The Influence of Neighbourhood Deprivation on Health Related Quality of Life In Advanced Arthritis

By

Nora Deane Cristall

A Thesis submitted to the Faculty of Graduate Studies of The University of Manitoba

in partial fulfillment of the requirements of the degree of

DOCTOR OF PHILOSPOHY

Faculty of Social Work

University of Manitoba

Winnipeg

Abstract

Arthritis is a growing aging and public health concern in Canada and elsewhere. As with many other chronic health conditions, arthritis occurs more often and has a higher impact on functioning for people who have lower incomes or live in an impoverished environment. There is a large body of research that supports a gradient between socioeconomic status and health and between area level poverty and decreased quality of life. Although this relationship is widely acknowledged, less is known about the influence of broader social conditions at the neighbourhood level on health outcomes. By examining quality of life from the theoretical framework of poverty as a fundamental cause of differences in health (Link & Phelan, 1995) and Bourdieu's (1984) theory of *habitus,* I provide an analysis of the direct impact of material and social deprivation on health related quality of life (HRQoL), as well as the impact considering the influence of age, body weight, physical functioning, gender, and coexisting health conditions. I also examine interaction effects between neighbourhood deprivation and individual characteristics. An explanatory three-level multilevel model supported a relationship between individual factors as well as deprivation at the neighbourhood level on quality of life. The impact of neighbourhood deprivation was more pronounced for mental health related life quality, with a history of another health condition making the largest contribution to the model. Physical HRQoL was impacted by gender in interaction with material deprivation and body mass index in interaction with social deprivation. I discuss implications for practice, service delivery, and policy and make suggestions for further research.

Acknowledgments

This paper would not have been possible without the ongoing support from my family, committee, colleagues, friends and statistics mentors I met on the journey. There were no better cheerleaders and examples in my life than my parents Gail and John Burns. Their unstoppable interest and enthusiasm for my work was maintained even when I had periods of waning interest. They continued to support my study when I had given up hope of ever taming the beast. Over my lifetime they have always encouraged higher learning and maintaining a sense of curiosity about all types of injustice in the world. This fueled an interest in going further to identifying community needs and a voice for those who cannot advocate for themselves. This ignited and continued to fuel my passion for advancing knowledge in social work scholarship and leadership.

My committee Sid, Lesley and Ranjan stayed with me through my compassionate leave and requests for additional time. Sarah Gehlert provided very valuable feedback and observations as my external examiner. Your thoughtful comments and feedback were valued at each step in the process. Providing support and guidance through my dissertation proposal and investigation process was pivotal to making this a meaningful investigation and vision for improved health care services. As the chair of my committee I learned a great deal from Sid regarding so many aspects of social work scholarship and research in social work and health care policy.

I am grateful for the very generous time Dr. Ronal Heck provided in structuring the data and providing me with guidance in multilevel data analysis at each step. Dr. Heck was tremendously gracious with time and patience in formulating my limited knowledge in multilevel statistics. Dr. Elif Acar was also most helpful in her statistics consultation and advice regarding how best to approach the study and how to interpret findings at each step. Without both of you this process would not have been possible.

A big thank you also goes to Ms. Laurie Walus, and the other staff at the Winnipeg Regional Health Authority Hip and Knee Institute who made accessing the data possible. Laurie continued to be my supervisor in a number of different capacities over the last several years and her confidence and unyielding support has been greatly appreciated.

Philippe Gamache and other members of The Institut National de Santé Publique du Québec, were also very helpful in providing the deprivation indices to me in a convertible file format and going back over missing or incorrect postal codes to make the data as complete as possible. With their leadership the institute inspired me to learn more about area level deprivation and the application in health research.

I also need to express my deepest gratitude to my immediate family, Jim, Jack and Maddy who are always patient with me. Your fortitude during this long journey and unwavering love is greatly appreciated.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

-2 LL	Minus 2 log likelihood
AIC	Akaike Information Criterion
ANOVA	Analysis of Covariance
BMI	Body Mass Index
Can-Marg	Canadian Marginalization Index
CI	Confidence Intervals
DepindexM	Material deprivation index
DepindexS	Social Deprivation Index
HRQoL	Health Related Quality of Life
ICC	Intraclass Correlation
IBM SPSS	IBM Statistical Program for the Social Sciences
MCAR	Missing Completely at Random
MCS	Mental Component Score
MI	Multiple Imputation
OKS	Oxford Knee/Hip Score
PCS	Physical Component Score
PHAC	Public Health Agency of Canada
SERI	Socioeconomic Risk Index
SES	Socioeconomic Status
SF-12	HRQoL- Short Form 12
VANDIX	Vancouver Area Deprivation Index

Chapter 1: Introduction

Rationale for Investigating the Influence of Neighbourhood Deprivation on Life Quality

In this dissertation, I examine the contribution of social causes to differences in health related quality of life (HRQoL) for people with advanced arthritis. This investigation is warranted as arthritis is a leading cause of incapacity and pain, resulting in decreased life quality and significant economic and social care burden (Hawker et al., 2002; Li, Gignac, & Anis, 2006). This is a burgeoning aging and public health concern as arthritis is one of the most prevalent chronic conditions affecting the older adult (Arthritis Society, Arthritis Community Research and Evaluation Unit [ACREU], 2013; Badley, Canizares, Perruccio, Hogg-Johnson, & Gignac, 2014; Miller et al., 2008; Public Health Agency of Canada [PHAC], 2010). The impact of the condition is an issue of health equity and social justice as individuals with lower socioeconomic status (SES) and from more deprived areas endure a greater burden of symptoms. Although the impact of deprivation on morbidity and mortality in the course of arthritis and other chronic health conditions is well documented (Guillemin, Carruthers, & Li, 2014; Yang et al., 2015), the mechanisms by which social factors actually impact quality of life and wellness remains poorly understood. My investigation advances knowledge in this arena as I examine differences in health outcomes, considering area level material and social deprivation. Few investigations to date have examined the impact of neighbourhood deprivation on HRQoL, and little attention has been paid to area level deprivation in arthritis care and research.

Drawing on the theoretical frameworks provided by Link and Phelan's (1995) *fundamental cause theory* and the theoretical concept of *habitus* (Bourdieu, 1984), I investigate the indirect and direct processes by which neighbourhood deprivation affects HRQoL in a population with advanced arthritis. This research is necessary, as much of the emphasis in quality of life research in chronic illness has focused on identifying biological and demographic influences, with far less attention to structural or environmental considerations. By exploring issues of health equity, and the social context of health, social work is in a unique position to advance scholarship in this area. It is important to continue to contribute to social work knowledge and to move this expertise forward in practice and research. In social work, research has trailed behind practice in taking a more holistic approach that encompasses the social, behavioural, and biological in understanding social phenomena (Gehlert, Mininger, Sohmer, & Berg, 2008). Although social work has a strong tradition in community development, integrating neighbourhood level indicators in research is rare in the social work literature. Very few investigations were found that examined the specific implications of neighbourhood deprivation.

There is a paucity of literature attempting to explain the specific mechanisms by which deprivation both directly and indirectly contributes to well-being and life quality. The relationships between different variables and causal explanations have not been comprehensively examined. To date, most investigations have ignored or poorly integrated the impact of SES markers in health services research (Daniels, 2008). As well, few investigations have examined the impact of neighbourhood deprivation on the older adult (Yen, Michael, & Perdue, 2009).

In a multilevel analysis combining neighbourhood deprivation indices and selected individual attributes, I advance current knowledge on the impact of the environment on living with arthritis. I explore three research questions in this dissertation:

1. Does neighbourhood deprivation have an independent negative influence on HRQoL for people living with arthritis?

2. Along with neighbourhood deprivation, does advancing age, body weight, functioning, gender, having other coexisting health conditions contemporaneously or in the past further influence HRQoL?
3. Are there interactions between these individual attributes and neighbourhood deprivation?

From these attributes, I identified a parsimonious model that postulates a theoretical framework to guide the discussion regarding how neighbourhood deprivation and selected attributes directly and indirectly contribute to differences in HRQoL.

My investigation contributes to current research in two unique ways. By integrating a fundamental cause and a habitus theoretical framework in this study, I expand knowledge on how deprivation impacts HRQoL for people living with arthritis. I also advance knowledge on pathways through which neighbourhood deprivation influences life quality by examining the interaction between area level deprivation and individual attributes.

Knowledge in this area is needed, as arthritis is a formidable health concern in Canada and elsewhere. Arthritic conditions affect over 4 million Canadians (Arthritis Society, ACREU, 2013; PHAC, 2010). Arthritis is a disabling and often chronic condition that limits mobility and contributes to increased dependency in later life (Weiss, 2011). With population growth in the older adult age cohort, it is estimated that by the year 2036, 7.5 million Canadians will have arthritic symptoms (Arthritis Society, ACREU, 2013).

The medical cost in Canada for arthritis-related care is estimated to be over $6 billion, with indirect costs estimated at close to $4 billion (PHAC, 2010). Along with the cost of surgical interventions, there are many indirect economic implications. Individuals with more advanced arthritis often have difficulty remaining in the workforce and maintaining financial independence

(Kaptein, Gignac, & Badley, 2009; Yoon & Doherty, 2008). The indirect costs of short-term disability, premature exit from work, and reduced performance and productivity are likely underestimated (Li et al., 2006).

Similar to other chronic health conditions, such as diabetes and heart disease, arthritis is often more of a burden for individuals with low income and those from more impoverished geographic areas. Low income and residence in a deprived neighbourhood are risk factors in developing arthritis and in reporting worse life quality for people who do have arthritis (Ackerman, Graves, Wicks, Bennell, & Osborne, 2005; Alishiri et al., 2008; Marra, Lynd, Esdaile, Kopec, & Anis, 2004). The incidence and severity of arthritis is estimated to be even higher in developing countries (Saffari, Meybodi, Ghanizadeh, & Koenig, 2014).

Arthritis is unequally distributed in the population with more women, the elderly and Indigenous people reporting higher incidence of the condition (Cañizares, Power, Perruccio, & Badly, 2008; Guillemin et al., 2014; Marra et al., 2004). Further study and policy uptake is needed to develop responsive services and health promotion strategies for Canada's aging population (Basta, Mathews, Chatterfield, & Brayne, 2008). There is an overwhelming need for hypothesis-driven research on models linking specific neighbourhood elements to health and vitality in the older population and to identify elements in the environment that contribute to reduced mobility for lower income seniors (Clark et al., 2009; Yen et al., 2009). Most investigations have occurred in the European and United States context (Callahan et al., 2011; Callahan et al., 2009; Harrison et al., 2009; Harrison et al., 2005); and may not be generalizable to the Canadian policy context.

Significance of the Study

By emphasizing quality of life in this investigation, I placed the emphasis on the lived experience of having a chronic health condition. Investigations to date have involved only limited examination of health outcomes such as HRQoL. This is an important calibration of impact and an indicator of the effects of symptom management on day-to-day living (Ashing-Giwa & Lim, 2008). This construct situates individuals' experiences of living with a health condition. Literature to date is scant on the relationship between quality of life and place, with little reflection on geographic location. The importance and meaning of place is neglected in quality of life research while there is strong evidence to support the relationship between life quality and the social environment (McKee, Kostela, & Dahlberg, 2015).

There is wide agreement that individual characteristic, individual level of income, and neighbourhood factors influence the prevalence and severity of arthritis (Ackerman et al., 2005; Alishiri et al., 2008; Harrison et al., 2009; Harrison et al., 2005; Mingo, Martin, Shreffler, Schoster, & Callahan, 2014; Rhemmes-Martin, Sheffler, Schoster, & Callahan, 2010; Yang et al., 2015). However, there continues to be significant unexplained variance in HRQoL indicators such as self-reported health and vitality, beyond the variance explained by individual characteristics and regional mean income (Cañizares et al., 2004; Matheson, Moineddin, & Glazier, 2008; Mingo et al., 2014).

As well, critical research involving the construct of HRQoL is necessary as there is divergence in the literature on how HRQoL is both conceptualized and measured (Bullinger, 2002; Di Gallo, Felder-Puig, & Topf, 2007; Ferrans, Zewick, Wilbur, & Larson, 2005). Key tensions such as identifying the range of factors that impact quality of life and how much emphasis should be placed on subjective perceptions of life quality continue. There is also disagreement in establishing what factors influence life quality in the chronic illness context (Taillefer, Dupuis, Roberge, & LeMay, 2003). Quality of life research rarely attempts to contextualize the individual within a region and situate the individual within that wider context (McKee et al., 2015). Also, to develop and provide responsive health care services, there is a pragmatic need to develop and advance models with attention to casual relationships (Ferrans et al., 2005). To date, more expansive casual explanations have been under conceptualized and under researched (McKee et al., 2015).

In this dissertation, I draw from two theoretical frameworks: the theoretical concept of *fundamental cause theory* presented by Link and Phelan (1995; Phelan & Link, 2005) and the concept of habitus presented by Bourdieu (1984; 1993; Bourdieu & Wacquant, 1992) and advanced by others (Durey, 2015; Mansyur, Amick, Franzini, & Roberts 2009; Shim, 2010; Singh-Manoux & Marmot, 2005). These complementary orientations provide a rich foundation for situating the influences of both material and social deprivation on health related quality of life.

Theoretical Framework

Link and Phelan (1995) put forward fundamental cause theory to explain the deleterious impact of reduced economic resources on health and well-being. Although their work has primarily focused on economic differences in mortality, this theoretical orientation has been applied to both longevity and life quality. Link and Phelan (1995) emphasized the impact of limited resources on health and well-being, and, as I will argue, in turn, reduced quality of life. There is a de-emphasis on the biological and behavioural causes of disease, recognizing poverty and reduced income as the root cause of poor health and quality of life. This orientation provides an explanation for how material deprivation in particular impacts health outcomes.

As Link and Phelan (1995) explained, SES markers such as income, level of formal education, and professional job status directly impact the extent of material and psychosocial resources available to a person. Wealth in the form of knowledge, money, influence, and prestige are recognized as fluid reserves that enable people to avoid risk and protect their health and life quality. In lower SES groups, there are competing demands for survival, and people often have limited resources to dispense when faced with adversity. It is argued that a differential in material resources impacts a person's ability to avoid and respond to hazards throughout the life course (Masters, Link, & Phelan, 2015; Phelan & Link, 2005; Phelan, Link, Diez-Roux, Kawachi, & Levin, 2004; Robert et al., 2009). This includes material assets as well as nonmaterial resources such as social networks, health capital and resiliency. Although their work has primarily emphasized health, the orientation has important implications for health-related outcomes such as life quality and therefore contributes theoretical clarity to this dissertation as a broad explanation of inequalities in health outcomes. In my investigation, I hypothesize that poverty of both social and material resources is a root cause of differences across the deprivation strata. The fundamental cause of differences in HRQoL is attributed to differences in area milieu. The material deprivation index in particular is an operationalization of this construct. I discuss this in further detail later in this chapter.

In western societies, there is an advantage to those with more resources who can expend monetary and nonmonetary capital in the face of illness or other adversity. This is often described considering differential access to goods and services and the increased risk of high stress in daily living in impoverished environments. Reduced access to goods and services place those with fewer resources at a disadvantage as health benefits often ricochet to the resource rich who can overcome obstacles and promote good health, with the reverse being true for the resource poor (Shim, 2010). There is wide agreement that a deprived environment will impact health and quality of life over time (Marmot, 2006; Mõtus, Gale, Starr, & Dreary, 2012; Robert et al., 2009). Directly, there is a biological impact that changes health, and indirectly, impoverished material resources and less optimal access to a healthy lifestyle and adequate food choices encourages the dependence on a carbohydrate rich diet and resulting health risks, such as obesity (Lebel, Riva, Pampalon, & Thériault, 2009; Matheson et al., 2006). Differences across the social strata impact the capacity to react to, and acquire and expend *health capital*. That is, the ability to proactively maintain health, synthesize medical information, and negotiate need (Shim, 2010). Often health maintenance and self-management are dependent on one's ability to mobilize resources and actively participate in illness management. This often compromises segments of the population who do not have the same access to formal and informal health and social care resources.

There is also evidence to support the negative influence of sustained high levels of stress from living in poverty to the progression of existing conditions and reduced resistance to the ramifications of unhealthy behaviours (Bartley, 2004; Burns, 2015, Robert & Li, 2001). The impact is often exponential, with a doubling effect of more exposure to negative events and depleted protective resources (Almeida, Neupert, Banks, & Serido, 2005; Cohen, Kaplan, & Salonen, 1999). There is a cumulative impact of adverse living conditions, excessive stress and the adoption of maladaptive unhealthy coping behaviours within the restrictive environment (Robert et al., 2009). Deprived neighbourhoods have fewer resources to sustain healthy activities, permanent employment, safety and other protective mechanisms. As well, poor individuals with less advantage are concentrated in areas, reinforcing limited community network resources and increasing risk for social isolation and diminished social supports.

I will argue that fundamental cause theory is complimented by the concept of habitus presented by Bourdieu (1984) and Bourdieu and Wacquant (1992). The theoretical epistemology is an amalgamation of the Marxist theory of structured inequality and Weberian beliefs about class hierarchy (Mansyur et al., 2009). Applying habitus, these researchers argue that different communities develop different subcultures within the larger geographic landscape. This shared community and culture informs both individual and collective practices. The social environment maintains class differences with class dependent and embedded ways of acting and knowing. From generation to generation, behaviours become homogeneous within groups, and the interpretations of how the environment works become fixed.

It is argued that patterns and expectations are embedded and function at the subconscious level. For both the oppressed and dominant group, the class hierarchy becomes the norm and differences are accepted. Dominant structures, such as government services and health care are static, assuming objective markers such as social class and gender role expectations are fixed and unchanging in what Bourdieu (1984) described as *cultural structuralism*. This is an organizing field determining how people within the structure behave and participate, with the habitus informing behaviour. This behaviour is predetermined by the organizing principles that influence behaviour, expectations, and relationships. This is often unconscious and reproduced within the field and wider social structure (Durey, 2015).

The burden of poor health outcomes has origins in colonialism, inequitable distribution of resources, and both symbolic and material multisystemic inequities. There continues to be structural marginalization at the individual level through social dislocation, and the subversive reinforcement of high-risk health behaviours and social exclusion. In a similar way, it is argued that inequality also encourages social exclusion within communities, and this, in turn, leads to isolation and reduced life quality (Kawachi & Kennedy, 1997; Wilkinson, 2005). With isolation and less social support, people withdraw and do not build the nonmaterial resources they need to keep healthy. Combining the symbolic and material dimensions of social status, cultural structuralism emphasizes the socio-environmental parameters that people live within every day and how they contribute to inequity in health outcomes (Mansyur et al., 2009). There is what Bourdieu (1977) described as a worldview, a “forgetting of history which history itself produces by incorporating the objective structures it produces in the second natures of the habitus” (p. 78–79). This is often played out in colonization and political upheaval where ethnic groups are cut off from their history and do not maintain the strengths cultural practices bring to a social group.

This allows unfair structures and practices to exist and be accepted as the status quo in mainstream culture. Different communities are viewed as different subcultures or habitus nested in larger areas in diverse sub-societies. The shared community and culture informs both individual and collective practices. The power structures and rigid formal hierarchies are maintained through learned expectations and institutional processes of, behaviours, and wellness. Subversive formal processes and institutional discrimination contribute to inequality as class expectations become entrenched in social norms and institutional structures that reflect these beliefs Mansyur et al. (2009).

In health care, for example, the biomedical western model of service dominates practices (Durey, 2015). The biomedical model focuses on individual behavior rather than the collective or social determinants of health. There is a primary focus on individual behaviours and biology. Traditional health care systems are hierarchical and established with the roles of professionals and patients fixed. Expectations of patients from low SES groups, for example, become fixed and result in differential access to treatment and expectations of care.

