroke. *Topics in Stroke Rehabilitation*, *22*(3), 194–200. https://doi.org/10.1179/1074935714Z.0000000024

Tassain, V., Attal, N., Fletcher, D., Brasseur, L., Dégieux, P., Chauvin, M., & Bouhassira, D. (2003). Long term effects of oral sustained release morphine on neuropsychological performance in patients with chronic non-cancer pain. *Pain*, *104*(1–2), 389–400. https://doi.org/10.1016/S0304-3959(03)00047-2

Taylor, A. W., Price, K., Gill, T. K., Adams, R., Pilkington, R., Carrangis, N., … Wilson, D.

(2010). Multimorbidity - not just an older person's issue. Results from an Australian biomedical study. *BMC Public Health*, *10*(1). https://doi.org/10.1186/1471-2458-10-718

Taylor, J. L., Parker, L. J., Szanton, S. L., & Thorpe, R. J. (2018). The association of pain, race and slow gait speed in older adults. *Geriatric Nursing*, *39*(5), 580–583. https://doi.org/10.1016/j.gerinurse.2018.04.004

Teo, K. K. (2019). Peripheral arterial disease. Retrieved January 29, 2021, from Merck Manual Professional Version website: https://www.merckmanuals.com/en-ca/professional/cardiovascular-disorders/peripheral-arterial-disorders/peripheral-arterial-disease?query=peripheral artery disease

Tessier, A. J., Wing, S. S., Rahme, E., Morais, J. A., & Chevalier, S. (2019). Physical function-derived cut-points for the diagnosis of sarcopenia and dynapenia from the Canadian longitudinal study on aging. *Journal of Cachexia, Sarcopenia and Muscle*, *10*(5), 985–999. https://doi.org/10.1002/jcsm.12462

Theis, K. A., Murphy, L., Hootman, J. M., & Wilkie, R. (2013). Social participation restriction among U.S. adults with arthritis: A population-based study using the international classification of functioning, disability, and health (ICF). *Arthritis Care and Re*, *65*(7), 1059–1069. https://doi.org/10.1002/acr.21977

Thompson, A. D., & Shea, M. J. (2020). Edema. Retrieved January 25, 2021, from Merck Manual Professional Version website: https://www.merckmanuals.com/professional/cardiovascular-disorders/symptoms-of-cardiovascular-disorders/edema?query=edema

Thompson, K. A., Terry, E. L., Sibille, K. T., Gossett, E. W., Ross, E. N., Bartley, E. J., … Goodin, B. R. (2019). At the intersection of ethnicity/race and poverty: Knee pain and physical function. *Journal of Racial and Ethnic Health Disparities*, *6*(6), 1131–1143. https://doi.org/10.1007/s40615-019-00615-7

Tiedemann, A., Shimada, H., Sherrington, C., Murray, S., & Lord, S. (2008). The comparative ability of eight functional mobility tests for predicting falls in community-dwelling older people. *Age and Ageing*, *37*(4), 430–435. https://doi.org/10.1093/ageing/afn100

Tilley, B. J., Cook, J. L., Docking, S. I., & Gaida, J. E. (2015). Is higher serum cholesterol associated with altered tendon structure or tendon pain? A systematic review. *British Journal of Sports Medicine*, *49*(23), 1504–1509. https://doi.org/10.1136/bjsports-2015-095100

Tolea, M. I., Ferrucci, L., Costa, P. T., Faulkner, K., Rosano, C., Satterfield, S., … Simonsick, E. M. (2012). Personality and reduced incidence of walking limitation in late life: Findings from the Health, Aging, and Body Composition study. *Journal of Gerontology: Physchological Sciences*, *67B*(6), 712–719. https://doi.org/10.1093/geronb/gbs001

Tomita, Y., Arima, K., Kanagae, M., Okabe, T., Mizukami, S., Nishimura, T., … Aoyagi, K. (2015). Association of physical performance and pain with fear of falling among community-dwelling Japanese women aged 65 years and older. *Medicine (Baltimore)*, *94*(35). https://doi.org/10.1097/MD.0000000000001449

Tomita, Y., Tanaka, S., Takahashi, S., & Takeuchi, N. (2020). Detecting cognitive decline in community-dwelling older adults using simple cognitive and motor performance tests. *Geriatrics and Gerontology International*, *20*(3), 212–217. https://doi.org/10.1111/ggi.13863