Similar to Link and Phelan’s (1995, 2005), (Phelan & Link, 2005), Phelan et al.’s (2004), and Masters, Link and Phelan’s (2015) bodies of work previously discussed, Bourdieu (1977, 1984) provides a theoretical framework to explain differences in mortality across the SES spectrum. However, Bourdieu (1977) provides an explanation of the differences in day-to-day life quality and the embedded nature of these differences within a culture, and of how a neighbourhood can impact life quality and health outcomes considering class based structures.

The emphasis on material impoverishment and entrenched habitus is consistent with what Bernard et al. (2007) describe as *neighbourhood deprivation*. As they explain, the embedded nature of the environment impacts the well-being and life quality of residents across five broad dimensions. First, there is a physical domain where proximity to goods and services limits or allows for access to necessary resources; this includes elements of the built environment, such as buildings and housing stock, as well as the ecological components that are shared like the extent of pollution, access to goods and services, access to green space and walkability of the sidewalks. Second is the economic realm dictated by the private market’s influence on availability of goods and services in the geographic area. Third is the institutional domain that considers the extent to which citizens have access to structures and institutionalized resources, such as social welfare income benefits, health care, and public education. Fourth is the nature of the social environment, the extent of local sociability and cohesion. The social environment includes the extent of social capital, community inclusion, and reciprocity between members. Last is the extent of organizations within the community; that is, the extent of social organizations and the ability of the community to mobilize and influence changes in the other domains.

In summary, this theoretical framework provides a context for examining the impact of deprivation at the neighbourhood level. A neighbourhood is a unique system with relevant resources and relationships that are well established and entrenched within an environmental border (Bernard et al., 2007; Drukker & van Os, 2003). The constructs of both material and social deprivation situate life quality considering the experience of impoverishment and embedded disenfranchisement at the community level. These domains provide a multidimensional explanation of the influence of place on health that is consistent with the theoretical framework that emphasizes the economic, institutional, and environmental realm captured in the fundamental cause and habitus theoretical contexts.

Chapter 2: Literature Review

I begin this literature review with an overview of arthritis as a chronic illness. I then summarize the expansive literature on the relationship between health and poverty and provide a description of the constructs of HRQoL and of neighbourhood deprivation, including how I define them both in this investigation. This includes a summary of investigations that have considered the impact of both indicators of neighbourhood deprivation and indicators of individual level income on HRQoL. I include studies that examine individual income because the studies that examine arthritis, area level disadvantage, and life quality are scant. This body of work also provides further insights into the impact of disadvantage on life quality in this chronic illness population. As well, these studies underpin the direct impact of poverty on this health outcome. I also include literature that examines the influence of neighbourhood deprivation on other health outcomes such as mortality, morbidity, and self-rated health as there are minimal investigations that consider the impact specifically on HRQoL. In the last section, I provide a comprehensive summary of the literature regarding community deprivation and its influence on other factors that are of interest in this study, including advancing age, gender, obesity, higher number of life time chronic health conditions, and physical functioning. In the final section I also review those investigations that have examined the influence of each of these factors on life quality.

Arthritis

Arthritis is a general health term used to describe a number of degenerative and inflammatory musculoskeletal and connective tissue conditions (PHAC, 2010; World Health Organization [WHO], 2007). This includes a spectrum of joint pain conditions that have a variety of symptoms and can range in severity from minor discomfort to complete debilitation. Most arthritis conditions impact adults. There are a variety of types of arthritis that impact children, such as juvenile idiopathic arthritis while some conditions such as osteoarthritis are developed and far more common in old age. There are in fact over 100 different conditions clustered in to the illness (Barlow, 2009). Investigations vary in what types of arthritis they include in study populations and how the condition has been diagnosed, either by self-diagnosis, family physician or a rheumatologist or surgeon. Classification is often difficult due to the lack of confirming diagnostic tests (Barlow, 2009). The most common types of arthritis are osteoarthritis, rheumatoid arthritis, ankylosing spondylitis and juvenile idiopathic arthritis. These are discussed below as they represent the most common arthritis conditions and are most often the population that receives joint replacement surgery.

Osteoarthritis is considered the most prevalent type of arthritis. Often symptoms involve loss of auricular cartilage and resulting pain, stiffness and difficulty initiating movement (Barlow, 2009: PHAC, 2010). The symptoms often involve pain and immobility in specific joints and the condition is classified by the joint affected, such as ‘osteoarthritis of the knee’. Many people have more than one joint impacted. With aging most people have joint deterioration and osteoarthritis can range from modest discomfort to complete joint degeneration. Along with advancing age, risk factors for developing osteoarthritis are being female, obesity, trauma to the joint, repetitive joint loading due to occupation, and heredity (Clough, 2009; PHAC, 2010). The condition often follows an unpredictable course with the deterioration of cartilage continuing with advancing age.

Rheumatoid arthritis is a multisystemic condition that involves swelling of joints and synovium and other autoimmune responses. The illness often develops in the early adult years with more women developing rheumatoid arthritis than men. Like osteoarthritis, there is a strong hereditary link. Rheumatoid arthritis can be detected by measuring the rheumatic factor, however, the factor does not always match disease severity. With rheumatoid arthritis the synovial membrane is inflamed and often thickens and progresses to deterioration of the cartilage and bones of the joint involved (Barlow, 2009; Clough, 2009).

Symptoms involve joint pain, fatigue, stiffness and generalized weakness. Individuals often develop anemia of chronic disease. There is often involvement of the hands and feet and eventually physical changes in the joint that impacts functioning. The illness often follows an unpredictable course with periods of remission and illness exacerbation. With sustained inflammation and high disease activity there is an increased likelihood of earlier death from other illnesses (Elliot, 2008).

Ankylosing Spondylitis is a group of conditions that involves inflammation in the spine as well as other systems. This can also involve vision (Clough, 2009). This illness group includes psoriatic arthritis where the skin over joints is also inflamed and develops psoriasis outbreaks that can flare up with or without joint pain flare ups. Ankylosing spondylitis often develops before age 40 and is far more prominent in men (Clough, 2009). There is a genetic component, although symptoms often begin and flare up with the onset of another infection. The symptoms most often involve pain and immobility in the spine and in the hip joints (Barlow, 2009). The point of connection between the bone, ligaments and tendons is often where the inflammation and deterioration occur.

Juvenile idiopathic arthritis is a cluster of chronic inflammatory condition that develops in early childhood. The condition affects both sexes but is more common in girls (Barlow, 2009). Symptoms can be found in a few joints, multiple joints and even the entire system, resulting in skin rash, fever and vision impairment (Clough, 2009; Barlow, 2009). Symptoms are most often acute and involve swelling in the ankles, wrists and knees. About 50% of children experience complete recovery; while others will go on to have varying levels of joint deterioration and symptoms throughout childhood and into adulthood. Similar to rheumatoid arthritis the disease has an unpredictable course with remission and periods of flare up. Children with idiopathic arthritis and people without any conditions in childhood can develop arthritic conditions in later life, and people with one arthritic condition can develop others involving multiple joints. This is often referred to as polyarthritis, when five or more joints in the body are inflamed and show signs of synovial membrane inflammation.

In this dissertation, I use the term *advanced arthritis* to describe degenerative musculoskeletal conditions that have resulted in chronic, persistent, and severe joint degeneration (Cobos et al., 2010). This is the clinical group that shows radiographic bone and joint changes with debilitating poor functioning and pain, primarily due to underlying osteoarthritis and rheumatoid arthritis (Cobos et al., 2010; Ethgen, Bruyère, Richey, & Dardennes, & Reginster, 2004). These patients are often candidates for total or partial joint replacement. The replacements are most often in the lower extremity joints of the hip and knee. This generally occurs in late adulthood and old age as the chronic condition progresses and causes permanent, irreversible joint damage, debilitating pain, and reduced mobility.

Arthritis care generates significant health expenditure and other costs (PHAC, 2010; Locker, 2008; Yang et al., 2015). This is a considerable issue in healthy aging, as complications from arthritis are associated with increased dependency, decreased mobility, and an earlier onset of frailty (Fried, Ferrucci, Darer, Williamson, & Anderson, 2004). The condition is often accompanied by chronic pain, joint failure, fatigue, and functional impairment (Barlow, 2009; Ethgen et al., 2004). Arthritis is a significantly disabling disorder that contributes to functional decline and impairment in activities of daily living. Having rheumatoid arthritis in particular, also places one at an increased risk of death from other health conditions, such as cancer and cardiovascular disease (Elliott, 2008). Also, there is often a causal cascade of symptoms and decline beginning with pain and fatigue progressing to eventual decrease in participation in employment and independence in activities of daily living (Elliott, 2008; Yang et al., 2015).

Fatigue is often a troublesome symptom. Of people with rheumatoid arthritis, 40% to 80% report having fatigue along with compromised physical ability (Barlow, 2009). The fatigue is most often intermittent and unpredictable. It may or may not occur with increased activity or other new or changed behaviour. This uncertainty can become a major hindrance as what starts off as a good day in the morning can change very quickly to a bad day by the afternoon or evening (Locker, 2008). This leaves one looking for a predictable pattern, perhaps related to exercise or a change in the weather, when in fact, the change in symptoms may not have a consistent trigger. Fatigue, pain, functional decline, and immobility are prominent symptoms that become persistent and chronic in one's life. Obesity also has a well-recognized causal effect in arthritis, with weight gain being the result of limited mobility and a more sedentary life, and, in turn, a further contributor to increased pain and reduced functioning (Barlow, 2009).

As advanced arthritis is more common in the older adult and elderly, many individuals with arthritis also struggle with co-occurring health conditions. The presence of co-occurring conditions often impacts overall functioning, well-being, and health maintenance. Co-occurring health conditions are more common with arthritis than with other chronic health conditions, such as diabetes or heart disease (Alonso et al., 2004).

Health and Poverty

Recognizing the influence of environmental and social factors on health can be dated back to the 1800's when Friedrich Engels and Rudolph Virchow included political, economic, and social forces in their writing about early death from disease (Raphael, 2006). In his first issue of the *Journal of Social Reform*, Rudolph Virchow noted that "physicians are the natural attorneys of the poor and social problems fall to a large extent within their jurisdiction" (as cited in Alleyne, 2000, p. 7). By the mid-20th century, further recognition of the limits of medical intervention came from another physician, Thomas McKeown, who presented the counterintuitive argument that lower mortality rates over the 18th and 19th centuries were due to improvements in living conditions and other broad social improvements, and were not the result of advances in medicine (Braveman & Gottlieb, 2014; Link & Phelan, 2002). This was further supported by Antonovsky (1967) who provided a comprehensive review of over thirty studies that supported a negative linear relationship between SES and, in particular, income and health. The analysis in these early works supported a materialist perspective, recognizing extreme poverty as incongruent with health and well-being, and as contributing to early death.

It was not until the late 20th century that social factors were widely identified as key health determinants in developed nations. International acclaim followed the 1980 Black Report (Department of Health and Social Security [DHSS], 1980) in the United Kingdom (UK). This was the first formal government report that presented the provocative conclusion that social factors, not biological indicators, contribute to longevity. This was empirically corroborated by data that substantiated a widening disparity in the UK in spite of decades of access to universal health services (Braveman & Gottlieb, 2014). The Black Report introduced the conceptual foundation to consider a variety of causal theories of inequality in death and chronic illness and to explore the influence of the structure and constitution of formal social systems and their effects on health. This was further supported in mainstream international health improvement efforts. In 1986 Canada hosted the World Health Organization (WHO) conference on health where the *Ottawa Charter for Health Promotion* established the broad social and environmental prerequisites for health (Raphael, 2006). These include factors such as, shelter, food, education, income, a stable ecosystem, sustainable environmental resources, equity, social justice and political peace (Raphael, 2006). This provided an international forum for the establishment of key factors identified as the social determinants of health (Raphael, 2006). More recently, the *Rio Declaration* (WHO, 2012) reconfirmed the deleterious impact of social factors on health and the need to advance a commitment that recognizes the evolving recognition of social determinants in the globalized environment. This declaration encourages the inclusion in social determinants of health agenda, improving living conditions across countries, a commitment to evaluating efforts to reduce inequity, and strategies to eradicate social differences in health outcomes.

In Canada and elsewhere there has been little headway in reducing the negative influence of social determinants on health and health inequality (Brassolotto, Raphael, & Baldeo, 2014; Braveman & Gottlieb, 2014; Hudson & Gehlert, 2015). This is attributed to structural barriers, such as the differential burden for accessing care (Loignon et al., 2015; Tang, Brown, Mussell, Smye, & Rodney, 2015) and the failure of public health policies, as well as other policy initiatives to redirect the dominant biomedical discourse in health promotion policy and research (Brassolotto et al., 2014). I will argue that there has also been limited improvement in social welfare benefits in Canada in particular.

There are a number of theoretical perspectives on the causal processes explaining how SES actually “gets under the skin” (McEwen & Mersky, 2002, p. 1727) to influence health. These can be categorized across five broad domains: the *materialist* perspective, the *neo materialist* perspective, the *political economy* perspective, the *cultural behavioural* perspective, and a *life course* perspective. I describe each briefly in the next section.

The materialist perspective (Bartley, 2004) considers poverty as the root cause of poor health. Theorists emphasize the difference in tangible resources, such as housing, access to healthy food and employment, residence in a safe neighbourhood, and income level on health (Bartley, 2004; Link & Phelan, 1995; Raphael, 2009; Sundmacher, Scheller-Kreinsen, & Busse, 2011). This perspective attributes less optimal health to the lack of resources in a capitalist society where there are marked class differences between the middle and working classes (Sundmacher et al., 2011). This view supports the assumption that poverty is the fundamental cause of these differences in health status (Link & Phelan, 1995; Masters et al., 2015). In impoverished areas, and for poor individuals, the extent of poverty influences poor health outcomes.

The neo materialist perspective expands on the materialist perspective with a consideration of the formal welfare and social care systems available to citizens (Bartley, 2004). This perspective emphasizes the impact of living conditions on individual health, along with the wider community factors that impact population health, such as income benefit programs and health and community services. The unequal distribution of health outcomes is seen as the product of differential access to material goods, as well as the quality of public services, income protection, health care resources, the extent of social welfare programs, and quality education and other services. There is well recognized differential access to services, even in countries with universal health care (Loignon et al., 2015). These elements are recognized as the structural matrix that influences overall health (Lynch et al., 2004).

The political economy perspective (Bartley, 2004) emphasizes the broader macro systemic influence in market societies. This perspective identifies politics and economic policies as the root source of disparity (Coburn, 2000, 2004; Lynch, Davey Smith, Kaplan, & House, 2000). From this perspective, there is also recognition of class structure and the unequal distribution of power (Muntaner, Chung, Murphy, & Ng, 2012). The orientation considers relational and structural approaches to SES and not only the traditional objective measures of income and education (Coburn, 2004). For example, urban poverty in large cities is viewed as the result of global capitalism, with a concentration of unskilled and sporadically employed workers in the inner city neighbourhoods (Tang et al., 2015). The wider influence of inequities in social position, political and economic power and wealth distribution within societies, characterizes health status as “more sociological than epidemiological” (Coburn, 2004, p. 41). Proponents also point to the biases inherent in what is researched, how health policies are formulated, and how clinical services are provided (Muntaner et al., 2012; Tang et al., 2015).

In the developed western countries of Canada, the US and the UK there is less infrastructure support to eradicate poverty and a skewed distribution of income resulting from taxation policies in comparison to other OECD countries (Raphael, 2006). The more recent conservative and neoliberal governance directions influence poverty rates and the distribution of wealth. These countries have comparatively higher poverty rates, rates of infant mortality, higher incidence of lower birth weight than other OECD countries that have more progressive government infrastructure and less extreme income distribution (Raphael, 2011).

While emphasizing the individuals role in their own health the behavioural cultural perspective provides a cluster of explanations of differences in health based on the assumption that differences in outcomes are the result of norms, attitudes, and variance in health practices and behaviours among social groups (Bartley, 2004). The term was originally put forward in the Black Report (DHSS, 1980) as a classification for health inequality theories that focus on the individual and what they described as reckless and irresponsible behaviour that leads to early death. This perspective points to the individual behaviour patterns that contribute to poor health, such as the consumption of carbohydrate rich food, alcohol and tobacco misuse, and the underutilization of health promotion measures, such as vaccinations, contraception, and early diagnostic screening (DHSS, 1980). From this perspective, differences in health behaviour are attributed to low educational opportunities and other cultural components that are embedded in social structures and are distinguishable by class (Townsend, Davidson, & Whitehead, 1988). This includes the impact of neighbourhood deprivation on behaviour, such as exposure to high crime, reduced emphasis on healthy lifestyles, and, I will argue, reduced social support. Reduced social contact reinforces isolation and social exclusion, and this limits health capital and other healthy social supports (Shim, 2010).

Since this early classification, research has continued to recognize behavioral differences across social groups in health behaviour such as ever eating high calorie foods, level of exercise, tobacco use, and other health practices (Bartley, 2004; K. L. Frohlich et al., 2006; Matheson et al., 2008). This has been described by Sundmacher et al. (2011) as an example of the habitus, as people assume the characteristics of their environment, and the environment, in turn, influences people by differentially providing resources, such as access to higher education, adequate social supports, and adequate employment. The disadvantage contributes to deterioration in health over time.

The life course perspective emphasizes the cumulative impact of deprivation across one's life time (Bartley, 2004). This perspective became more prominent in the1980s as longitudinal studies on health outcomes became more available and pointed to the temporal nature of poor SES and poor health, and the longitudinal impact of poor opportunities early in life (Williams, Calnan, & Dolan, 2007). The perspective recognizes class as stable over time with disadvantage in childhood most often followed by disadvantage in adulthood, such as reduced educational opportunities, lower paid jobs, and other class-defining experiences. This includes factors such as poor housing in unsafe low income neighbourhoods in both childhood and adulthood. The impact on health is recognized as cumulative and compounding. There is strong empirical evidence to support the deleterious impact of poverty in childhood and the risk of adverse health outcomes during adulthood and later life (Robert et al., 2009). These differences often persist, even if the individual moves out of poverty as a young adult (Raphael, 2011). From a life course perspective, health status is understood as a long-term adaptive process that develops and maintains an ability or inability to avoid disease and accidents. This takes into account the cumulative impact of experiences and events across a lifetime and the long-term impact of repeated unhealthy experiences (Rapael, 2006; Robert et al., 2009). From a life course perspective a theoretical focus and empirical body of work has been established by social work scholar Stephanie Robert (Robert & Lee, 2002; Robert & Li, 2001; Robert & Ruel, 2006; Yao & Robert, 2008). Robert provides a life course perspective to consider area deprivation and health outcomes within a social justice framework. Her research and scholarship focus on how the neighbourhood context impacts the health and vitality of residents and how disparity in the geographic area contributes to health disparities over the life span. Robert and her colleagues have provided a foundational body of work that demonstrates how SES and race affect health over the life course and into old age. These studies consistently support a gradient relationship between neighbourhood poverty and the risk of earlier death. In these investigations neighbourhood poverty explained variance beyond poverty at the individual level.

Discrimination and working against widespread prejudice and racism also takes a substantial toll on health. Striving in environments with entrenched racism have has been proven to increase blood pressure, ruminative thinking, impede performance and interfere with memory and cognition (Steele, 2010). Through the life course, persistent experience with institutional racism impedes full participation in society and has a considerable toll on health.

The life course perspective (Bartley, 2004) also recognizes the cumulative benefit of health promoting behaviour. This includes the long term impact of enriched development in prenatal and infant health, early childhood development, family life, school and work readiness, and successful transition through the life course. There is also agreement that differences in life circumstances impact the ability to cope and respond to change, recognizing the double burden of more exposure to stress and fewer resources to cope with stress (Robert et al., 2009). This perspective is also consistent with Bourdieu’s (1984) concept of habitus, acknowledging the embedded nature of poverty at both a personal and community level.

Internalized marginalization links identity with performance (Steele, 2010) and under achievement begins to take a toll in young adulthood and has impact through adult earning years and into old age. As well, it is acknowledged that the relationship between socioeconomic factors and health is complex and dynamic, involving multiple systems that influence gene expression that may only manifest in the body many decades later (Braveman & Gottlieb, 2014).

Poverty has been linked to reduced health back to the 18th century and the early work of Friedrich Engels and Rudolph Virchow. In traditional medical investigations SES was often considered a confounding variable and an attribute that needed to be controlled for in research, and not the potential cause of differences in outcomes (Marmot & Brunner, 2005). Since this early time there was acknowledgment that absolute poverty was detrimental to health and could result in early death. In early investigations there was building interest in examining more complex relationships, such as specific illnesses and the gradient nature of the relationship between health and wealth. The gradient nature of the relationship between SES and health was introduced and refined in a large body of empirical investigations starting with the Whitehall Studies of British civil servants by Marmot and Wilkinson (2001). Marmot and colleagues followed British civil servants over ten years and found that lower job grade was associated with higher risk of early death. This work was followed by the Black Report in the UK in 1980 that again confirmed the detrimental impact of poverty and the SES gradient in longevity. Since this report and related documents, higher income, job status, and education have been consistently linked to a lower risk of mortality and disability (Bartley, 2004; Braveman & Gottlieb, 2014; Cohen et al., 1999; K. L. Frohlich, Ross, & Richmond, 2006).

This literature includes a number of divergent health status markers and a variety of populations primarily in the western countries of the UK, US, and Canada. These markers include, all-cause mortality, life expectancy, prevalence of infectious diseases, chronic health conditions, and even death from accidents and suicide (K. L. Frohlich et al., 2006; Loignon et al., 2015; Ross, Oliver, & Villeneuve, 2013). This gradient is present across indicators of SES, such as education and job classification and across age groups (K. D. Lawson et al., 2013; Robert et al., 2009). This exists in the universal health care context as a linear relationship between health and longevity has also been found in Canadian investigations (Terashima, 2011). In the Canadian context, as well as European countries with universal health care and comparatively expansive social welfare programs, the gradient continues. Over the last 25 years a substantial body of work supports a broad range of indicators of poverty and SES status as determinants of health outcomes. There is growing literature regarding the pathways and processes by which social factors influence health with evidence supporting a causal relationship between a number of poverty and SES markers. More recent research is examining biological and psychological processes and other pathways in this complex relationship (Braveman & Gottlieb, 2014). Several of these investigations are discussed further in the next section when the studies relate to variables of interest in this investigation.

In summary, literature to date has chronicled the impact of poverty on health and has provided a broad landscape to expand current knowledge by investigating the specific health condition of arthritis, deprivation at the neighbourhood level, and health related life quality. This dissertation contributes to the literature because I examine the experience of living with a health condition, as opposed to the more gross markers of mortality and the existence of comorbid health conditions that this previous described literature focuses upon. In the following sections, I review in detail the construct of health related quality of life and neighbourhood deprivation to further articulate the constructs, as I use them in this investigation. Following this I will discuss specific selected investigations as they relate to the study topic.

Health Related Quality of Life (HRQoL)

Unlike the well-documented historical legacy of health and poverty, HRQoL is a much newer field of investigation. Quality of life became a popular concept during the social indicators movement of the 1960s (Bowling, 2000; Rapley, 2003). A number of governments introduced *quality of life* as a concept to quantify the impact of policies and programs on the lives of individuals (Day & Jankey, 1996). During this time, extensive social program initiatives promoted community wellness and emphasized health promotion, moving away from economic performance indicators of growth such as the gross domestic product to more qualitative lifestyle indicators (Raphael, Brown, Renwick & Rootman, 1996). The approach matured to include other indications of psychological and subjective perspectives on life experience, moving the concept from the community to the individual and her or his appraisal of her or his own situation.

Quality of life is a term used to capture individuals' "perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (WHO, 1997, p. 1). This concept quantifies the appraisal of the richness and depth of an individual's life and includes subordinate constructs such as happiness, well-being, self-rated health, and satisfaction with life. There are inconsistencies regarding what elements are considered to be within and outside of the HRQoL framework. Qualities such as perceived well-being, self-rated health, happiness, and satisfaction with social care and supports, have been used in the construct of quality of life itself and also as distinct mediating variables in model development (Ashing-Giwa & Lim, 2008). In a comprehensive review of randomly selected HRQoL conceptual frameworks published between 1965 and 2001, Taillefer et al. (2003) found that fewer than half of the models had clearly distinguished what factors were included in HRQoL frameworks and what variables were thought to be outside the framework.

A substantive contribution from the field of health promotion originated with the work of Antonovsky (1967). In a study of menopausal women, Antonovsky noticed the variations in life appraisal and resiliency of holocaust survivors. He identified fortitude in particular individuals and a counterintuitive overall positive orientation to life and well-being in spite of horrific experiences. He introduced the widely influential *salutogenic* orientation to quality of life. The approach moved away from the emphasis on pathogenic forces in shaping health and well-being to what he termed a salutogenic model. Central to his theory is the concept of *sense of coherence*, a dispositional orientation reflecting the ability to integrate what is happening within the social context and the ability to make meaning out of the situation and manage the response (Antonovsky, 1967; Eriksson & Lindström, 2006). An innate sense of coherence is tempered by what he termed *general resistance resources*, such as personality, knowledge, intelligence, resilience, coping, social supports, culture, and health promotion beliefs. Antonovsky recognized these factors as pivotal to an individual's sense of coherence and adaptation under stress. This model influenced many other HRQoL theorists (Lindström & Eriksson, 2010).

Building on this foundation, HRQoL has become very popular as a quantifiable health outcome and evaluation measure with wide application in health and social care research. In health care investigations, HRQoL instruments are an evaluation measure used to discriminate health outcomes between patient and client groups and at different points in time (Furlong, Barr, Feeny, & Yandow, 2005). Growth in investigations has been exponential since the mid 1970s with the number of investigations using HRQoL measures close to doubling every 5 years since that time (Draper & Thompson, 2001). HRQoL instruments are now routinely included in many randomized clinical trials and as a clinical endpoint in evaluation research.

Evolution within specific specialty areas has contributed to diversity in the development of conceptual frameworks. What is included in the concept, and how other elements are thought to influence life quality, has been poorly articulated with variation in development across fields and specialty areas (Taillefer et al., 2003). Concept and theoretical analyses have been provided in a number of comprehensive review articles. These have included population-specific reviews and discipline-focused concept analyses. Comprehensive reviews are available from the perspective of medicine (Bullinger, 2002); palliative care nursing (Jocham, Dassen, Widdershoven, & Halfrens, 2006); nursing theory (Plummer & Molzahn, 2009); spinal cord injury (Hammell, 2004); and cerebral palsy in childhood (Rosenbaum, Livingston, Palisano, Gallupi, & Russell, 2007). Interestingly, the concept analyses and review articles are markedly diverse and present a variety of nuances in interpretation. There are substantial challenges with operationalizing the construct of health related- quality of life (Tobiasz-Adamczyk, 2013).

However, in spite of challenges, HRQoL measures provide a pragmatic way to quantify perceptions of well-being, given health constraints. The construct provides an expansive view of survivorship, and disability. This provides a reflection of self-rated health and functioning and is an indicator of well-being influenced by the person, her or his physical health status, and her or his environment.

HRQoL is a widely used patient reported health outcome measure for examining the impact of a disability or treatment on a person's life. This primarily captures satisfaction with and appraisal of one's health and other aspects of life, in the context of health. This is understood as an organizing term rather than a single well differentiated entity. Empirical investigations have operationalized the construct to primarily reflect a subjective appraisal of how one would rate her or his life quality and vitality compared to normative expectations and what most people would describe as desirable. The emphasis is most often on comparisons to perfect health status, such as the absence of pain, ability to climb stairs, and minimal emotional distress. Most measures are reductionist, indicating negative functions and the absence of ability (Tobiasz-Adamczyk, 2013). For joint replacement populations specifically, Mascarenhas has defined

HRQoL as “patients’ overall quality of life based upon the amount of pain they are experiencing and the amount of function that they have retained” (2009, p. 209).

As there is a broad range of definitions available, it is important to acknowledge at the outset what I mean by the term HRQoL in this dissertation. In this investigation, I recognize HRQoL as an umbrella term that considers the extent to which individuals feel they can enjoy the full range of experiences they want to enjoy in their lives. This includes self-appraisal of health, happiness, wellness, and symptom interference in goals and aspirations. This is viewed as a personal interpretation of how individuals see health status integrated in their daily activities and pursuits. This is based on the assumption that one’s self-appraisal is dynamic, adaptive, and rational (Tobiasz-Adamczyk, 2013).

There is agreement that the measurement of HRQoL is important in quantifying the impact of illness and recovery from a health condition on life quality. Instruments to measure HRQoL provide a practical summary of a cluster of health domains into one index for comparing the individual or group score to established norm-based scores (Robert et al., 2009). Standardized scoring allows for comparison across points in time and between patient and client groups. They importantly capture patients’ viewpoints and can direct clinical decision making (Tobiasz-Adamczyk, 2013). Their wide application and ease of administration has moved instrument development ahead of conceptual refinement. It is estimated that there are now more than 1,000 instruments available to measure HRQoL (Claes, Van Hove, van Loon, Vandevelde, & Schalock, 2010).

In this investigation, I use the Medical Outcomes Study Short Form -12 (SF-12) developed by Ware, Kosinski, and Keller (1996). This is referred to as a short version of the longer Medical Outcomes Study (SF-36), which provides a 36-item measure. Both the SF-36 and

SF-12 captures a snapshot of both physical and mental health-related life quality, given health constraints. This measure is a reductionist view, comparing current health quality to what is assumed to be perfect health. This includes symptom interference in daily life with items related to pain, and mobility, as examples. I discuss this measure further in the Methodology Chapter.

Neighbourhood Deprivation

Neighbourhood influence on health grew out of the field of environmental gerontology (Phillipson, 2007). Neighbourhood deprivation investigations and theoretical development has broadened the field of HRQoL differences to include the impact of *place* on health.

During the era of the Black Report, Townsend (1987) articulated the concept of *deprivation* beyond the individual to include the geographic area or place. He identified conditions, independent of income, that were experienced by the poor. Townsend noted that the poor lack the income to escape these area conditions (Townsend, 1987). Examining area-level deprivation and the impact on health outcomes became more popular in the 1980s with exponential growth over the next 10 to 15 years (Diez-Roux & Mair, 2010). There was, and continues to be, growing interdisciplinary acknowledgement that one's living conditions and local environment impact longevity and many other aspects of health and well-being, independent of the influence of individual-level SES. However, the strength of the relationship has varied across investigations, with effects more modest than associations between health and poverty as measured at the individual level (Diez-Roux & Mair, 2010).

The early work conducted by Townsend and his colleagues in the late 1980s defined neighbourhood deprivation as "a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs" (Townsend, 1987, p. 125). This has been followed by a growing body of work in the

UK and elsewhere. Neighbourhood deprivation articulates a typology of both the context and composition of a small geographical area (Bernard et al., 2007; White Matheson, Moineddin, Dunn, & Glazier, 2010). The *context* of an area is a reflection of shared chance and choice of living in a poor, suboptimal neighbourhood or, inversely, a resource-rich and appealing neighbourhood. It is assumed that housing location is influenced by means and individual choice as well as exposure to opportunities and resources. The context of the neighbourhood also considers access to resources, the extent of social cohesion and other characteristics of the shared habitus.

Individuals in a geographic area often represent a *composition* of shared similar socioeconomic characteristics such as lower education, lower job status, and lower income. The composition of the neighbourhood provides a representation of the individuals in the neighbourhood who are assumed to share socioeconomic and other characteristics. This reflects the SES of those who live in the area.

It is agreed that the two constructs, context and composition, are intertwined, with each reinforcing the other and together influencing health and quality of life (Cummins, Curtis, Diez-Roux, & Macintyre, 2007). Often, deprived geographic areas are a milieu for people living below an income line that is considered reasonable. They are environments that are impoverished, lack resources, have suboptimal housing stock, exhibit a precarious social climate, and have reduced access to goods and services. As well, there is often reduced social cohesion and resulting isolation in poor neighbourhoods (Keefe, 2013). This is a construct consistent with fundamental cause theory, attributing reduced health outcomes to measurable differences in materialistic wealth.

While neighbourhood composition examines the shared characteristics of individuals in neighbourhoods, the context emphasizes the structural and environmental influences in the shared environment. It is recognized that a geographic area that lacks resources most often also has social and material dispossession. The concept is often operationalized as a compilation of indicators in readily available administrative data such as census information that are agreed to reflect impoverishment and poverty.

The early work by Townsend (1987) and his colleagues identified key aggregated attributes that were assumed to capture the primary elements of deprivation. These were gleaned from the census data of an area and developed into one index to provide a summative score for comparison across neighbourhoods. The original Townsend index (1987) included the census-based descriptors of percentage of unemployed over the age of 16, percentage of households with no car ownership, proportion of nonhome ownership expressed as a percentage of all households, and percentage of overcrowded households living in the area (Townsend, Phillimore, & Beattie, 1988). This index and other earlier similar indices (Morris & Carstairs, 1991) used unweighted scoring.

In Canada, four indices have been derived from Statistics Canada census information: the N. Frohlich and Carriere (1997) Socioeconomic Risk Index (SERI), the Institute National de Santé Publique Index (INSPQ: Pampalon & Raymond, 2000), the Matheson et al. (2006) Canadian Marginalization Index (Can-Marg) Index, and the Vancouver Area Neighbourhood Deprivation Index (VANDIX; Bell, Schuurman, Oliver, & Hayes, 2007). These indices are similar, with small differences in item selection and the scale development. For example, the census variables included in the Can-Marg involves more indicators of poverty such as the percentage of residents living below the low-income threshold and proportion of people in receipt of transfer payments, while the other scales compare average income of neighbourhoods to a reference mean. The INSPQ index is the only one that uses social indicators such as the proportion of individuals separated, widowed, divorced, and living alone.

In Manitoba, N. Frohlich and Carriere's (1997) SERI has been used in provincial studies to identify population-based health resource needs. The index uses unweighted census items and is a single score indicating level of deprivation at the dissemination level. The scale was developed for use with other attributes, such as gender and age /gender distribution. The index includes indicators at the census tract level that represent risk of impoverishment, such as homes needing major repair, movement in and out of the area and minority language spoken as the first language in the household. The SERI has been used in combination with other variables in mapping out service needs across the province of Manitoba (Roos et al., 1997).

Pampalon and Raymond (2000) developed the INSPQ index for application in health and social service planning. The index has been used in a number of applications in Quebec and with the Canadian Institute of Health Information across Canada (Pampalon, Hamel, & Gamache, 2008). The INSPQ index has also been used in an examination of neighbourhood differences in suicide mortality (Burrows, Auger, Gamache, St-Laurent, & Hamel, 2011); overweight and obesity prevalence (Lebel et al., 2009); life expectancy (Pampalon et al., 2008; Ross et al., 2013; Saint-Jacques, Dewar, Cui, Parker, & Dummer, 2014; Terashima, 2011); depression and chronic illness (Gariepy, Blair, Kestens, & Schmitz, 2014); severe injury (F. Lawson, Schuurman, Amram, & Nathens, 2015); and health and social service utilization (Philibert, Pampalon, Hamel, Thouez, & Loiselle, 2007). The scale is standardized for the Canadian population and was developed using principle component analysis. Initial item selection was influenced by the construct of deprivation initially identified by Townsend, who differentiated between material and social aspects of deprivation (Pampalon et al., 2012). Unlike the other Canadian scales, the INSPQ index separates material or monetary deprivation from social deprivation.

The score provides a ranking for the postal code/dissemination area in a range from 1 to 5 based on the regional zone distribution. For Manitoba, the prairie provinces of Alberta, Saskatchewan and Manitoba, provide the deprivation range calibration for the deprivation quintiles. Therefore the quintiles are determined based upon distribution of the index rating across the three provinces, and then the postal code area is assigned a quintile ranking based on the regional norms and not the norms of the entire country.

The Matheson et al. (2006) Can-Marg index was developed for comparison of health and well-being needs between neighbourhoods. The index uses similar census variables with an emphasis on dependency, residential instability, ethnic concentration, and material deprivation. Each of the dimensions represents a separate index with a standardized score for the larger geographic area. The Can-Marg has been used in a variety of multilevel investigations examining regional variations in health indicators, such as stress and depression (Matheson et al., 2006); self-reported health (White et al., 2010); gender and body mass index (BMI; Matheson, Moineddin, & Glazier, 2008); hypertension rates (Matheson, White, Moineddin, Dunn, & Glazier, 2010); and Chinese immigrant self-reported health (L. Wang & Hu, 2013).

Table 1 provides a side-by-side comparison of all the indices described. The Can-Marg is similar to the other indices but it also includes census items related to the proportion of residents who immigrated within the last five years, an age dependency ratio of the proportion of residents under the age of 14 and over 65 to the proportion of residents 15 to 64 years of age, the proportion of residents who identify as a minority and the proportion of residence who moved to the area within the last five years.

Table 1

Deprivation Indices

Composition focus	Townsend (1987)	SERI (1997)	INSPQ (2008)	Can-Marg (2006)	VANDIX (2007)
Education employment		Proportion graduated high school	Proportion 15+ with no high school	a) Proportion with no high school b) Proportion with degree/ diploma	a) Proportion no high school b) Proportion with university degree
	Percentage of population >16 unemployed	a) Unemployment rate for >15 b) Rate of employment for women c) rate of labour participation in 3 employment categories	Ratio of >15 employed to not employed	Proportion < 15 unemployed	Rate of unemployment
Income	Percentage of households with no car ownership	Average total household income	Average income of people >15	a) Proportion >15 receiving transfer payments b) Proportion below the low income cut off	Average income
Housing	Non home ownership as percentage of all households	a) Percentage home ownership b) Percentage spending > 30% of income on housing		Proportion of homes needing major repair	Percentage home ownership
Lone parenthood		a) Lone parent (female) families b) Percentage between 15-25	Proportion lone parent families	Proportion lone parent families	Proportion lone parent families

(continued)

Table 1 (continued)

Composition focus	Townsend (1987)	SERI (1997)	INSPQ (2008)	Can-Marg (2006)	VANDIX (2007)
Other	Percentage overcrowding per size of house	a) Percentage moved ≤ 5 years b) The age–dependency ratio c) Proportion French and Aboriginal speaking	Proportion > 15 living alone	a)Percentage moved ≤ 5 years b) The age–dependency ratio c) Proportion minority d) Proportion immigrated ≤ 5 years	

Using a theory driven framework, the VANDIX was developed in Vancouver with item selection input from an expert panel across British Columbia health authorities (Bell et al., 2007). The VANDIX includes similar items to the other Canadian indices, with the addition of the proportion of the population with a university degree. The VANDIX has been used to examine neighbourhood differences in self-rated health (Bell et al., 2007), emergency room use (Schuurman, Bell, Hameed, & Simons, 2008), and injury risk (Bell, Schuurman, & Hameed, 2008). Table 1 provides a side-by-side comparison of the Canadian indices.

The size of the geographic area of analysis often varies from study to study as there is no agreed upon unit of geography (Krieger et al., 2002). Many Canadian investigations use the census tract as the unit of analysis. Usually the tract is a population of 2,500 residents while the dissemination area or postal code is the size of a city block or approximately 400 to 700 residents (Statistics Canada, 2013).

Neighbourhood Deprivation and Quality of Life

In Canada and elsewhere, neighbourhood level indicators of poverty and deprivation have been linked to lower self-rated health and other indicators of poor health outcomes distinct from the impact of individual markers of SES (Basta et al., 2008; Godley, Haines, Hawe, & Shiell, 2010; Mair, Diez-Roux, & Galea, 2010; Matheson et al., 2008; Matheson et al., 2010; Menec, Shooshtari, Nowicki, & Fournier, 2010; Yen et al., 2009). Deprivation is also linked to less optimal outcomes in chronic illness and a greater prevalence of chronic health conditions (Barr, Diez-Roux, Knirsch, & Pablos-Méndez, 2001; K. D. Lawson et al., 2013). This has relevance in the Canadian context where disparity in health persists in spite of decades of access to universal health care (N. Frohlich & Mustard, 1996). Health status continues to be more closely correlated with both individual and area income than with availability of care (K. L. Frohlich, Ross, & Richmond, 2006).