Tuokko, H., Griffith, L. E., Simard, M., & Taler, V. (2017). Cognitive measures in the Canadian Longitudinal Study on Aging. *Clinical Neuropsychologist*, *31*(1), 233–250.

https://doi.org/10.1080/13854046.2016.1254279
Tuokko, H., Griffith, L. E., Simard, M., Taler, V., O'Connell, M. E., Voll, S., … Raina, P. (2019). The Canadian longitudinal study on aging as a platform for exploring cognition in an aging population. *Clinical Neuropsychologist*, *34*(1), 174–203. https://doi.org/10.1080/13854046.2018.1551575
Turk, D. C., Okifuji, A., & Scharff, L. (1995). Chronic pain and depression: Role of perceived impact and perceived control in different age cohorts. *Pain*, *61*(1), 93–101. https://doi.org/10.1016/0304-3959(94)00167-D
U.S. National Library of Medicine. (2020a). Albumin blood test. Retrieved June 15, 2021, from https://medlineplus.gov/lab-tests/albumin-blood-test/
U.S. National Library of Medicine. (2020b). White blood cell count (WBC). Retrieved June 15, 2021, from https://medlineplus.gov/lab-tests/white-blood-count-wbc/
UCLA: Statistical Consulting Group. (n.d.). Introduction to regression with SPSS lesson 2: SPSS regression diagnostics. Retrieved October 9, 2020, from https://stats.idre.ucla.edu/spss/seminars/introduction-to-regression-with-spss/introreg-lesson2/#s5
UK Biobank Coordinating Centre. (2007). *UK biobank: Protocol for a large-scale prospective epidemiological resource. Protocol no: UKBB-PROT-09-06 (main phase)* (Vol. 06). Stockport, Cheshire, UK.
Valderas, J. M., Starfield, B., Sibbald, B., Salisbury, C., & Roland, M. (2009). Defining comorbidity: Implications for understanding health and health services. *Annals Of Family Medicine*, *7*(4), 357–363. https://doi.org/10.1370/afm.983
ValdimarsdÓttir, U., Helgason, R., Adolfsson, J., Steineck, G., & Helgason, R. (2002). The unrecognised cost of cancer patients' unrelieved symptoms: A nationwide follow-up of their surviving partners. *British Journal of Cancer*, *86*(10), 1540–1545. https://doi.org/10.1038/sj.bjc.6600271
Van Der Leeuw, G., Eggermont, L. H. P., Shi, L., Milberg, W. P., Gross, A. L., Hausdorff, J. M., … Leveille, S. G. (2016). Pain and cognitive function among older adults living in the community. *Journals of Gerontology: Medical Sciences*, *71*(3), 398–405. https://doi.org/10.1093/gerona/glv166
Vancampfort, D., Stubbs, B., Firth, J., & Koyanagi, A. (2018). Handgrip strength, chronic physical conditions and physical multimorbidity in middle-aged and older adults in six low- and middle income countries. *European Journal of Internal Medicine*, *61*, 96–102. https://doi.org/10.1016/j.ejim.2018.11.007
Vancampfort, D., Stubbs, B., & Koyanagi, A. (2017). Physical chronic conditions, multimorbidity and sedentary behavior amongst middle-aged and older adults in six low- and middle-income countries. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), 1–13. https://doi.org/10.1186/s12966-017-0602-z
Velez, M. P., Alvarado, B. E., Rosendaal, N., Da Câmara, S. M., Belanger, E., Richardson, H., & Pirkle, C. M. (2019). Age at natural menopause and physical functioning in postmenopausal women: The Canadian Longitudinal Study on Aging. *Menopause: The Journal of the North American Menopause Society*, *26*(9), 958–965. https://doi.org/10.1097/GME.0000000000001362
Verdejo-García, A., López-Torrecillas, F., Calandre, E. P., Delgado-Rodríguez, A., & Bechara, A. (2009). Executive function and decision-making in women with fibromyalgia. *Archives of Clinical Neuropsychology*, *24*(1), 113–122. https://doi.org/10.1093/arclin/acp014

Veronese, N., Koyanagi, A., Solmi, M., Thompson, T., Maggi, S., Schofield, P., … Stubbs, B. (2018). Pain is not associated with cognitive decline in older adults: A four-year longitudinal study. *Maturitas*, *115*, 92–96. https://doi.org/10.1016/j.maturitas.2018.07.001

Victorian Government Department of Human Services. (2002). *Victorian population health survey 2001: Selected findings*. Melbourne, Victoria: Rural and Regional Health and Aged Care Services Division.