Although there are a number of investigations with general populations, very few investigations were found that corroborated a link between neighbourhood deprivation and arthritis prevalence or severity. The few articles found do support a link between reduced self-reported health, the prevalence of arthritis, and neighbourhood deprivation. In a population of community dwelling family physician patients reporting having arthritis, Callahan et al. (2008) examined the association between self-reported health, race, level of education, and higher rates of community level poverty. Self-reported arthritis was associated with lower education and community poverty. For White patients without a high school education, and living in an area with high poverty, the odds of reporting arthritis was 1.55 (95% CI 1.10-2.17) times the likelihood of White participants with at least a high school diploma who were living in a low poverty neighbourhood. Area poverty and level of education contributed to even greater differences in African American participants with a low education in high poverty areas exhibiting a higher likelihood of 2.06 times the odds (95% CI 1.16-3.66) of having arthritis.

In a Canadian population based study of the prevalence of arthritis, Cañizares et al. (2008) found a higher prevalence of arthritis reported for individuals with low income as well as for individuals living in census tract areas with a higher percentage of low-income residents. Using both individual and area predictors, Cañizares et al. explored the incidence of self-reported arthritis in the 2000–2001 Statistics Canada Canadian Community Health Survey. They found wide variation in the prevalence of arthritis across Canadian regions. Regional area income and individual characteristics, such as female gender, older age, Indigenous ancestry, currently smoking, and high body mass, contributed to the likelihood of reporting arthritis. The impact of census tract income was independent of individual factors. In fact, low-income individuals residing in low-income neighbourhoods had a higher likelihood of reporting arthritis than low-income individuals residing in high-income neighbourhoods.

Individual Income, HRQoL, and Arthritis

As few studies are available that examine neighbourhood deprivation and arthritis, I review key articles that examine individual or household income, HRQoL, and arthritis. I also present selected studies that provide further evidence of the connection between HRQoL and neighbourhood deprivation for populations with arthritis.

Looking specifically at individuals awaiting lower extremity joint replacement in Australia (*n* = 214), Ackerman et al. (2005) found that low annual household income was associated with increased psychological distress and reduced HRQoL. In this investigation, Ackerman et al. used the Assessment of Quality of Life instrument (AQOL) to measure HRQoL (Hawthorne, Richardson, & Osborne, 1999). This is a generic HRQoL instrument validated in Australia. This relationship between AQOL score and low income remained even after controlling for differences in age and gender. Ackerman et al. found that this population overall had very low reported life quality. The average HRQoL score for participants in this study was in the bottom 5% of HRQoL average ratings in the general Australian population.

Findings were similar in a cross-sectional study of 411 rheumatoid arthritis patients in a large urban centre in Iran. Alishiri et al. (2008) examined the contribution of individual attributes to both subscores of the Medical Outcomes Study SF-36 (Ware & Sherbourne, 1992): the physical component score (PCS) and the mental health component score (MCS). Each component score represents a separate construct with one focused on physical related functioning, the PCS, and the other focused on mental health symptoms and impact on quality of life, the MCS. Alishiri and colleagues found that increased pain, low household income, longer disease duration, and patient reporting more severe disease, depression, and a higher rate of co-occurring health conditions predicted reduced PCS scores. Separating the low versus high PCS and MCS scores into different groups, Alishiri et al. (2008) were able to predict the PCS score with 84% accuracy.

The variables that were associated with poor MCS were similar. These included low household income, co-occurring health conditions, patient assessment of disease activity, and higher pain levels. The variables provided accuracy in predicting the MCS at a rate of 75%. In both models, low income contributed independently and substantially to the final model, having the highest odds ratio (*OR* = 15.5 for PCS and *OR* = 6.8 for MCS). It is interesting to note that the contribution of low annual household income was even greater in the MCS than the PCS score. This demonstrates the importance of considering both mental and physical health in practice and research.

Interestingly, not all studies have corroborated an SES association with reduced HRQoL and low individual or household income, in the arthritis population. In a cross-sectional investigation of individuals awaiting knee replacement surgery in Quebec, Desmeules, Dionne, Belzile, Bourbonnais, & Frémont (2009) found no variance in HRQoL scores by household income or education. Using the SF-36 PCS and MCS sub scores no difference was found across household income groups. Desmeules et al. argued that universal access to care eliminated the presence of differential impact of income. Desmeules et al. pointed out the significantly low PCS and MCS scores in comparison to age matched Canadians in the general population. However, as the authors noted, the small sample size ($N = 197$) suggests a risk of type II error. That is, incorrectly assuming there is no impact of household income on HRQoL when in fact there is one.

Similar null findings were reported in a study assessing the independent impact of household income on HRQoL for the general population using another measure of HRQoL, the Health Utilities Index -3 (HUI-3) developed by Feeny, Furlong, Boyle, and Torrance (1995). Huguet, Kaplan, and Feeny (2008) examined differences in scores between a community sample of Canadians and Americans age 65 and older ($n = 755$ Canadians and $n = 1151$ Americans). They controlled for a large number of factors, including marital status, race, presence of a chronic health condition, tobacco use, physical activity, and access to a family physician. Although low incomes Americans were 62% more likely to report lower HRQoL than Americans in the high-income group, differences were not found in the Canadian respondents. As in the Desmeules et al. (2009) investigation, the study authors attributed the absence of differences in the Canadian respondents to access to universal health care, as well as government investment in health promotion and more responsive pension benefits.

However, using the same data and including all age groups as Huguet et al. (2008), McGrail, van Doorslaer, Ross, and Sanmartin (2009) did find differences in HUI-3 scores in both the Canadian and American samples (*N* = 5153 Canadians and *N* = 2744 Americans). McGrail and colleagues found that family income accounted for nearly half of the variance in HUI-3 scores in both the American and Canadian respondents, such that lower income contributed to 50% of HUI-3 differences in participants from both countries. They did find that the gradient was even steeper in the American sample, and they attributed this to health care system factors and a higher prevalence of obesity and smoking in the American population. This study and the two previous investigations demonstrate the influence of differences across age groups, differences controlling for individual attributes, and different measurements of HRQoL.

In a Canadian investigation of patients attending rheumatology clinics across Canada (*N* = 2,023) low SES, as measured by a high school or lower education, and a family income less than $50 thousand, Yang et al. (2015) found that changes in the MCS and PCS were influenced by individual markers of SES. Yang et al. found statistically significant differences in reported disease activity and a lower PCS for the lower education group at baseline. Self-reported disease severity improved with clinic attendance for the low education group on most measures; yet significant differences continued between the low education group and high education group throughout the investigation. With improved management, differences between the lower and higher income groups decreased after 1 year in the clinic with improved symptom management. However, lower family income continued to predict worse Health Assessment Questionnaire (HAQ; Kirwan & Reeback, 1986) scores at 1-year follow-up. The HAQ, like many other patient reported outcome scales is a generic and subjective measure of functioning and disease interference in daily living and life quality. However, Yang and colleagues did find that reduced HRQoL for low SES patients was partially mitigated by specialty interventions.

Unfortunately, Yang et al. (2015) were unable to consider a lower family income than $50,000 due to sample size. This is an annual income well above the Canadian low income cutoff. Unfortunately, area measures of deprivation were not included in this investigation, and they may have gone further to explain differences in progression. Although differences based on age, tobacco use, employment, and marital status were identified as contributing to differences between the high and low SES populations, they were not explored further or considered as moderating or confounding variables.

The study by Yang et al. (2015) and other investigations examining individual level SES and HRQoL in arthritis support the link between material resources and reduced life quality. Outside of the Desmeules et al. (2009) and Huguet et al. (2008) studies, all of the investigations support a gradient relationship between individual or household income and reduced life quality in arthritis and other populations. Many of these investigations have small sample sizes, and therefore the generalizability of findings may be limited. However, these investigations do provide evidence to corroborate the impact of poverty as a fundamental cause of health and HRQoL inequity.

Area Income/Neighbourhood Deprivation, HRQoL, and Arthritis

A small number of studies have examined the differential experience of individuals residing in a low-income geographic area and effects on outcomes in an arthritis population. These have been primarily with UK and United States (US) samples. In a secondary analysis of a large randomized controlled trial of treatment for rheumatoid arthritis patients in the UK (*N* = 455), Harrison et al. (2005) used the Townsend Index to investigate differences in HRQoL based on deprivation quintiles. In this investigation, Harrison et al. used two measures of HRQoL, the SF-36 (Ware & Sherbourne, 1992) and the European Quality of Life Five (EQ-5D; EuroQoL, 1990). They found a significant relationship between higher neighbourhood deprivation and higher disease severity, greater pain, poorer physical functioning, poorer mental health, and lower quality of life on both measures. These relationships persisted and remained statistically significant when age, sex, tobacco use, treatment group, and disease duration were controlled.

In a 3-year follow-up study ($N = 1{,}393$), Harrison et al. (2009) found both area deprivation and individual measures of SES contributed to reduced subjective health assessment in a polyarthritis clinical population. Using the same Townsend Index, they found that patients from more deprived areas reported lower HRQoL than patients from less deprived neighbourhoods. For this investigation Harrison et al. employed a modified HAQ for application in the UK. This involved very slight modification of word usage on a few of the items. The relationship between area deprivation and HRQoL persisted when controlling for baseline score, age, sex, and symptom duration (Harrison et al., 2009). They also noted an interaction effect between self-identified social class at baseline and area level deprivation indicating the two, in combination, further influence HRQoL.

Callahan et al. (2011) reported similar findings in a study of community dwelling individuals in North Carolina US with self-reported arthritis ($N = 968$). Callahan et al. (2011) examined differences in household income, level of education, occupation, home ownership, neighbourhood poverty level in tertiles, the SF-12 PCS and MCS and HAQ scores as the measures of HRQoL. They also recorded the number of unhealthy days reported each month. All of the models were adjusted for age, gender, BMI, race, and count of comorbid health conditions. They found that household income and education were strong predictors of reduced PCS scores. More unhealthy days per month were also reported for individuals who were in the lowest neighbourhood poverty tertile. Individual level indicators of SES and community poverty level both had a significant negative impact on MCS scores. Callahan et al also found that low household income was a strong predictor of lower physical health related scores and number of reported unhealthy days while community poverty did not have as strong an association with the SF-12 PCS.

In a cross-sectional study of the same cohort, Mingo et al. (2014) found that both individual and community level poverty were predictive of worse mental health symptoms in this arthritis population. By examining the influence of level of education, occupation class, household income and home ownership, they found an additional influence of area poverty on mental health. Living in a more impoverished community was associated with lower mental health scores on three separate measures, including the SF-12 MCS. Three of the four individual level factors also contributed to reduced mental health scores; these included level of education, occupational class, and household income. Mingo et al. found an additional independent contribution from area level deprivation above these three individual level indicators of SES. These findings and the study by Callahan et al. (2011) are similar to previous extensive research by Callahan and colleagues who have demonstrated an association between both individual markers of SES, such as level of education, with an additional influence from community level poverty and reduced HRQoL in arthritis (Callahan et al., 2009; Callahan et al., 2008; Rhemmes-Martin et al., 2010).

It is important to note a bias in referral patterns and even entry into a clinical sample across income groups. Exploring joint replacement, specifically, Hawker et al. (2002) did find income differences in access to surgery. In a study of access to joint replacement surgery in Ontario (N = 48,218), Hawker et al. explored the process of being referred to an orthopedic surgeon. Individuals who had less income and lower education were less likely to be referred to specialists for the surgery. They found there was a greater need for the surgery in this population and a willingness to have the surgery, but less access to the specialty surgeon. Hawker et al.'s study importantly highlights the barriers in accessing universal health care and the inequitable referral patterns for this surgical procedure. The same pattern has been documented for referrals to rheumatologists, with SES and geographic location predicting timely access to rheumatology specialty care (Widdifield et al., 2014; Yang et al., 2015). Although investigating SES differences in access to surgery and specialty care is beyond the scope of this study, this is an important methodological consideration that I discuss further in the limitations section.

In summary, the literature to date supports an inverse relationship between deprivation, measured by both individual or household income and neighbourhood level deprivation and HRQoL. There is also strong evidence to indicate that the relationship between neighbourhood deprivation and HRQoL is independent of individual measures of income. Less is known about casual pathways, and in most investigations, there is a large amount of unexplained variance.

Also, there is wide variation in how income, neighbourhood deprivation, and quality of life are measured and HRQoL vary from investigation to investigation but; the findings remain similar. There is compelling evidence to date to support an enduring inverse relationship between area or individual deprivation and health outcomes. In the next section I review the individual level variables used in this investigation and selected studies to date that have examined variance in HRQoL and neighbourhood deprivation. Many of the selected investigations include one or more of the variables of interest and provide valuable insight across the characteristics of age, BMI, gender, functioning and co-occurring health conditions.

Neighbourhood Deprivation, Advancing Age, BMI, Gender, Functioning, Coexisting Health Conditions and HRQoL

HRQoL and age. Aging and neighbourhood deprivation is of high policy interest, as many jurisdictions have embraced strategies to enhance *aging in place*, that is, supporting residents in the home community to remain independent as long as possible. This is challenging for segments of the population as self-reported health and other correlates of HRQoL challenge independence and tenure in the geographic area. Lower self-reported health has been found for older Canadian females in comparison to males, with this relationship more pronounced for new Canadians (L. Wang & Hu, 2013).

Differences in HRQoL have also been noted in chronic illness populations with younger age cohorts reporting lower HRQoL. In investigations examining chronic arthritis, specifically, worse outcomes were found for younger age groups with multiple health concerns. In a study in Scotland (N = 7,054) examining both physical and mental health K. D. Lawson et al. (2013) found progressive deterioration in appraised life quality with the impact of area deprivation most profound for younger adults with multiple comorbidities. They attributed the inverse relationship to the possibility that people in different life stages respond differently to living with a chronic health condition.

In a large UK population-based study of individuals over age 75 (N = 13,004) in the UK, Basta et al. (2008) found the risk of cognitive impairment to be 2.3 times higher in the most deprived neighbourhoods. They found a significant linear trend between the Townsend Score of an area and cognitive impairment across deprivation quintiles. After controlling for age and gender Basta et al. found that neighbourhood deprivation presented an additional risk of cognitive decline to all individuals in the neighbourhood, regardless of individual measures of social class or education.

In an investigation of the relationship between HRQoL, number of chronic diseases and neighbourhood deprivation, for community dwelling 65 to 71 year olds (*N* = 1,091) in Edinburgh Scotland, Mõtus et al. (2012) confirmed a relationship between living in deprived neighbourhoods and reduced self-rated health and HRQoL. The investigation employed the Scottish Index of Multiple Deprivation, an index that captures deprivation in a small geographic area based on the proportion of low income residents, unemployment, poor health, level of education, extent of skills and training of area residents, and barriers to housing, services, and crime rates. The Quality of Life (QOL)-BREF instrument (WHO, 1996) was the measure of HRQoL. High neighbourhood deprivation was significantly associated with lower HRQoL, lower cognitive functioning, lower educational attainment, and higher total number of chronic diseases. However, there was no association found between neighbourhood deprivation and mental HRQoL. In a large longitudinal investigation by Ellaway, Benzeval, Green, Leyand, and Macintyre (2012), it was also found that the differences in self-reported health gap between neighbourhood groups widened as people aged. The differences in self-reported health between the least and most deprived area was widest for the over 65 years of age group. This was most pronounced for men over the age of 65. Ellaway et al. found the possibility of reporting poor health at a younger age was far greater in poor neighbourhoods and that this increased more steeply than in affluent areas. They attributed this to the cumulative long-term impact of both low income and residence in an impoverished environment.

Neighbourhood deprivation and age. There is strong evidence that the neighbourhood context has a more profound impact on the elderly than other age cohorts. Declining health and physical vulnerability make the elderly more dependent and susceptible to the influence of the community in which they live (Basta et al., 2008; Breeze et al., 2005). Area deprivation has been associated with the aging issues of decreased mobility (Lang, Llewellyn, Langa, Wallace, & Melzer, 2008), age at death (Menec et al., 2010), cognitive decline (Basta et al., 2008) long-term illness (Malmstrom, Johansson, & Sundquist, 2001), and increased health care utilization (Lemstra, Neudorf, & Opondo, 2006).

In a local investigation of the prevalence of chronic health conditions in the age 65 and older adult in Winnipeg (*N* = 77,930), Menec et al. (2010) found significant differences in the prevalence of health conditions between the poorest and wealthiest neighbourhoods. It was found that Winnipeggers living in lower income neighbourhoods had significantly more health conditions. There was a gradient between neighbourhood income quintile and the number of health conditions reported. At each step higher in the average area income, the odds of having a chronic health condition increased. The neighbourhood income effects were strongest in the older adult age group of 65 to 74; however, differences persisted into the 85 and older age group.

HRQoL and body mass. High body weight is a risk for reduced life quality and can also affect mobility and symptom management such as pain and fatigue**.** Higher BMI—a body weight to body height ratio—is a risk factor for worse outcomes with arthritis (Fransen, Simic, & Harmer, 2014). In a synthesis of investigations up to 2013, Fransen et al. (2014) found extensive research to support the additional risk of obesity in joint deterioration. In large longitudinal investigations of patients with arthritis in both Norway and Australia, obesity was found to close to triple the risk of joint replacement for men, and this risk was close to four times greater for women (Mork, Holtermann, & Nilsen, 2012; Y. Wang et al., 2013). Obesity is a well-recognized cause, and resulting effect, of knee osteoarthritis in particular (Fransen et al., 2014).

Obesity has also been linked to the increasing likelihood of having at least one or more co-occurring health condition. Using data from the 2003 Canadian Community Health Survey (*N* = 127,610), Jiang Chen, Manuel, Morrison, and Mao, and the Obesity Working Group (2007) found that the likelihood of having a co-occurring chronic health condition increased with increasing body weight. For participants in the highest weight range, a BMI equal to or greater than 40.0, the likelihood of comorbid conditions such as diabetes, hypertension, heart disease, arthritis, and asthma was higher than for any other weight group.

Neighbourhood deprivation and body mass. Obesity is of particular interest in the course of arthritis as increased body weight presents further risk to symptom progression and an increased risk of joint deterioration. Body weight has also been identified as a key contributor to health inequity, particularly in late work life (Sundmacher et al., 2011). In an investigation of body weight and area deprivation in Ontario, Matheson et al. (2008) found differences in self-reported health particularly with women from deprived neighbourhoods reporting the highest body weight.

HRQoL and gender. Women have been found to experience more distress with arthritis and other rheumatic conditions. This includes reporting more pain and difficulty with performing daily activities than men (Ashlstrand, Björk, Thyberg, & Falkmer, 2015; Barlow, 2009; Clough, 2009). Although more women have arthritis and report more distress with the, little is known about the differences in HRQoL between men and women.

Neighbourhood deprivation and gender. Outside of the studies by L. Wang and Hu (2013), Mork et al. (2012), and Matheson et al. (2008) no studies were found that included gender differences in examined the differential impact of geographic area. As they noted, older women reported lower self-rated health and life quality, and obese women in more impoverished neighbourhoods are at increased risk of low self-rated health. Also, Elleway et al. (2011) indicated that the gap in self-rated health between areas can be greater for men than for women. It is recognized that current measures and indices of deprivation fall short in capturing elements that impact women in particular (Matheson et al., 2008) or in accounting for intersecting considerations of gender and SES (Veenstra, 2011).