Vincent, A., Whipple, M. O., McAllister, S. J., Aleman, K. M., & St Sauver, J. L. (2015). A cross-sectional assessment of the prevalence of multiple chronic conditions and medication use in a sample of community-dwelling adults with fibromyalgia in Olmsted County, Minnesota. *BMJ Open*, *5*(3), 1–5. https://doi.org/10.1136/bmjopen-2014-006681

Visser, M., Kritchevsky, S. B., Newman, A. B., Goodpaster, B. H., Tylavsky, F. A., Nevitt, M. C., & Harris, T. B. (2005). Lower serum albumin concentration and change in muscle mass: The health, aging and body composition Study. *American Journal of Clinical Nutrition*, *82*(3), 531–537. https://doi.org/10.1093/ajcn.82.3.531

Walco, G. A., Krane, E. J., Schmader, K. E., & Weiner, D. K. (2016). Applying a lifespan developmental perspective to chronic pain: Pediatrics to geriatrics. *Journal of Pain*, *17*(9), T108–T117. https://doi.org/10.1016/j.jpain.2015.11.003

Walker, S. P., Esterhuyse, K. G. F., & Van Lill, L. (2010). The role of coping responses in the relationship between perceived stress and satisfaction with life amongst chronic pain patients. *Southern African Journal of Anaesthesia and Analgesia*, *16*(5), 13–17. https://doi.org/10.1080/22201173.2010.10872703

Wang, Y., Huang, L., & Zhou, L. X. (2019). Correlation between exercise, personal income level and health-related quality of life in patients with newly diagnosed stable angina. *Military Medical Research*, *6*(36), 1–8. https://doi.org/10.1186/s40779-019-0226-5

Washburn, R. ., & Ficker, J. . (1999). Physical Activity Scale for the Elderly (PASE): The relationship with activity measured by a portable accelerometer. *Journal of Sports Medicine and Physical Fitness*, *39*(4), 336–340.

Washburn, R. A. (2000). Assessment of physical activity in older adults. *Research Quarterly for Exercise and Sport*, *71*(2), 79–88.

Washburn, R. A., Smith, K. W., Jette, A. M., & Janney, C. A. (1993). The Physical Activity Scale for the Elderly (PASE): Development and evaluation. *Journal of Clinical Epidemiology*, *46*(2), 153–162.

Watson, S. (2018). Depression Topic Overview. Retrieved August 28, 2021, from Gale Health and Wellness Online Collection website: https://www.gale.com/open-access/depression

Wei, M. Y., Kabeto, M. U., Galecki, A. T., & Langa, K. M. (2019). Physical functioning decline and mortality in older adults with multimorbidity: Joint modeling of longitudinal and survival data. *Journals of Gerontology: Medical Sciences*, *74*(2), 226–232. https://doi.org/10.1093/gerona/gly038

Weiner, D. K., Gentili, A., Coffey-Vega, K., Morone, N., Rossi, M., & Perera, S. (2019). Biopsychosocial profiles and functional correlates in older adults with chronic low back pain: A preliminary study. *Pain Medicine*, *20*(7), 1300–1310. https://doi.org/10.1093/pm/pny065

Weiner, D. K., Rudy, T. E., Morrow, L., Slaboda, J., & Lieber, S. (2006). The relationship between pain, neuropsychological performance, and physical function in community-dwelling older adults with chronic low back pain. *Pain Medicine*, *7*(1), 60–70. https://doi.org/10.1111/j.1526-4637.2006.00091.x

Welsh, V. K., Mallen, C. D., Ogollah, R., Wilkie, R., & McBeth, J. (2019). Investigating multisite pain as a predictor of self-reported falls and falls requiring health care use in an older population: A prospective cohort study. *PLoS ONE, 14*(12), 1–18. https://doi.org/10.1371/journal.pone.0226268

Wilder, M. E., Kulie, P., Jensen, C., Levett, P., Blanchard, J., Dominguez, L. W., … McCarthy, M. L. (2021). The impact of social determinants of health on medication adherence: A systematic review and meta-analysis. *Journal of General Internal Medicine, 36*(5), 1359–1370. https://doi.org/10.1007/s11606-020-06447-0