HRQoL and functional ability. Functional ability, that is, the extent one can participate in routine mobilization and activities, such as transferring in and out of bed, climbing stairs, and walking, is often assessed clinically and, in health research, as an indication of how much an illness impacts daily activities. This provides a snapshot of how much symptoms interfere with daily activities of living. I found no specific studies that specifically explored HRQoL and variance in physical function, but it has been found that physical ability does not necessarily predict self-appraised life quality (Eriksson & Lindström, 2006). There is often a response shift, with expectations changing with adjustment to functional limitations

Neighbourhood deprivation and functional ability. I found no specific studies that examined neighbourhood deprivation and functional ability in an arthritis population. However, reduced physical functioning and neighbourhood deprivation have been linked to premature limited mobility in older age groups. In a cross sectional population based investigation Lang et al. (2008) examined walking ability in community dwelling residents in England who were over age 60 (N = 4,148). The investigators found that individuals living in the most deprived neighbourhoods were more likely to experience walking gait impairment, a lower walking speed, and challenges when walking up a flight of stairs or walking 100 yards. The relationship remained after controlling for individual level SES, demographic factors and health status.

HRQoL and coexisting health conditions. As mentioned, co-occurring medical conditions are a major complicating concern in arthritis and other chronic illnesses. With aging populations, and for those with arthritis in particular, having more health conditions is associated with reduced quality of life (Menec et al., 2010; Mujica-Mota et al., 2015). In a large investigation of family practice patients in the UK (N = 8,254), Mujica-Mota et al. (2015) found patients who had more than two chronic health conditions reported lower life quality, with the quality of life score declining with each count of additional health condition. The combination of arthritis and diabetes was *super additive*, indicating an exponential effect of these two conditions. As well, they found that depression had the largest effect on HRQoL, and the association was strongest in the young adult age groups. Arthritis, back pain, and other joint pain had the biggest overall impact on HRQoL. Unfortunately in the Mujica-Mota et al. study, area level deprivation was controlled for and not assessed as a contributor.

In a systematic review of studies Fortin et al. (2004) examined the association between having co-occurring health conditions and quality of life conducted between 1990 and 2003. Fortin et al. found a consistent relationship between the number of conditions and reduced overall satisfaction with life and/or HRQoL. Similar to the Mujica-Mota et al. (2015) investigation, Fortin et al. found that the presence of four or more chronic conditions was associated with reduced mental health life quality and more psychological distress. In spite of inconsistencies in the measurement of both multiple morbidities and quality of life, the relationship was consistent across all of the studies examined.

Neighbourhood deprivation and coexisting health conditions. I found no specific studies that examined variation in the number of comorbidities associated with neighbourhood deprivation specifically. However, individual income has been linked to reduced HRQoL and self-rated health. In an investigation of health clinic participants 65 and over (*N* = 352), Bayliss, Ellis, and Steiner (2007) found that the number of co-occurring conditions, high levels of contact with a physician, reporting financial constraints, higher number of physical symptoms, depression, lower income, male gender, and reduced physical functioning all contributed to lower perceived health status. Although this investigation did not examine HRQoL specifically, perceived health status, a subordinate construct under the HRQoL umbrella, was used and therefore I included it in this review. Bayliss et al. noted that co-occurring symptoms often interacted and interfered with each other, with a compounding effect of health symptoms, lower income, lower physical functioning and reduced self-rated health.

Summary

Researchers acknowledge that these factors are often mutually confounding as advancing age, gender, conditions, obesity, and reduced functioning are interrelated. As well, there may be a bi-directional relationship between these individual variables, HRQoL and neighbourhood deprivation, and all of these factors can influence broader circumstances such as employment, adequate housing, and other social conditions.

A relationship between reduced quality of life, neighbourhood deprivation, and advancing age has been corroborated along with a similar inverse relationship with higher body mass, decreased mobility, and higher number of coexisting health conditions contributing to lower quality of life. I found no literature specifically examining gender and self-reported health or life quality; however, there is evidence to support a difference in HRQoL between neighbourhood areas with men showing larger differences in self-rated health between the affluent and more impoverished areas. Differences between men and women may be overlooked if not specifically identified as an independent influence. As discussed, this is an important consideration in progressive health equity research. Further research is warranted as most of the literature to date is limited to cross-sectional investigations, and few investigations have examined a specific clinical population. As well, much of the literature reflects research conducted outside of Canada. In the next chapter, I present the methodology for this study.

Chapter 3: Methodology

In this analysis, I employed a series of steps to allow for model development and comparison at each step, while accounting for nesting of individuals from the same geographic areas. I selected multilevel modeling analyses to consider the cross-level nature of the hypothesis, recognizing the relationship between variables at different hierarchical levels. This provided an opportunity to examine interaction effects between variables at different levels, while accounting for within group and between group variations (Hox, 2010; Tabachnik & Fidell, 2013; Snijders & Bosker, 2012). This approach also avoids potential inflation of effects due to the non-independence of errors. This provided an opportunity to *contextualize* the relationships and examine the micro and macro influences on outcomes (Snijders & Bosker, 2012). There was also an opportunity to provide a fine grain analyses of differences between neighbourhoods and larger geographic regions by examining the impact of explanatory variables on the dependent variables using random intercepts and slopes for Level 2 and Level 3 groupings.

This is possible with multilevel modeling as the approach takes into account differences in nested group intercepts (i.e., the value of the dependent variable, *y*, when the explanatory variable, *x*, is 0) and group slope (i.e., the differences in the gradient between the explanatory variables and the dependent variable). The modeling allows for an examination of the variables at both the individual level and geographic area level, within a nested structure. While providing more accurate standard errors multilevel modeling establishes more reliable estimates of effects (Randenbaush & Bryk, 2002). This is of interest as it is hypothesized that slopes and intercepts of the relationships between the independent and the dependent variables can vary across the areas, and the differences between deprivation levels could be minimized or missed in a primary single-level linear model. The model building process also allows for the identification of groups of subjects more affected by area deprivation in the three level structure.

In model development, there was an opportunity to examine both the direct and interaction effects of age, BMI, gender, current and a history of coexisting health conditions and physical functioning in a multistage process. The direct and interaction effects of material and social deprivation on both mental and physical health were examined in a series of separate models. I also examined the interaction effects of material and social deprivation together as this has been found to further explain variability in other investigations (Dupont, Pampalon, & Hamel, 2004; Pampalon & Raymond, 2000; Terashima, 2011). The three-level data structure accounts for the nonindependence of error terms at each level by recognizing the expected within-group variance. The analysis culminates with a comparison of explanatory models and the best explanation of variables that influence the dependent variables, both mental and physical HRQoL, within the three level structure.

Research Hypotheses

As previously mentioned, this investigation is hypotheses driven as the approach begins with assumptions about the relationship between a number of variables and HRQoL. I hypothesize that individuals from more deprived areas will experience reduced HRQoL, and specific attributes can further explain this relationship. Given the vast literature to date, it is assumed that older adults, those with higher body weight, those exhibiting decreased functioning, and those with more health conditions will have lower HRQoL. Further, this may be different for men and women. This investigation will move from the bottom up (Hox, 2010) by building a series of models to examine the null and research hypotheses as follows:

1. Research Hypothesis One. Material and social neighbourhood deprivation negatively affect physical and/or mental HRQoL in addition to personal attributes such as age, BMI, gender, functioning and health conditions.
   - Null Hypothesis One: Material and social neighbourhood deprivation *have no additional effect* on physical and/or mental HRQoL after variance related to personal attributes such as age, BMI, gender, functioning, coexisting health conditions is accounted for.
2. Research Hypothesis Two. The impact of material and social deprivation on HRQoL varies in mean score (intercept) and strength of the relationship (slope) across the regional location of postal code area and forward sortation area.
   - Null Hypothesis Two: There is no difference in the impact of social and material deprivation on HRQoL in mean score (intercept) and strength of relationship (slope) across regional location.
3. Research Hypothesis Three. Individual and neighbourhood attributes and interaction effects between individual characteristics and reduced material and social deprivation contribute to variability in HRQoL.
   - Null Hypothesis Three: Individual and neighbourhood attributes and interaction effects provide no contribution in predicting HRQoL.

The structure of the variables within the three-level model is depicted in Figure 1. The three level structure provides a grouping variable at Level 3, the forward sortation area. There are 70 groups at Level 3. The dissemination area/ postal code groupings are all nested within the large geographic area of the forward sortation with a total of 4,880 groupings. At this level there are two variables, material deprivation and social deprivation. At Level 1, individuals are nested within the postal-code grouping. At this level, there are six individual variables: age, BMI, gender, physical functioning, coexisting health condition, and coexisting health condition history. At Level 2 there are two variables: material deprivation and social deprivation. The grouping variable of full postal code is nested within the large forward sortation grouping. This nesting allowed me to investigate the impact of individual and area level variables, accounting for data from the micro level of the subject and area level of the neighbourhood, within a larger geographic community.

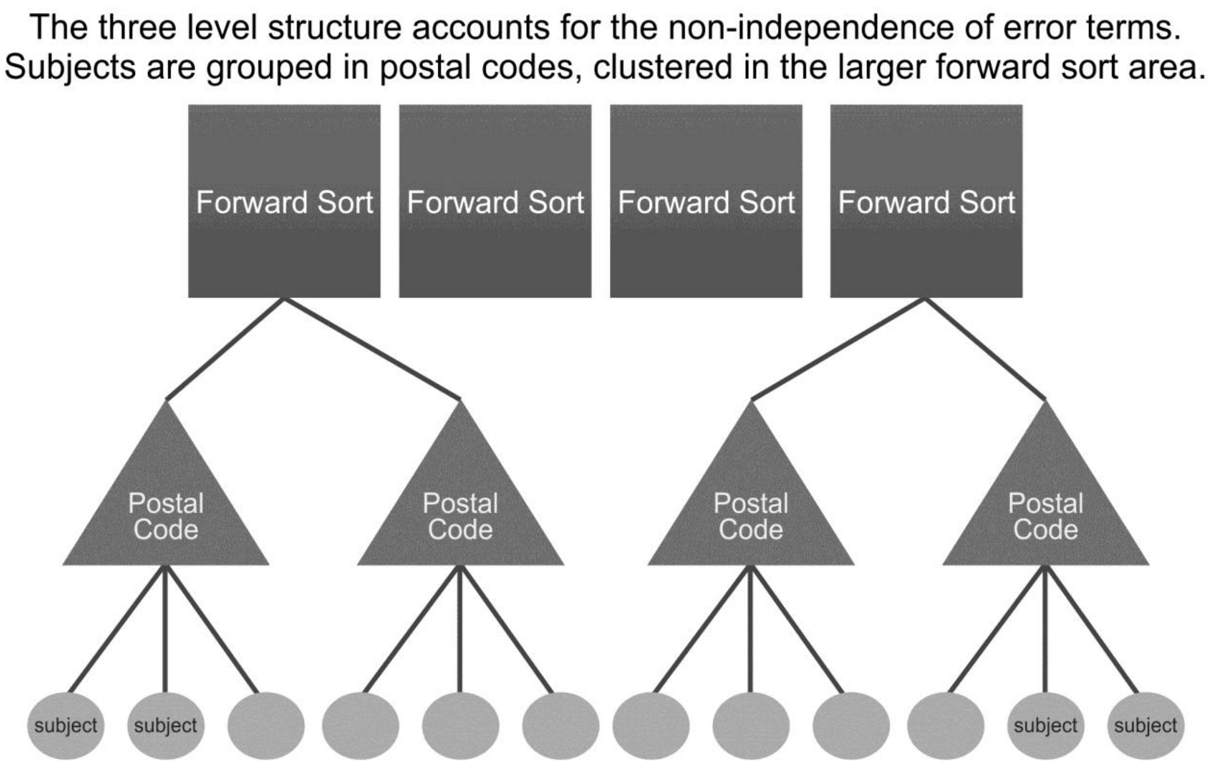


Figure 1: Grouping of postal codes within forward sortation areas leads to non-independence of errors. Ie: people in Winnipeg Fort Garry would have more in common with each other as would people in rural Saskatchewan. The data is naturally structured in this hierarchy as opposed to flat format.
MLM considers the cross-level nature of the hypothesis, recognizing the relationship between variables at different hierarchical levels. This provided an opportunity to examine interaction effects between variables at different levels, while accounting for within group and between group variations.

Data Source

I obtained individual level data for this secondary analysis from the clinical database for Winnipeg Regional Health Authority (WRHA) Joint Replacement Registry. All of the items represent information collected from the patient and are not corroborated by a medical record. The data in the registry were collected on an ongoing basis when a total knee or hip joint replacement recipient had agreed to surgery and was on the waiting list for a joint replacement and *The Patient Information Sheet and Consent Form* were completed by the participant and return mailed to the WRHA Joint Registry Analyst. An example of the registry form is included as Appendix A. The database repository includes all participants referred to participating orthopedic surgeons in Manitoba between May 2001 and May 2011. The registry includes subjects waiting for total hip and knee replacements. The vast majority of lower extremity joint replacement candidates have deterioration related to arthritis or arthritis related joint deterioration post injury or accident. It is acknowledged that some joint replacement recipients may have no primary underlying arthritis condition and numbers are very low and less than 1%[1]. Traumatic knee and hip replacement patients would access surgery through a hospital emergency department and not wait on a surgical wait list. For this investigation the registry only provided the specifically identified variables. I selected the variables related to the six individual attributes as there is literature linking the selected attributes to reduced life quality for this population and/or similar chronic populations. These data were used to build the combined data set.

Given that this was a secondary analysis I will briefly review some of the challenges I experienced. In this investigation I used secondary data, that is, data that I did not collect and

---

[1] Noted in verbal correspondence with the registry Medical Director Dr. Eric Boehm January 7th, 2016.

was developed initially for a different purpose. Although the repository data are collected for potential research purposes it was not a survey per se and not a combination of items that have been selected for comparison to other research or to further establish the validity of the measures. There were particular issues that warrant mentioning and these are data quality and the limitation related to the availability of only specific variables and not necessarily variables suited to this specific investigation.

As various individuals collected data over a ten-year period, there was a large difference in quality of input. I found errors that required tedious data cleaning. There were small capitals instead of small letters that were not read by the software and the letter o instead of the number 0. This made it necessary to run frequencies several times and convert errors to values within the study range. These are not uncommon problems with secondary data use or, in fact, other quantitative research methods (Smith, 2008).

I needed to use the variables collected and therefore had to create formulas in Excel and convert and combine different fields to establish a numeric value for such items as BMI and age. This, again, was time consuming and tedious if there were errors in birth year, month or day. The size of the data set contributed to the time required. I did not have raw scores for the MCS and PCS and could not establish a Cronbach’s alpha for these two items. This may present difficulties with comparison to other investigations (Smith, 2008). Also, I was limited in the selection of variables and so many other variables related to social situation, individual SES, and race, for example, would have provided a much richer landscape to this study.

However, there were advantages in using secondary data that should also be mentioned. There was no information that would identify any one individual and this mitigated any ethical risk as there was no potential harm to any respondent or a possible privacy breach. The database and INSPQ indices by postal code were available with written permission and the costs of collecting data were mitigated by this availability and secondary use of this existing information.

When I received the data set for this investigation, 17,059 subjects had completed the information. The date of the first subject's surgery was October 9, 2001 and the last was October 19, 2011. These data included a number of raw scores, dates, and other variables that I used to build the variables for the combined data set.

I requested variables from the registry that I thought contributed to an explanation of the relationship between neighbourhood deprivation and HRQoL. As indicated in the literature review, each of the variables selected has an empirical link to the literature on neighbourhood deprivation and health outcomes. I excluded other attributes, such as pain points, psychological distress and tobacco use, as less is known about these variables and their impact on life quality or relationship with neighbourhood deprivation. The identified variables also provide a marker to identify more at-risk individuals based on characteristics such as obesity, gender, and physical functioning. I discuss each of these selected individual variables separately later in this section.

Using the subjects' postal codes and a unique patient identifying registry number, I combined the repository data with data secured from the INSPQ- index for the material and social deprivation score assigned to the postal code. The postal code area, also referred to as the dissemination area, is a small geographic residential unit of approximately 700 to 800 households or a city block (Statistics Canada, 2013). I matched postal codes to the most appropriate census year, 2001 or 2006, depending on the date of data collected. I matched all data before 2003 to the deprivation index using 2001 census data to allow for a more accurate matching of the respondent's residence at the time of surgery. Only six cases had surgery dates before 2003, and for these cases, I used the deprivation index for the 2001 census data. I merged the deprivation index file and repository data using the assigned case identifier and established the combined data set.

I then organized the combined data set to reflect the three-level structure. Given the small group numbers, I deleted from the dataset 98 cases with a postal code with less than five residents; most of these were outside of Manitoba, Northwestern Ontario, rural Saskatchewan, or Nunavut, leaving 16,961 cases. I deleted an additional 59 cases that did not have postal codes, leaving 16, 902 cases. There were no deprivation indices available for an additional 695 cases, leaving a total of 16,207 subjects. Deprivation indices were missing due to the absence of census data for a specific geographic area. These are often remote areas or geographic units too small to collect adequate sampling of census items.

By merging the registry data with the INSPQ deprivation indices the combined data set provided the additional variables and grouping information for the three-level structure. This was done by establishing a grouping variable of the first three alpha numerics of the postal code for the third level groping. The grouping, the forward sortation area, represents area residency in a forward sortation grouping population of approximately 8,000 households (Canada Post, 2014; Statistics Canada, 2013). For areas with less than 10 cases, I combined the forward sortation area with similar geographic locations. I identified similar areas that were in close geographic proximity (e.g., a similar urban geographic area or similar rural community in the same province). This involved combining similar small rural communities with other similar small towns or municipalities in the same region of a province. For small forward sortation areas in urban centres such as Winnipeg and Brandon, I combined the cases with neighbouring forward sortation areas in close proximity. This resulted in a total of 70 forward sortation areas.

Appendix B lists the multiple correlation and variance porportion condition index and other additional tables (Tables B1–B5); the listing of forward sortation areas is shown in Table B3.

At Level 2, the full six-digit alphanumeric postal code provided the grouping variable. There were a total of 4,880 postal code/dissemination areas. Given the large number of postal codes, I nested the postal code within the larger forward sortation area. Once the data were merged into the combined data set, I exported the file from Microsoft Excel® to IBM's SPSS® version 22 for data cleaning and further analyses. In the following section, I provide a detailed summary of the variables at each level and the steps in the study design. I follow this with a discussion of the steps in the multilevel analyses.

Dependent variable HRQoL SF-12 MCS and PCS subscore. HRQoL was the outcome variable of interest. The Medical Outcomes Study SF-12- version I (Ware et al., 1996) was used as the measure. This is a 12-item condensed version of the longer Medical Outcomes Study SF-36 (Ware & Sherbourne, 1992). The SF-12 is a widely used generic measure of HRQoL that is very easy to complete (Gandhi et al., 2001). The instrument uses a 4-week recall of health related life quality for most of the items. The SF-12 items capture eight subscales. The subscales include two questions regarding physical functioning, one question on vitality, two questions on role limitation, one item on pain, one item on self-rated general health, one item on social functioning, two on the extent of role interference because of emotional functioning, and two questions related to affect and emotional well-being. Summary scores were established based on factor analysis with orthogonal rotation (Ware et al., 1996). Using a scoring algorithm, the subscales are weighted and summed to formulate the PCS and MCS scores. The repository provided the summary scales for each subscale. The subscales have established norms of 50 for nonclinical populations for both the MCS and PCS, and a standard deviation of plus or minus 10.

In-scale validation using a factor analysis with a varimax rotation and subsequent scree test, the SF-12 Version 1 has been consistent found to present two factors: a mental health component score and a physical health component score (Gandhi et al., 2001). The scale is considered a reliable and valid measure of self-appraised quality of life, including self-rated health. In the validation guided review, Gandhi et al. found a broad distribution of results with no floor or ceiling effect. The measure also demonstrates good empirical validity with other measures of health quality such as the longer version SF-36 (Australian Health Outcomes Collaboration [AHOC], 2005: Resnick & Parker, 2001).

There is also content agreement between the SF-12 and the OKS in relation to extent of pain symptoms (Conaghan, Emerton, & Tennant, 2007; Dawson, Fitzpatrick, Murray, & Carr, 1998; Garratt, Brealey, Gillespie, & the DAMASK Trial Team, 2004; Webster & Feller, 2016). This is a widely used measure of HRQoL in investigations involving populations with arthritis. While the SF-12 correlated highly with the SF-36 (Gandek et al., 1998) the correlation between the SF-12 and SF-36 for an arthritis population awaiting knee replacement has been estimated at $r = .90$ for the MCS and .96 for the PCS, $p < .0001$ (Webster & Feller, 2016). In scale development, Gandhi et al. (2001) examined the psychometric properties of the scale in aggregate data for a series of randomized controlled studies of osteoarthritis ($N = 592$) and rheumatoid arthritis patients ($N = 654$). Using the SF-12 items embedded in the SF-36 they found the instrument has a similar distribution to the SF-36 and that pain and physical functioning items correlated more strongly with the PCS while emotional and vitality related items correlated more closely with the MCS. The correlation with the SF-16 persisted across time, at two, four and six weeks for the PCS at $r = 0.92$ to $r = 0.95$, (p < .001) and $r = 0.92$ to $r = 0.96$ ($p < .001$) for the MCS. In this investigation moderate correlations were found between clinical indicators and both MCS and PCS. There are some limitations noted in the SF-12-I in distinguishing between disease groups and in providing enough variability in scores in studies with a sample of fewer than 500 respondents (AHOC, 2005). Given the large sample size, variability in scores is not a major concern in this investigation.

I found no studies that tested the internal consistency of the SF-36 and SF-12 yet investigations have supported the instrument's construct (Gandek et al. 1998; Ware et al., 1996) and criterion validity (Vilagut et al., 2013). The SF-12 is preferred for its brevity and the 12 items accurately predict 90% of the variability in the SF-36 (Gandek et al., 1998). Both items are considered an adequate measure of physical and health-related life quality form the patient's perspective. The MCS in particular is considered a reasonable screening instrument for clinical depression and anxiety. In a large multi European study the SF-12 MCS was found to accurately predicting recent and active mental health symptoms (Vilagut et al., 20). Only the summary scores are available in the WRHA Joint Registry. They were established with orthogonal scoring coefficients. Therefore, each score is based on population norms of 50 (*SD* =10).

To test the independence of the MCS and PCS score, I examined the Pearson *r* in the correlation table to rule out the possibility that they are measuring the same or completely unrelated constructs. With an $r = -.14$ there was no concern with the independence of the subscales. Although the correlation was significant at $p <. 001$, there was minimal concern of non-independence for development of the final models.

Age. I established the age at time of questionnaire completion using the date of birth and surgery date. The date of data collection was also available, and often the surgery date was, on average, 4 months later. I calculated age at time of surgery using the variables date of birth and date of surgery allowing for leap year with the formula (date of surgery– year of birth x 365.25) leap year. Age was measured in years as a continuous variable.

Body weight BMI. I established BMI from the height to weight ratio. This is a single number representing the height to weight ratio of an individual. BMI is established using the formula of weight in kilograms divided by height in meters squared (kg/m^2). BMI has been used as a classification to establish the range of body weight associated with health risk (Health Canada, 2003). Health Canada has identified the following weight classifications: underweight, BMI, ≤ 18.5; normal weight, BMI 18.5 to 24.9; overweight, BMI 25 to 29.9; obese class I, BMI 30 to 34.9; obese class II, BMI 35.0 to 39.9; and obese class III, BMI ≥ 40 (Health Canada, 2003). As I collected the height and weight data using imperial measurement, I calculated the BMI from the height in feet and inches and weight in pounds using the formula (weight in pounds / [height in inches x height in inches] X 703). The variable was treated as a continuous value.

Functional status. I measured functioning using the OKS (Dawson et al., 1998). The OKS provides a single index measure of knee or hip pain and functional status. The OKS is a well-established measure of functional ability, movement, and pain and is widely used in joint replacement investigations. The measure was originally developed in consultation with patients and experts and is considered a robust measure with evidence to support both the convergent and divergent ability of the measure to capture hip/knee pain and functioning (Harris, Dawson, Jones, Beard & Price, 2013). Index scores are strongly correlated with the surgical assessment and patient assessment of goals and the American Knee Society Clinical Rating System; a physician-based rating of joint deterioration (Maempel, Clement, Brenkel, & Walmsley, 2015).

The OKS is also sensitive to change and has been used to measure improvements post knee replacement (Alviar et al., 2011). The OKS is also a reliable and valid measure of joint pain and functioning and has been used in investigations with outpatient populations with osteoarthritis (Xie, Ye, Zhang, Liu, Lei, & Li, 2011) and to assess surgical recovery (Garratt et al., 2004). There is content agreement between the OKS and items on the SF-36 related to pain (Conaghan et al., 2007; Dawson et al., 1998; Garratt et al., 2004).

The OKS is a 12-item questionnaire with identical items using joint appropriate language related to functioning and pain from the hip or the knee. Exploratory principal component factor analysis supported a one-factor solution. Internal consistency has been established in previous investigations. In scale development, the OKS demonstrated internal consistency with a Cronbach's alpha of .84 for a pre-surgical population and .89 at 6 months follow-up (Dawson et al., 1998).

The responses categories for each item are from 1 to 5, with 1 representing worst score and 5 the best or minimal presence of pain or functional limitation. The OKS provides an unweighted cumulative score with 12 being the best possible score and 60 indicating severe pain and limited functioning. As with the SF-12, further scale development is recommended to validate the OKS' reproducibility, minimally important change, and responsiveness of clinical change (Alviar et al., 2011).

It has been argued that the OKS lacks an a priori hypothesis and therefore construct validity has been questioned (Alviar et al., 2011; Terwee et al., 2007). As well, there is concern that the self-reporting of items may provide misleading information on actual functioning (Whitehouse, Blom, Taylor, Pattison, & Bannister, 2005). I used the summary score in this analysis as a continuous variable. I closely examined multicolinearity with the PCS and the zero order Pearson *r* correlation for these two measures to rule out issues with colinearity. With an $r = -.51$, there was no concern for colinearity as they appear to capture different constructs with the PCS capturing physical related life quality and the OKS physical functioning.

Gender. Gender was captured as a dichotomous variable responding to “What is your gender?” male or female. To accommodate analysis in the linear modeling, I recoded gender to female 1 and male 0.

Coexisting health conditions now. I included having one or more other illnesses as a variable of interest in this investigation. Self-identified health conditions have been found to reasonably corroborate and correlate with medical records review (Bayliss et al., 2007). This also captures other physical and mental health conditions the respondent may be concerned about managing and finds limiting. I measured the presence of other concurrent health conditions by establishing a binary response to the question, and the response of *yes* to “Yes it limits my activities” and *no* “it does NOT limit my activities.” I coded as a *yes* those respondents who indicated they had at least one of the active chronic health conditions listed that limited their activity. The selected conditions were established in consultation with orthopedic experts involved in the development of the registry and are similar to conditions identified in prior research (Bayliss et al., 2007). I treated this as a nominal dummy variable, with *no* indicating not having any coexisting limiting conditions, as a 0 and *yes* indicating at least one of the conditions limits current activities as 1.

Health conditions history. Similar to the item regarding coexisting health condition now, I established this variable as an indication that a history of another health condition was diagnosed or identified by the patient. This was established by *yes* to the response “Place a check mark in the box if you have had this condition.” As with the item, coexisting now, this was created from a sum of any variables with an answer to at least one other health condition history in the response to the item. I treated this as a nominal dummy variable, with *no* indicating not having any coexisting conditions, as a 0 and *yes* indicating at least one of the conditions as a 1. As this related to having the condition in the past, I referred to this as a history of existing health condition to differentiate from a condition that is continuing to limit activities. The health conditions included in the list are presented in Table 2.

Table 2

Lifetime and Existing Health History Index

Condition	Yes, I have had the condition	Yes, current problem
Heart disease		
Lung disease		
Diabetes		
Ulcer or stomach disease		
Kidney disease		
Liver disease		
Cancer		
Depression		
Osteoarthritis (other areas)		
Rheumatoid arthritis		

Neighbourhood deprivation. Material and social deprivation were measured using the INSPQ deprivation index (Pampalon & Raymond 2000). The INSPQ provides two measures of deprivation at the dissemination[2]/ postal code level gleaned from Census Canada data. I refer to them in this document as DepindexM for the material deprivation index and DepindexS for the

[2] The dissemination area and postal code are the same geographic area. Dissemination is an older term used by Statistics Canada.

social deprivation index. As mentioned in the previous section, this is an index depicting deprivation at the full postal code level, representing an area the size of a city block or 700 to 800 households. The postal code was assigned a separate quintile ranking for each of material and social deprivation, from 1 representing the least deprived population, or top 20% to 5 representing the most deprived, or the lowest 20%. These quintile rankings were developed separately for large Canadian cities, the Prairie Provinces, and the Territories, with rankings representing percentages based on the Canadian province or territory of the larger geographic area (Pampalon & Raymond, 2000).

The DepindexM and DepindexS were developed by Pampalon and Raymond using a principal component analysis with a varimax rotation to ensure independence of items. The index captures two distinct components of deprivation at the neighbourhood level, separating *material* and *social* deprivation into two individual summary scores (Pampalon & Raymond, 2000).

The DepindexM is composed of the census items related to SES of residents in the postal code geographic area. Items include, the percentage of persons without a complete high school education, the ratio of employed adults to the total adult population, and the average after-tax personal income for the area. These are considered indicators of poverty and low SES at the regional level.

The DepindexS reflects the constructs of inclusion and cohesion in the neighbourhood composition. This includes the census items of the proportion of persons living alone, the proportion of persons widowed, separated, or divorced, and the proportion of single parent families (Pampalon & Raymond, 2000). These are considered indicators of social fragmentation and social isolation. The indicators have compared favorably to other measures of social isolation and fragmentation including the number of children and families in receipt of social welfare benefits, movement in and out of the area and individual measures of social isolation and anomie (Pampilon Pampalon, Hamel, Gamache, Simpson, & Philibert, 2014).

I selected the INSPQ deprivation indices as the measure of neighbourhood deprivation for this study for a number of reasons. The indices have items linked to deprivation theory and have been used in other investigations linking geographic characteristics to health outcomes in Canada (Gariepy et al., 2014; Lebel et al., 2010; Saint-Jacques et al., 2014). As well, in scale development, selected indicators were transformed to established normality in distribution to provide weighted variables based on the forecasted Canadian population.

The INSPQ indices also provide a conceptual framework to consider material and social deprivation, constructs consistent with the concepts of the fundamental cause of poverty and habitus discussed in Chapter 1. I treated both indices as an interval/continuous level of measurement as has been the approach in other investigations (Gariepy et al., 2014; Lebel et al., 2010; Saint-Jacques et al., 2014; Terashima, 2011). The indices provide content validity with the theoretical underpinnings of deprivation and the theory of area level deprivation and inequalities in health, particularly for investigation in health disparity research (Pampalon et al., 2014). The indices also have shown construct validity in scale development by examining correlation with other census indicators of social fragmentation such as residential mobility and the proportion of renters compared to homeowners (Pampalon et al., 2014).

Descriptive Analysis, Correlations, Comparing Means and Initial Analysis of Variance

After completing the data cleaning, assessment of assumptions, and analysis of missing data, I began the analysis with an examination of the means for each dependent variable and a count of dichotomous variables. This was followed by bivariate correlations of Level 1 and

Level 2 predictors and the dependent variables. I then compared means for dichotomous variable groups to determine if there were any specific group differences at the outset. I then analyzed group variance, with an analysis of variance (ANOVA) of deprivation indices. I determined if there were Level 2 or Level 3 groups by covariate interactions prior to the multilevel analysis (Snijders & Bosker, 2012). This provided insight regarding the variance within the three-level structure. This helped determine the extent of between group and within group variability in the two dependent variables.

Multilevel Analysis

Following calculation of the univariate distributions, bivariate group means and ANOVA, I conducted multivariate analyses in four steps for each dependent variable. This allowed for nesting of similar postal codes in the large forward sortation vicinity to provide a structure for the deprivation index intercept and slope to vary as they were tied to the postal code. Without nesting, the postal code would represent the same value as the deprivation index, allowing for no variability. As well, there were a large number of very small postal code units and this would interfere with populating all of the cells in the hierarchical models. The nested forward sortation areas at Level 2 were then clustered in Level 3 as the third level for a three-level hierarchical model. This provided further examination of variance in grouping variables in the larger geographic area. This clustering is similar to other studies that consider the within groups similarities of subjects in groups, situated in larger grouping variables (Heck, Thomas, & Tabata, 2013; Snijders & Bosker, 2012; Tabachnick & Fidell, 2013). To account for the nested nature of the postal code within forward sortation area, I structured grouping variables at Level 2 and Level 3 by recoding the forward sortation area with a nominal numeric value. I recoded each postal code area in a similar way, with a nominal numeric by postal code, allowing each to be clustered within the larger forward sortation grouping to which they were related. I assigned ties in the ranking a sequential value within each variable. This recoding provided values in the grouping variable that sped up processing time by recognizing a numeric value as opposed to the alpha numeric name for values within each group.

The multivariate analyses followed an exploratory model building and refining process beginning with an empty model, then a full model, a model with the addition of Level 2 variables, a model with interactions between Level 1 and Level 2 variables and then back to a parsimonious model. Null and statistically significant findings were examined in model comparison. Next, I describe each of these steps in the model building process.

Step 1. I began the analysis with an empty model or what is called a *null intercept only model*. This established the variance in dependent variable explained by the data structure. This model allows the intercept at Level 2 and Level 3 to vary for the dependent variable. Equation 1 depicts the formula for the null intercept only model. This equation and all of the subsequent notations follow the symbols established for multilevel modeling presented by Heck et al. (2013) and Snijders and Bosker (2012). Equation 1 provides the common means for partitioning the variance into three levels. Equation 2 provides the notations for the intraclass correlation (ICC) established in Step 1.

$$p = \sigma^2\ level3/(\ \sigma^2\ level\ 1 + \sigma^2 level2\ + \sigma^2\ level3) \qquad \text{Equation 1}$$

$$p_1 = \frac{t^2}{t^2 + \sigma^2} \qquad \text{Equation 2}$$

In Equation 2, p_1 represents the expected population population variance between macro-units, while *t* represents the influence of the three-level structure on the dependent variable. In this step, the model has no Level 1 predictors or fixed effects and the internal homogeneity of

Level 2 and Level 3 units are examined to determine the proportion of total variance explained by each level. This also determines the correlation of subject scores within the higher level nesting structure (Snijders & Bosker, 2012). The ICC, the estimated amount of variance in the dependent variable that can be explained by the data structure, is established from this empty model. This determines the need to proceed with multilevel modeling or traditional hierarchical linear modeling that does not account for variance due to data structure. The empty model provides a baseline to compare subsequent models to for goodness of fit, changes in pseudo R^2, proportional reduction in residual variance and effect size.

The process began with the null intercept only model to establish the ICC and allow for model comparison in subsequent steps. The three level model is presented in equation 3.

$$Y_{ijk} = y_{000} + u_{0j} + r_{0jk} + \varepsilon_{ijk} \qquad \text{Equation 3}$$

In Equation 3, Y_{ijk} *is* the HRQoL subscale for subject in level $_{i,}$ in postal code $_{j,}$ within forward sortation level $_{k.}$ y_{000} represents the Level 3 intercept, and u_{0j} represents the Level 3 random effect. R_{ojk} represents the Level 2 random effect and ε_{ijk} represents the Level 1 residual. This explains the four-parameter estimation in the intercept only model. The three variance estimates in Equation 3 are used to partition the variance into Level 1, Level 2 and Level 3 components for the null intercept only model.

All of the models were run with Maximum Likelihood (ML) estimation to account for the nested nature of the data. This allowed the estimates to be conditional on the point estimates of fixed effects, considering the variance and covariance components (McCoach & Black, 2008). This allowed me to compare models with different fixed and random effects. For model comparison to subsequent fuller models, I recorded the -2 log likelihood (-2 LL) and Akaike

Information Criterion (AIC) for each model. This indicated explanatory power of the model and model fit and helped me select among competing models for the best model fit. The null model provided the reference point to compare the improvement in fit to subsequent models. I compared the -2 LL between models by subtracting the values and establishing the deviance value; that is the difference subtracting the smaller value from the larger -2 LL value. I assessed this value for significance by using the critical value of chi-square X^2, with the difference in number of parameters indicating the degrees of freedom (McCoach & Black, 2008; Sniders & Bosker, 2012). To establish the extent of improvement in estimation considering the number of parameters I interpreted the differences in -2 LL along with the AIC.

Hypothesis testing required careful consideration of the sample size, method of data collection and nature of the research question. To avoid the more common pitfalls of; not determining the range of effect and only a dichotomized accepting or rejection of the null, establishing what findings can be attributed to data as it is observed, taking into account sample size and suitable significance level, and the limitation of a binary rejection or acceptance of hypotheses (Silva- Ayçaques, Suárez-Gil & Fernández-Somoano, 2010). I integrated cautionary processes across the study. I integrated precautions to ensure that null hypothesis testing was rigorous and that findings supported or refuted in the alternative hypothesis.

In establishing a range of effect and not just a rejection or acceptance of the null I ensured I examined changes in variance explained, effect size and the extent the parameters contributed to the model. For this I examined the magnitude of the parameter estimates and the magnitude of the improvement in model fit. This was further supported in my closer examination of selected terms that appeared to have relationship with the dependent variable. I isolated these relationships to have a different look at specific sub groups. This closer look at interactions also addressed the second pitfall of what findings effects are attributed to what relationships in the data. To counter the risk of inflated values due to the large sample size in establishing significance I set a very rigorous *p* value to counter the large sample size and the increased likelihood of a type one error. That is, assuming the null hypothesis is not true and accepting, falsely, significant results. With the large sample size there was an increased likelihood of finding differences that are false and therefore falsely rejecting the null. I also further ensured null hypothesis significance testing by structuring the data in the three levels to take into account the actual dimensional structure of the data and allow for error term calculation at all three levels. This provided further insurance that inferences were related to true difference and not the result of probability errors. I also examined effect sizes and attempted to quantify the importance of effect, given the potential for a false magnification of effect.

Step 2. In Step 2, I added all six Level 1 predictors to the model as fixed effects in the first three-level *random intercepts model* (Snijders & Bosker, 2012). For this step, and subsequent analyses, I grand mean centred all of the variables as suggested by Hox (2010), Heck et al. (2013) and Snijders & Bosker (2012). The dichotomous variables of gender, co health conditions now and co health conditions history were also grand mean centred. This allowed for the estimated variance in the intercept to be comparable to the other variables (Heck et al., 2013). Grand mean centering also allows for model convergence and minimizes the impact of colinearity between the interaction effect and the predictors (Tabachnik & Fidell, 2013). The centering also allows for straightforward interpretation of variance in the intercept and slopes, with the intercept having a meaningful value for comparison across independent variables. This also supports confidence in establishing effect size when comparing model improvement

(Tabachnick & Fidell, 2013). The addition of the six fixed effects predictors to the model at Level 1 is explained in equation 4.

$Y_{ijk} = \pi_{0jk} + \pi_{1jk}X_{1,\ldots,}\ \pi_{6jk}X_6 + \varepsilon_{ijk}$ Equation 4

Levels 2 and 3 continued to have a random intercept and scaled identity matrices as specified in Equation 3. The six predictors at Level 1 remained fixed effects at Level 2 and Level 3. In this and subsequent steps, I present the findings with estimates, standards error (*se*), and 95% confidence intervals [CI].

A model with the addition of both Level 2 predictors will follow this initial fixed effects model. To do this, I reran the intercept only model to include the material and social deprivation indices for a total of eight fixed effects. The addition of two fixed effects at Level 2 is depicted in Equation 5. The Level 1 model remains the same as Equation 4, ($\pi_{1jk} – \pi_{6jk} = \beta_{10k} – \beta_{60k}$), as does the model at Level 3. The Level 2 slope also remains fixed.