Wise, R. A. (2020). Chronic obstructive pulmonary disease (COPD). Retrieved January 9, 2021, from Merck Manual Professional Version website: https://www.merckmanuals.com/professional/pulmonary-disorders/chronic-obstructive-pulmonary-disease-and-related-disorders/chronic-obstructive-pulmonary-disease-copd?query=chronic obstructive pulmonary disease

Wolever, R. Q., Goel, N. S., Roberts, R. S., Caldwell, K., Kligler, B., Dusek, J. A., … Abrams, D. I. (2015). Integrative medicine patients have high stress, pain, and psychological symptoms. *Explore, 11*(4), 296–303. https://doi.org/10.1016/j.explore.2015.04.003

Wranker, L. S., Rennemark, M., & Berglund, J. (2016). Pain among older adults from a gender perspective: Findings from the Swedish National Study on Aging and Care (SNAC-Blekinge). *Scandinavian Journal of Public Health, 44*(3), 258–263. https://doi.org/10.1177/1403494815618842

Wranker, L. S., Rennemark, M., Elmstahl, S., & Berglund, J. (2015). The influence of personality traits on perception of pain in older adults - findings from the Swedish National Study on Aging and Care - Blekinge study. *Scandinavian Journal of Pain, 7*(1), 3–8. https://doi.org/10.1016/j.sjpain.2014.12.004

Xu, X., Rao, Y., Shi, Z., Liu, L., Chen, C., & Zhao, Y. (2016). Hypertension impact on health-related quality of life: A cross-sectional survey among middle-aged adults in Chongqing, China. *International Journal of Hypertension*. https://doi.org/10.1155/2016/7404957

Yang, Y. C., Lin, M. H., Wang, C. S., Lu, F. H., Wu, J. S., Cheng, H. P., & Lin, S. I. (2019). Geriatric syndromes and quality of life in older adults with diabetes. *Geriatrics and Gerontology International, 19*(6), 518–524. https://doi.org/10.1111/ggi.13654

Yorke, A. M., Curtis, A. B., Shoemaker, M., & Vangsnes, E. (2017). The impact of multimorbidity on grip strength in adults age 50 and older: Data from the health and retirement survey (HRS). *Archives of Gerontology and Geriatrics, 72*, 164–168. https://doi.org/10.1016/j.archger.2017.05.011

Yoshimoto, T., Ochiai, H., Shirasawa, T., Nagahama, S., Kobayashi, M., Minoura, A., … Kokaze, A. (2018). Association between serum lipids and low back pain among a middle-aged Japanese population: A large-scale cross-sectional study. *Lipids in Health and Disease, 17*(1), 4–9. https://doi.org/10.1186/s12944-018-0907-1

Zahorec, R. (2001). Ratio of neutrophil to lymphocyte counts — rapid and simple parameter of systemic inflammation and stress in critically ill. *Bratisl Lek Listy, 102*(1), 5–14.

Zeng, F., Sun, X., Yang, B., & Fu, X. (2016). Life events, anxiety, social support, personality, and alexithymia in female patients with chronic pain: A path analysis. *Asia-Pacific Psychiatry, 8*(1), 44–50. https://doi.org/10.1111/appy.12222

Zheng, H., Schnabel, A., Yahiaoui-Doktor, M., Meissner, W., Van Aken, H., Zahn, P., & Pogatzki-Zahn, E. (2017). Age and preoperative pain are major confounders for sex differences in postoperative pain outcome: A prospective database analysis. *PLoS ONE,*

12(6), 1–14. https://doi.org/10.1371/journal.pone.0178659
Zimmer, Z., & Zajacova, A. (2018). Persistent, consistent, and extensive: The trend of increasing pain prevalence in older Americans. *Journals of Gerontology: Social Sciences*, *00*(00), 1–12. https://doi.org/10.1093/geronb/gbx162
Zis, P., Daskalaki, A., Bountouni, I., Sykioti, P., Varrassi, G., & Paladini, A. (2017). Depression and chronic pain in the elderly: Links and management challenges. *Clinical Interventions in Aging*, *12*, 709–720. https://doi.org/10.2147/CIA.S113576

APPENDICES

Appendix A: Model Assumption Testing

Assumptions of PCA

After removing the strict scoring method for the animal naming test from the PCA and retaining body fat percentage instead of weight, the determinant was significant at $p < 0.00001$ but the correlation matrix did not reveal any correlations larger than 0.90, satisfying the assumption of no multicollinearity. The component correlation matrix did not reveal any correlations that were 0, allowing for the oblique (promax) rotation to be used. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.82, indicating a large sample size and satisfying the assumption. Bartlett's test of sphericity was significant at $p < 0.001$, satisfying the assumption of large enough correlations between variables. < 50% of residuals were over an absolute value of 0.05, indicating that a good model was produced.