$\pi_{0jk} = \beta_{00k} + \beta_{01k}material_{jk} + \beta_{02k}social_{jk} + r_{0jk}$ Equation 5

$\pi_{1jk} – \pi_{6jk} = \beta_{10k} – \beta_{60k}$

I then reran the intercept only model with the addition of cross-level interaction terms for a total of 25 variables as fixed effects. I compared interactions for goodness of fit and parameter estimates for both main and interaction effects. From this model building, I built up the parsimonious model by removing variables that were not significant to $p < .001$. Variables that were close to significant were included in the initial model building process. I compared each of these steps for changes in model fit and R^2 differences in preparation for building the parsimonious model. Given the research driven nature of this investigation, significance values were considered to be one tailed and were therefore halved to reflect the established direction of the relationship between the independent and dependent variables. From the selected variables and interaction effects, I established a parsimonious model that best predicted the MCS and PCS separately with the smallest number of explanatory variables. In this step, I tested the first hypothesis: Material and social neighbourhood deprivation negatively affect physical and/or mental HRQoL in addition to the personal attributes of age, BMI, gender, health conditions, and functioning.

Step 3. In the third step, I explored the impact of a random intercept and slope for each Level 2 predictor in a series of *random intercept and random slope models* in this step, I examined the parsimonious model with the additional benefit of variance at Level 2 and then Level 3 by allowing both the intercept and slope of the deprivation index to vary. This was conducted separately for each deprivation index, at both levels, for an additional four models. For this step, I changed the covariance matrix from identity to unstructured, to accommodate the addition of random parameters (Heck et al., 2013). Equation 6 depicts the addition of a random slope at Level 2 in the three-level model in Equation 4 and random at Level 3 in Equation 5 with the addition of random varying slopes at Level 3.

$\beta_{01k}=\gamma_{010}+u_{01k}$ Equation 6

$\beta_{02k}=\gamma_{020}+u_{02k}$

In this step, u_{0jk} and u_{02k} represent the random slope at Level 2 and then Level 3 as additions to Equation 4. If these slopes were found to be significant and provided a contribution to model fit they would have been included in model refinement and the establishment of the parsimonious model. At this step, I changed the covariance matrix from identity to unstructured to accommodate for the addition of random parameters (Heck et al., 2013). In this step, the second Hypothesis is tested. That is, whether neighbourhood deprivation slope and intercept varies at the geographic area. I compared the random intercept and random slope models -2 LL and AIC for model fit and the proportional reduction in variance with a comparison of the parsimonious model and null model to determine if there was an improvement to model fit related to any of the random slopes and intercepts at either Level 2 or 3 for material or social deprivation.

Step 4. In the final step I conducted a number of evaluations in final model review. This further clarified some of the hypothesis testing, and provided further explanation of relationships. I conducted a detailed examination of close to significant and significant interaction terms to determine if there were any additional improvements to model fit with dichotomized groupings of gender, younger and older age or lower and higher BMI. I also examined significant interactions in graphs and partial correlations to determine if any further explanation can be gleaned on the nature of the relationship between the interaction variables and selected dependent variable that could further complement findings (Aguinis, Gottfredson, & Culpepper, 2013).

To further substantiate validity of findings, I reran the parsimonious model with the larger initial data set using multiple imputation to replace missing data. I chose multiple imputation as the method of data replacement as it makes no assumptions about randomness of missing data and is the method most suited for secondary data analysis (Tabachnick & Fidell, 2013). This further examined suitability of fit and ensured that validity was not threatened by eliminating cases with missing data. I compared the parsimonious model from the complete data set (N = 10,427) to the missing values estimated data set (N = 16,902) to enhance confidence in assuming results are a true reflection of estimates, not influenced by missing cases. I used multiple imputation to calculate missing values for age, BMI, OKS, PCS, and MCS. I entered gender, coexisting health conditions, and health condition history as predictors in the model as these variables did not have any missing values. The imputation was set at three iterations. I compared the results between the null model and the final parsimonious model to determine improvements in model fit and determine if the parameter estimates fell within the confidence intervals of the missing values replaced data. I compared the parameter estimates across all variables to see if they fell within the 95% confidence intervals of the estimates in both the final parsimonious models. This supported the stability of results and generalizability of findings.

This interaction and data set comparison is followed by a discussion of, improvement in model fit, effect size and changes in R^2 between the various steps. This includes a comparison of changes to AIC and -2 LL for model fit. I also explore effect size changes between the null model and subsequent models.

The R^2 change was established for all of the models at each level to further examine model contribution to variance explained following the process presented by Snijders & Bosker (2012). This determined the strength of association of a group of variables in predicting variance, as a proportion of the total variance in the dependent variable (Tabachnick & Fidell, 2013). This established the extent of variance explained by the addition of various parameters to the null model. I considered the change in R^2 as a pseudo R^2 as there are noted substantial complications with comparing models that include random components (Heck et al., 2013; McCoach & Black, 2008; Snijders & Bosker, 2012). I considered pseudo R^2 along with the deviance between the -2 LL and the difference between the AIC for each model. I established the best model fit by comparing the goodness of fit indicators, the AIC and differences in -2 LL. Following this, the effect size was established comparing the null model with no predictors to all subsequent models. To do this I compared residuals following the process outlined in Equation 7.

$$\eta 2 = \frac{s_1^2 + s_2^2}{s_1^2} \qquad \text{Equation 7}$$

In Equation 7, $\eta 2$ represents the model change, considering differences in the residual between s_1^2 the null model and s_2^2subsequent models. This required subtracting the residual from the intercept only model from the residual of the subsequent models. $\eta 2$ evaluated the predicted variance-improvement in the model considering the fixed predictors (Tabachnick & Fidell, 2013). However, caution is warranted in applying and interpreting the extent of effects in multilevel modeling (Snijders & Bosker, 2012; Tabachnick & Fidell, 2013). At each step in the findings and discussion I tempered possibilities of limiting acceptance or rejection of the null. Instead of reducing assumptions to an acceptance or rejection I examined the extent of all of the relationships to the dependent variables, considering the data structure and the complex nature of the research hypotheses.

In Chapter 4, I begin by presenting the results for the data cleaning and missing values analysis and then describe the sample, correlations, and comparison of selected means. In Chapters 5 and 6, I provide a comprehensive review of the multilevel analyses of the MCS and then the PCS. In this approach, I am able to present evidence to support fundamental cause theory and the impact of the habitus on HRQoL outcomes. I follow these chapters with a comprehensive discussion of the findings and how they support the selected theoretical frameworks.

Chapter 4: Analysis

In this chapter, I first describe the data preparation and the cleaning and testing of assumptions in a step-by-step review. Second, I present descriptive and bivariate analysis; and finally, I compare selected group means and ANOVA's to further understand the trends in the data set.

Data Preparation

The preparation began with the combined WRHA Hip Registry and INSPQ index data set. The process of enquiry began with data cleaning, where I corrected obvious errors in entry: I went back to the INSPQ data manager to secure all available deprivation indices on postal codes and corrected entry mistakes, such as lowercase numbers and the letter o instead of the numeric 0 in the postal code. I noted that the data were collected over 10 years and there were changes in the quality of entry over this extended time frame. However, most of the data changes were modest, and I converted incorrect values and captured missing postal codes for approximately 60 additional cases. This resulted in a total of 10,427 cases with most of the data available at both Level 1 and Level 2.

From that point, I structured the data for the three-level analyses. Table 3 provides a summary of the variables I used in this investigation. The outcome variables are the two HRQoL subscales: the PCS and MCS. The data include identification for the postal code level as rnpostal and the third grouping level of forward sortation as forward sort.

Table 3

Data Definition of WRHA Joint Registry and Area Deprivation Data

Label	Description	Level	Measurement
Age	Age in years	Individual	Interval
BMI	Body mass in kg/m^2	Individual	Interval
OKS	The Oxford Hip/Knee score. A standardized measure of knee/hip functioning and pain related to joint degeneration	Individual	Interval
Gender	Gender as indicated by the respondent; male or female	Individual	Nominal
Coexisting conditions	Having at least one or more other selected health condition that impacts life now	Individual	Nominal
Health condition history	Having a history of one or more other health condition	Individual	Nominal
DepindexM	Material Deprivation Index Score of monetary related deprivation at the postal code area	Postal Code at Level 2	Interval
DepindexS	Social Deprivation Index score of socially related deprivation at the postal code area	Postal Code at Level 2	Interval
PCS	Standardized measure of physical health related quality of life.	Individual	Interval
MCS	Standardized measure of Mental Health related quality of life.	Individual	Interval
Rnpostal	Postal code identifier; 4,880 groups	Postal Code at Level 2	Nominal
Forward sort	Forward sortation group identifier; 70 groups	Postal Code at Level 2	Nominal

Missing Values

Following this cleaning, I examined the data for missing values. On the dichotomous item gender, two values were missing, and I replaced them with values that best fit the responses to other items: one was coded as male and one female based on the educated guess of recorded height and weight. For the nominal variables of coexisting health condition and health condition history, I coded missing items as no history and no current conditions for 819 cases. This likely underestimates the number of subjects with a history or coexisting health conditions now.

A missing value analysis of the remaining variables—DepindexM, DepindexS, age, BMI, OKS, PCS, and MCS—indicated that values were missing in a nonrandom pattern (Tabachnick & Fidell, 2013). The missing value analysis revealed that 10,427 cases (62%) had no missing values. Of the remaining cases, most cases had one missing value at 2,770 (38%), with 2,063 (12%) having two items missing, 1,033 (6%) having three missing values, 585 (3%) having five, and 24 cases having six variables missing. The variable with the highest number of missing values was not surprising as the BMI had 4,027 (23.8%) missing; this was primarily due to missing reported body weight. For the PCS 3,043 (18%) were missing and for the MCS 3,042 (18%) were also missing. For both DepindexM and DepindexS, 694 (4%) cases were missing, as the postal codes were not available. Few were missing from the OKS at 593 (4%), and only five cases were missing for age.

The Little's MCAR chi-square X^2, (79, N = 16,902) = 853.56, $p < .001$ indicates that the pattern of missingness was not random. The primary differences in missing at least one value to no missing cases revealed group differences on a number of variables. For missing at least one value, there was a modest increased likelihood of residency in more materially deprived neighbourhoods (M = 3.20) compared to the missing on at least one value group (M= 3.07), *t*(16,206) = - 4.52, $p < .001$. The same was true for social deprivation groups of not missing (*M*= 3.03) compared to the missing at least one value group (*M* = 2.90), *t*(16,206) = -4.55, $p < .001$. For the missing at least one value group, the average age was higher (*M* = 70.20) in comparison to the not missing values group (*M* = 66.52), *t*(16,895) = -17.90, $p < .001$. The missing group also had a modestly lower BMI (*M* = 30.30) compared to not missing (*M* = 31.10), *t*(12,873) = 5.40, $p < .001$). The missing group had a substantially lower OKS score (*M* = 37.30) compared to the not missing group (*M* = 40.20), *t*(16,307) = 15.39, $p < .001$, indicating the missing values group, on average, reported fewer problems with physical functioning. The differences in missing and not missing groups for the dependent variables were not significant. However, the differences were statistically significant for the deprivation indices, age, BMI, and OKS, with respondents with missing data being on average older, heavier, and having a higher level of physical functioning than those with no missing data. There was also a modest difference in material deprivation area as those with at least one missing value were more likely to live in a less advantaged area.

I deleted cases with missing values and continued the analysis with the remaining sample of *N* = 10, 448. The sample with no missing values is referred to as the complete data set. I maintained the original data set and replaced missing values using multiple imputations to confirm the improvement in fit of the parsimonious model and to demonstrate that its validity was not limited to the sample with no missing data. I discuss these comparisons in Chapters 5 and 6. I continued the additional steps—data cleaning and testing of assumptions, descriptive analysis, bivariate analysis, means comparison and multilevel model building—with the complete (no missing) data set (*N* = 10, 448).

Outliers

I identified univariate outliers using frequency distribution and boxplot examination using the criterion of a value greater than three times the inter quartile range. I used *Z* scores and boxplots to establish a z criterion to identify outliers. I set the z criterion at + or - 3 standard deviations from the mean (Tabachnick & Fidell, 2013). There were a number of outliers on age, BMI, OKS, and MCS. I attempted appropriate transformations as outlined in Tabachnick and Fidell (2013) for each of these variables, but there was no improvement in the skewness of distribution or the number of outliers.

I modified individual outlying values to the next lowest or highest value to a point where they were not greater than three times the interquartile range on each of these four variables. I changed outliers on the following variables: for age, I brought 11 age values up to age 35 and 3 down to age 97; for BMI, I assigned 4 low values to the next lowest value of 19 and reassigned 19 high scores the next highest value of 50; for the OKS, I changed three high scores to the next highest value of 64; for the PCS, I assigned six scores the next lowest value of 7.50 and 24 the next highest value of 55.71. There were fewer outliers on the MCS, where I changed four lower scores to the next lowest score of 15.24 and one high score to the next highest score of 79.07. No univariate outliers remained after these adjustments.

To account for the two levels of data, I identified multivariate outliers among first-level predictors within forward sortation areas, using Mahalanobis Distance (D^2). This was determined in a series of 70 multiple regressions with an analysis of D^2 scores. I established a critical value of $X^2 = 28.91$ using the X^2 for 9 degrees of freedom and a D^2 critical value of $p < .001$. I identified 21 multivariate outliers and eliminated them from the data. In general, outliers appeared to have two or more values that pulled away from the group such as a particularly high or low MCS score, age over 85 or under 35, or BMI below 25 or higher than 45. Therefore, the remaining sample included 10,427 cases.

I established normality and linearity for the continuous variables with both the OKS and MCS having a modest negative skew (OKS = -.59, MCS = -.41). Outside of these two minor concerns, residual analysis indicated that the variables followed an essentially normal distribution of values.

I found no specific issues with normality of distribution, linearity, and homoscedasticity for the interval level variables age, BMI, OKS, DepindexM, DepindexS, MCS, and PCS. Normal and detrended probability plots substantiated normality of distribution. Scatter plots of each independent variable against the dependent variable ensured linearity of the relationship between the dependent and independent variables. Multiple regressions of each dependent variable with the independent variables of age, BMI, OKS, DepindexM, and DepindexS indicated linearity of independent variables and each of the dependent variables. In an examination of the squared multiple correlation for each dependent variable, I found no specific concerns with multicolinearity or singularity for the variables age, BMI, OKS, DepindexM, DepindexS, and separately for each dependent variable, the MCS, and PCS. The variance proportion confirmed that no variables had a variance proportion greater than .50 or a condition index greater than .30 (Tabachnick & Fidell, 2013). The squared multiple correlations for both MCS and PCS and age were high at 12, however attempted transformations did not improve the index and the analyses continued without transformation. The squared multiple correlation and variance proportion condition index for each dependent variable are included in Appendix B.

I examined the relationship between each independent variable and each dependent variable, while controlling for the other independent variables in partial regression plots. Linear and quadratic fit lines and R^2 differences between the two lines ensured linearity between the independent and dependent variables. Visual inspection of the partial regression plots and residual plots also confirmed linearity between each of the dependent variables and the independent variables.

Reliability

I established reliability for the OKS using the Cronbach's alpha. The alpha for the 12 items was $\alpha = .87$. This indicates the OKS is a reliable single item measure for this sample (Dawson et al., 1998). Only the composite *z* scores for the PCS and MCS were available and used in this analysis. The reliability of the PCS and MCS is well established in the literature, and the *z* score in the general population has a mean of 50 and a standard deviation of 10 (Ware et al., 1996). The mean and standard deviation of the PCS in the study sample of $M = 28.99$ (SD = 8.27) indicates a lower average score and a somewhat restricted range. I found a higher mean and greater variation in scores with the MCS, with mean of 51.45 ($SD = 11.96$). The average MCS was higher than scores that would be found in the general population, while the PCS is, on average, far lower.

Descriptive Statistics and Comparing Means

As expected, the sample mean age was at an older adult age of 66.26 years ($SD = 11.12$) with a minimum age of 35 and the maximum age of 97. The BMI mean of 31.11 (SD= 6.47) with a minimum of 19 and maximum of 50 indicates, on average, an overweight group in the obese class I category (Health Canada, 2003). This is not surprising, given the high risk of obesity in joint degeneration and higher body weight as the result of reduced joint functioning. The mean for the OKS was also high as expected at 40.21 ($SD = 8.86$) with a minimum of 3 and maximum of 60. The median for the material deprivation index is 3, the mode being 3; and the mean 3.04

(*SD* = 1.38). The median for the social deprivation index was 3, mode of 1 and mean 2.87 (*SD* = 1.45). This is close to what would be expected; particularly for the material deprivation score. The social deprivation lower quintile indicates lower social deprivation residency is slightly overrepresented in this sample. Also, both deprivation indexes have a low, negative kurtosis, indicating, as would be expected, a flat distribution with limited range. Table 4 provides information on the measures of central tendency, mean, median, mode, skewness and kurtosis. As can be seen in Table 4, skewness and kurtosis on each variable confirms that distribution is essentially following a normal curve.

Table 4

Measures of Central Tendency for Interval and Continuous Variables

Variables	Mean	Mode	Median	Standard deviation	Skewness	Kurtosis
DepindexM	3.04	3	3	1.38	-.029	-1.24
DepindexS	2.86	1	3	1.45	.121	-1.35
Age	66.26	65	66	11.12	-.22	-.31
BMI	31.11	27	30	6.46	.750	.37
OKS	40.21	42	41	8.86	11.95	8.27
MCS	51.45	63.24	52.65	11.95	-.42	-.45
PCS	28.99	29.30	28.18	8.27	.50	.22

Note. *N* = 10,427.

Comparing group means. The sample contained 5,934 women for 56 % of the sample. Most of the sample reported having another health condition at 63.07% (*n* =6,576), while fewer subjects reported having a history of another health condition at 27% (*n* = 2,906). There were group differences in mean PCS and MCS scores by gender and existing or history of other health conditions. Table 5 provides a summary of the means and standard deviation of PCS and MCS, by gender and by coexisting health condition group.

There were group differences in MCS on the dichotomous variables. Women (*n* = 5,934) reported, on average, a lower MCS (*M* = 50.09, *SD* = 12.03) than men (*M* = 53.25, *SD* = 11.60, *n* = 4,493). This was a statistically significant difference *t*(10,425) = -13.48, *p* < .001. For subjects with another health condition (*n* = 6,576), the average was lower (*M* = 50.23, *SD* = 12.05) than the group without another health condition (*M* = 53.54, *SD* = 11.48, *n* = 3,851), and this difference was also statistically significant *t* (10,425) = 13.76, *p* < .001. For respondents having a history of a coexisting condition, the pattern was similar, but with a far lower mean for the MCS for the group with a history of another health condition (*M* = 47.94, *SD* = 12.47, *n* =2,906) compared to no history of another condition (*M* = 52.81, *SD* = 11.47, *n* =7,521), *t*(10,425) = 18.94, *p* < .001. There was a similar pattern for the PCS with women, on average, reporting slightly lower scores (*M* = 28.28, *SD* = 7.89, *n* = 5,934) than men (*M* = 29.93, *SD* = 8.66, *n* = 4,493), *t* (10,425) = -10.15, *p* < .001. Having another health condition also predicted lower PCS scores (*M* = 28.07, *SD* = 7.90, *n* = 6,576) compared to not having another condition (*M* = 30.58, *SD* = 8.66, *n* = 3,851), *t*(10,425) =15.12, *p* < .001). As well, respondents with a history of a co-occurring condition reported a lower PCS score (*M* = 27.45, *SD* = 7.66, *n* = 2,906) compared to no history (*M* = 29.59, *SD* = 8.42, *n* = 7,521), *t*(10,425) = 11.90, *p*<.001. Comparing group means demonstrates differences in the dependent variables based on the grouping of female gender, having an existing health condition and having a history of a co-occurring condition.