Assumptions of Binary Logistic Regression

All tolerance scores were above 0.10 and VIF scores were below 10, satisfying the assumption of no multicollinearity. The Hosmer-Lemeshow statistic was nonsignificant at $p = 0.17$ (χ^2 (8) = 11.62, $p = 0.17$), satisfying the assumption and indicating a good model. All interaction terms were nonsignificant ($p > 0.05$) or close to no significance, satisfying the assumption of linearity between the continuous correlates and the logit transformation of the dependent variable. Cook's distance was < 1, leverage values were > 0 and < 1, the studentized residuals showed that 0.50% of cases were outside ±1.96 and no cases were outside 2.58, and the DFbeta value was < 1.

Assumptions of Ordinal Logistic Regression

All tolerance scores were above 0.10 and VIF scores were below 10, satisfying the assumption of no multicollinearity. The Pearson goodness-of-fit statistic was nonsignificant at $p = 0.81$ (χ^2 (10 594) = 10 471.43, $p = 0.81$), satisfying the assumption. The test of parallel lines was nonsignificant at $p = 0.70$ (χ^2 (20) = 16.31, $p = 0.70$), satisfying the assumption of proportional odds.

Assumptions of Multinomial Logistic Regression

All tolerance scores were above 0.10 and VIF scores were below 10, satisfying the assumption of no multicollinearity. The Pearson goodness-of-fit statistic was nonsignificant at $p = 0.05$ (χ^2 (15 864) = 16 155.84, $p = 0.05$), satisfying the assumption. All interaction terms were nonsignificant ($p > 0.05$) or close to no significance, satisfying the assumption of linearity between the continuous correlates and the logit transformation of the dependent variable.

Assumptions of MANCOVA for Pain Presence

There is an independence of observations and a sufficient sample size (n = 20,458). The range of Mahalanobis distance was 2.04 to 263.62; the CLSA already checked for outliers through their OPAL system(Raina et al., 2008), so no outliers were removed because it represented the true data. The dependent variables showed normality (examined in descriptive statistics), satisfying the assumption. There was no multicollinearity present, satisfying the assumption. Box's M test was significant at $p < 0.001$, so Pillai's trace was used to report multivariate significance. There was a linear relationship between all pairs of dependent variables and all dependent-covariate

pairs in each group of the independent variable, satisfying the assumption. The covariates were retained in the analysis.

Assumptions of MANCOVA for Pain Intensity

There is an independence of observations and a sufficient sample size (n = 7,071). The range of Mahalanobis distance was 2.04 to 263.62; the CLSA already checked for outliers through their OPAL system(Raina et al., 2008), so no outliers were removed because it represented the true data. The dependent variables showed normality (examined in descriptive statistics), satisfying the assumption. There was no multicollinearity present, satisfying the assumption. Box's M test was significant at $p < 0.001$, so Pillai's trace was used to report multivariate significance. There was a linear relationship between all pairs of dependent variables and all dependent-covariate pairs in each group of the independent variable, satisfying the assumption. The covariates were retained in the analysis.

Assumptions of MANCOVA for Pain Impact

There is an independence of observations and a sufficient sample size (n = 7,071). The range of Mahalanobis distance was 2 to 263.02; the CLSA already checked for outliers through their OPAL system(Raina et al., 2008), so no outliers were removed because it represented the true data. The dependent variables showed normality (examined in descriptive statistics), satisfying the assumption. There was no multicollinearity present, satisfying the assumption. Box's M test was significant at $p < 0.001$, so Pillai's trace was used to report multivariate significance. There was a linear relationship between all pairs of dependent variables and all dependent-covariate

pairs in each group of the independent variable, satisfying the assumption. The covariates were retained in the analysis.