Table 5

Means and Standard Deviation of PCS and MCS by Gender and Health Condition Status

	Gender		Health condition now		Health condition history	
Variables	Male	Female	No	Yes	No	Yes
MCS Mean (SD)	53.75 (11.60)	50.09 (12.04)	53.54 (11.48)	50.23 (12.06)	52.80 (11.46)	47.94 (12.47)
PCS Mean (SD)	29.93 (7.89)	28.28 (8.66)	30.58 (8.65)	28.07 (7.90)	29.58 (8.42)	27.45 (7.67)
Significance t	MCS -13.48* PCS -10.15*		MCS 13.57* MCS PCS 15.15* PCS		MCS 18.94 PCS 11.90 *	

Note. Numbers in parentheses represent standard deviation; N = 10,427.
* $p \leq .001$

Reviewing the proportion of the study sample population distribution by deprivation index quintile also yielded interesting findings. Examining the most materially and socially deprived areas, quintile 5, I found that women and men were close to evenly represented at 21% of each gender (n = 1,158 female; n = 904 male). This pattern was similar for coexisting health conditions with each group having similar representation at 21 % (n = 2,062) of the total population living in the most materially deprived neighbourhoods. This is, as would be expected given that the distribution is in quintiles based on the regional area, and a sample this large would be expected to follow a normal distribution. However, this pattern was different for those reporting a history of other health conditions with 21.8% (n = 634) of those having a health condition history living in more materially deprived areas compared to 19% (n = 1,428) of the respondents reporting no history. The difference was not significant for gender or co-occurring health condition now, but there was a significant $X^2 = (4, N = 10{,}427) = 21.80$, $p < .001$ difference for having a history of a coexisting health condition and living in a materially deprived area.

There was a somewhat different distribution for social deprivation scores. The proportion of women living in quintile 5 was 23% (*n* = 1,295) compared to men at 16.2% (*n* = 690). As well, a larger proportion of subjects who reported having another health condition lived in the most socially deprived areas at 22% (*n* = 1,179), with 18 % (*n* = 717) of those reporting having no other conditions living in the most socially deprived areas. The pattern was similar for reporting a history of health conditions with 24% (*n* = 680) of those reporting a history living in the most socially deprived areas compared to 19 % (*n* = 1,305) of those having no history. There was a statistically significant group difference for gender X^2 (4, N = 10,427) = 99.36, p <.001, co-existing health condition at X^2 (4, N = 10,427) = 43.11, p < .001, and co-occurring history at X^2 (4, N = 10427) = 21.80, p < .001. This indicates that there was an overrepresentation of residency in more socially deprived neighbourhoods, based on gender and co-occurring health condition status, with more women and respondents with other health conditions living in more socially deprived neighbourhoods. This was similar to the over representation found for those with a health condition history and residency in a materially deprived neighbourhood.

Bivariate analysis. Although a number of the bivariate correlations were significant, no correlations were close to a value that would indicate non-independence in measurement, closer to or over .70. I found a statistically significant small negative correlation between age and BMI, r (10,427) = -.24, p < .001. However, this may be related to the phenomenon of response shift (Sprangers & Schwartz, 1999) with chronic illness that explains the phenomenon of how people adjust to reduced functioning and physical changes and HRQoL has adapted to changes in expectation and dependence on complete physical functioning for satisfaction with life. There was also an expected small statistically significant correlation between BMI and the PCS r (10,425) = -.12, p <. 001 and MCS r (10,427) = -.15, p < .001, indicating a negative correlation between higher BMI and reduced physical HRQoL. However, there was a counterintuitive positive relationship between MCS and BMI. This indicates a small positive relationship between mental HRQoL and increasing body weight. As expected, there was a significant negative correlation between the PCS and OKS r (10,427) = -.51, p <. 001, indicating the close relationship between reduced physical functioning and decreased physical HRQoL.

The OKS also had the anticipated negative correlation with the MCS r (10,425) = -.33 p < .001, yet this correlation was not as strong as the relationship with the PCS. There was very low correlation between the PCS and deprivation indices, but there was a small negative correlation between the MCS and material deprivation r (10,427) = -.051, p <.001 and MCS and social deprivation index r (10,427) -.06, p < .001). This supports the working hypothesis that social and material deprivation both have a negative linear relationship with mental HRQoL. A summary of all bivariate correlations is presented in Table 6. All correlations are two-tailed and the statistical tests are indicated in symbols as follows: Pearson's (r), point biserial correlation (r_{pb}) for the dichotomous to continuous variables, and phi (Φ) for the dichotomous to dichotomous correlations. I examined two-tailed significance given the possibility of bidirectional association for variables.

Table 6

Bivariate Correlations of All Variables

Variable	1	2	3	4	5	6	7	8	9	10
1 Age	1.00	-.24* *r*	-.01 r	-.06* r_{pb}	08* r_{pb}	.08* r_{pb}	-.06* *r*	.05* *r*	-.04* *r*	.04* *r*
2. BMI	-.24* *r*		.09* *r*	-.08* r_{pb}	.07* r_{pb}	.08* r_{pb}	-.12* *r*	-.04* *r*	.081* *r*	.03* *r*
3. OKS	-.01 *r*	.09* *r*		-.16* r_{pb}	.12* r_{pb}	.12* r_{pb}	-.51* *r*	-.33**r*	.06* r	.03* r
4.Gender	-.06*r_{pb}	-.08* r_{pb}	-.16* r_{pb}		-.15* Φ	-.10* Φ	.10*r_{pb}	.13* *r*	.01 r_{pb}	-.09*r_{pb}
5. Health condition now	.08* r_{pb}	.08* r_{pb}	.12* r_{pb}	10* Φ		.43 Φ	-.14*r_{pb}	-.13*$\mathrm{r_{pb}}$	.03* r_{pb}	.05* r_{pb}
6. Health condition lifetime	.08*r_{pb}	.07*r_{pb}	.12* r_{pb}	.10* Φ	.43* Φ		-.12* r_{pb}	-.18* r_{pb}	.04* r_{pb}	.07* r_{pb}
7. PCS	-.06* *r*	-.12* *r*	-.51* *r*	.10* r_{pb}	-.15* r_{pb}	-.12* r_{pb}		-.14* *r*	-.03* *r*	.00 *r*
8. MCS	.06**r*	-.15 **r*	-.33* *r*	.13* r_{pb}	-.13*r_{pb}	-.18* r_{pb}	-.14* *r*		-.05* *r*	-.08* *r*
9. DepindexM	-.04**r*	.08* *r*	.06**r*	.01 r_{pb}	.03*r_{pb}	.04* r_{pb}	-.03* *r*	-.05**r*		-.06* *r*
10. DepindexS	.04* *r*	.02**r*	.03**r*	-.09*r_{pb}	.05*r_{pb}	.07*r_{pb}	.00 *r*	-.06* *r*	-.06* *r*	

Note. *N* = 10, 427.
* *P*. ≤ .001, Pearson's correlation *r*, point biserial correlation r_{pb}, and phi correlation Φ.

Analysis of Variance

Group mean differences were present for both deprivation indices and MCS in a one-way ANOVA. Post hoc tests indicate that only the least materially deprived (*M* = 52.42, *SD* = 11.66, *n* = 2,529, $p < 001$) and most materially deprived quintiles, (*M* = 49.68, *SD* = 12.05, *n* = 1,985, $p < .001$) differ significantly. The post hoc criterion Tukey's HSD and Games-Howell support a statistically significant difference between these two groups F (4,10422) = 8.44, $p = .000$. There was more than a two-point difference in MCS between the highest and lowest material deprivation quintiles, indicating significant variation between the most and least deprived groups.

Similar differences were found for the social deprivation index and MCS with the most (*M* = 52.42, *SD* = 11.66, *n* = 2,529) and least deprived groups (*M* =49.67, *SD* = 12.05, *n* = 1,985) having a statistically significant difference $F(4,10422) = 18.706$, on post hoc comparisons by Tukey's HSD least squared difference $p < .001$), and Games-Howell post hoc test ($p < .001$) with the least deprived and the most deprived having close to a three-point difference in MCS. No difference in-group variance was found for the PCS and material deprivation. Group variances were also examined for the Level 2 and Level 3 groupings and it was found that most of the variance was at Level 1. The deprivation index and dependent variable ANOVA table is provided in Appendix B4 and B5 for further reference.

A one-way ANOVA of the dependent variable by Level 2 and Level 3 grouping variables, the dissemination area, and forward sortation area, indicates modest differences across areas, an important component of multilevel modeling (Snijders & Bosker, 2012). For the MCS, there were no significant differences across dissemination areas F (236, 10190) = 1.21, $p = .017$, while there were significant differences across forward sortation areas F (69, 10357) = 3.52, $p < .001$. For the PCS, there were significant differences across dissemination areas $F(236,10190) = 1.31$, $p <.001$, and differences across forward sortation areas $F(69,10357) = 2.1$, $p < .001$, indicating that variability is attributed to the geographic area grouping at Level 2 and Level 3 for the PCS. This preliminary ANOVA demonstrates that variability can be attributed to the three-level structure of the data in the absence of explanatory variables. I examine variance further in the ICCs in Step 1 at the beginning of the next and subsequent chapter.

Summary

From this initial review of the data, there were obvious correlations and differences in means that support fundamental cause and the deleterious impact of the habitus on life quality. There are notable differences in the mean level of physical HRQoL across levels of material deprivation. Also, a difference in the sample distribution by deprivation index corroborates an overrepresentation of respondents who have a contemporary or a history of other health conditions in the most materially and socially deprived neighbourhoods. I acknowledge that these relationships are complex, yet these findings indicate that poor health in one's lifetime is linked to living in a more deprived area.

To further understand these relationships, multivariate multilevel investigation of contributions to HRQoL considering individual characteristics, area deprivation and postal code nested in forward sortation area.

Chapter 5: Multilevel Modeling Results: Mental Component Score

Here and in Chapter 6, I report on key results in the multivariate analyses. Here, I describe in detail the results at each of the four steps in the model-building process for the MCS. I used a three-level multilevel linear model to examine mental HRQoL, while adjusting for individual level and contextual level covariates. I also examined cross-level interaction effects in the development of a parsimonious model that best explains variation in MCS score within the three-level structure.

In this analysis, I examined 10,427 respondents in 4,880 postal code areas within 70 larger geographic areas known as forward sortation areas. As with all multilevel models, this model building required that I follow a number of steps building from the bottom up. I began at Step 1 with *a null intercept only model*. That is, an intercept only model to determine the distribution of data and its influence on the dependent variable with the random intercepts without any explanatory variables. In this model the data were organized in the three level grouping and the intercept was allowed to vary across the postal code level and the forward sortation level. In Step 2 I expanded the model by adding individual Level 1 variables in the first of a series of three level random intercepts models. I followed this initial model with contextual neighbourhood level variables at Level 2, and then I formulated a model with cross-level interaction terms. I then built down, removing insignificant variables, comparing a series of sparse models to the most parsimonious model that represents the best model fit with the least number of variables in this random intercept, fixed slope three-level structure.

In Step 3, I compared model fit using random intercept random slope models, allowing material and social deprivation, each separately, to vary at Level 2 and then at Level 3. I was able to determine if allowing the indices intercept and slope to vary at Level 2 and then Level 3 improved model fit. In Step 4, I conducted a model refinement process. I closely reviewed selected dichotomized interaction effects to glean further information about specific sub-populations. I then performed graphic examination of selected grouping variables. Following this close review I compared changes from the null model to the parsimonious model using the complete values dataset in comparison to the missing values estimated data. This provided an opportunity to ensure that validity was not threatened by the deletion of missing values cases. Step 4 provided me with a close look at interaction terms and the experience of specific sub populations as well as the validity of findings considering the large number of missing values. In this last step I also compare all of the models and select the best model fit for explaining the relationship of all of the variables to MCS in the three level structure.

In total, I compared 14 models across the four steps. I compared all models on model fit and change in R^2 to establish a final parsimonious model that best explains the variance in MCS score. I provide a brief discussion of model fit and variance explained between the various steps. The model steps are present in Table 7 for easy reference.

Table 7

MCS Model Building Process

Step	Process	Variables
Step 1: Null intercept only model		
Step 2: Fixed effects models		
2a)	Level 1 predictors	Age, BMI, OKS, gender, co-ill now, co-ill history
2b)	Level 1 and 2 predictors	Age, BMI, OKS, gender, co-ill now, co-ill history + DepindexM, DepindexS
2c)	Level 1 and 2 predictors and interactions	Age, BMI, OKS, gender, co-ill now, co-ill history, DepindexM, DepindexS, age•DepindexM, BMI, DepindexM, OKS•DepindexM, Gender• DepindexM, co-ill now•DepindexM, co-ill history•DepindexM, Age•DepindexS, BMI•DepindexS, OKS•DepindexS, Gender•DepindexS, co-ill now•DepindexS, co-ill history•DepindexS, DepindexM•DepindexS
2d)	Building the parsimonious model	Age, BMI, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, DepindexM•age, DepindexM•BMI, DepindexS•Age, DepindexS•BMI, DepindexM•DepindexS
2e)	continued	Age, BMI, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, DepindexM•BMI, DepindexS•Age, DepindexS•BMI, DepindexM•DepindexS
2f)	continued	Age, BMI, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, DepindexS•Age, DepindexM•DepindexS•Age, DepindexM•DepindexS•BMI
2g)	continued	Age, BMI, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, DepindexS• age, DepindexS•BMI
2h)	continued	Age, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM,
Step 3: Random intercept random slopes models		
3a	DepindexM varying at Level 2	Age, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, + DepindexM random at Level 2
3b	DepindexM varying at Level 3	Age, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, +DepindexM random at Level 3
3c	DepindexS varying at Level 2	Age, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, +DepindexS random at Level 2
3d	DepindexS varying at Level 3	Age, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, +DepindexS random at Level 2
Step 4: Exploring interaction terms		
4a	Graphing differences and comparing complete cases to missing values estimated datasets	Age, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM

Note. Co-ill = co-illness; • indicates an interaction relationship between the variables.

Step 1

Given the hierarchical structure of the data, I began my analysis with a null intercept only model; this established the ICC for the MCS, which I determined by running the intercept only three-level model without any explanatory variables and employing Equation 1 in Chapter 3.

I calculated the ICC with the following values: 2.338558/ (128.209418 +13.919472 + 2.338558) = .016 I established the ICC for the MCS as .016 or 1.6%. The value of p_1 = .016 indicates a large portion of the total variance is attributed to individual characteristics. As the value of ICC is closer to 0 than to 1, the value indicates modest variability among Level 2 and Level 3 groupings. This variability indicates the range of values for the dependent variable within the Level 2 and then Level 3 clusters.

The variance between the postal codes nested within forward sortation at Level 2 and Level 3 combined was .097 or 10%. At the individual level, the variance between subjects was .889 or 89%. This indicates that a much larger variance in MCS occurs at the individual level. The residuals, and AIC and -2 LL for the null model provide a base to compare fuller models throughout the analysis and to establish an R^2 coefficient of each subsequent model. Although this value is small, there was still a need to continue with multilevel modeling given the data structure and to explore this variability to determine if part of the variability is accounted for in individual attributes and contextual variables.

Step 2

In this first of the random intercept fixed slopes models, Step 2a, the six individual level variables were added as fixed effects. All of the variables were grand mean centred to provide standardized slopes for comparison. This allows for comparison of effect size on the dependent variable (Heck et al., 2013; Snijders & Bosker, 2012). This included the three continuous variables and the dichotomous variables of gender, coexisting health history and coexisting now and the deprivation indices.

The three-level model was greatly improved with the addition of the six Level 1 predictors. The estimate for both age and BMI indicated a small positive relationship between higher age and MCS (b = .07, t = 7.13, p < .001), indicating that higher age was predictive of higher MCS. Although the direction for BMI was also positive, the estimate was not significant (b .04, t = 2.34, p = ns). This was unexpected, given the theory and anticipated association between older age, higher BMI, and reduced MCS. BMI did not make a significant impact on the dependent variable, while the other five variables presented significant estimates to p < .001. Having a history of another health condition made the largest contribution with an estimate of b = -3.36 (t = -12.45, p < .001) variance in MCS slope. This indicates that individuals with a history of another health condition are likely to report on average up to a 3.36 point lower MCS score. Having another illness has a substantial toll on MCS as a ≥ 3 point difference in score is considered a clinically significant difference (Janzen et al., 2013). This is > 3 point difference for one variable only and shows the dramatic toll having a health condition history takes on current mental health status.

Female gender had the next highest contribution to the model at b = -1.66 (t = -7.34), p < 001, indicating that being female was predictive of an average 1.66 point lower score in MCS. A similar strong relationship was present for having another current health condition. Although age and OKS had statistically significant estimates, their predicted impact was less. The OKS relationship is, as expected, positive as the direction is the reverse of the MCS score, with higher score representing higher physical functioning while a lower MCS score indicates reduced mental

HRQoL. As depicted in Table 7, the addition of Level 1 predictors significantly improves the model fit $X^2 = (6, N = 10{,}427) = 81162.735 - 79728.395 = 1{,}434.34$, $p < .001$.

As expected, the individual attributes explained variability in MCS and substantially improved the model fit; this indicates that these individual attributes further explain variance in MCS over the null model. Although it was anticipated that individual variables would improve the model, I found some of the estimates counterintuitive. It was surprising that BMI did not contribute to variance in MCS as much of the literature supports a strong relationship between higher BMI and reduced life quality. As well, I was surprised the direction of the relationship with age as younger age was predictive of lower MCS.

The results are presented in Table 8 for a side-by-side comparison with the null model to this full model. In this first random intercept fixed slopes model, variance in Level 2 intercept continued to be significant, indicating that the MCS intercept (predicted mean) continued to vary between postal codes nested in forward sortation areas. There continues to be a significant contribution to the model from the random intercept of the small area at Level 2.

The addition of Level 2 contextual predictors, both deprivation indices, further improved model fit. The estimate for age continued to have a small positive relationship between higher age (b =. 07, $t = 7.302$, $p < .001$) and a higher MCS indicating that older age was predictive of higher (better) MCS. BMI also had a positive estimate; however, the contribution continued to be not significant ($b = .04$, $t = 2.57$, p < ns). The impact of the individual level estimates remained similar to Step 2a, while social deprivation at Level 2 provided an estimated small additional change to MCS ($b = -.39$, $t = - 4.50$, $p < .001$), indicating a .39 decrease in MCS per unit difference in social deprivation index. This is a .39 difference per deprivation quintile presented in Table 8.

Table 8

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of MCS, Null, and Full Model

Parameter	1 null model	Step 2a all Level 1 predictors
Fixed effects		
Intercept	51.14* (.25) [50.64-51.64]	51.25* (.20) [50.85-51.64]
Level 1 (individual)		
Age		.073* (.01) [.05- .09]
BMI		.05+ (.02) [.01-.07]
OKS		-.38* (.01) [-.41--.36]
Gender		-1.66* (.23) [-2.11- -.1.22]
Co-existing conditions		-1.00 * (.25) [-1.50--.51]
Condition history		-3.36* (.27) [-3.89—2.83]
Random parameters		
Residual	128.21* (2.30) [123.80-132.78]	113.39* (2.00) [109.55-117.37]
Intercept/ forward sort	2.34* (.71) [1.29-.22]	1.20* (.43) [109.54- 117.37]
Level 3		
Forward sort*full postal code	13.92* (2) [10.50-18.45]	10.17* (1.64) [.60- 2.44]
Level 2		
AIC	81170.735	79748.395
-2 LL	81162.735	79728.395
Number of parameters	4	10

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. N = 10,427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood.
* $p \leq$ 001, + $p \leq$ 05.

For material deprivation, the influence was similar, but slightly lower b = -.33, (t = -3.56), p < .001), indicating a .33 decrease in MCS score with every decrease in deprivation quintile. As the MCS is a standardized z score, this indicates a gradient -.39 change in MCS score for each reduction in the grand mean centred social deprivation index score and similarly a -.33 score difference in material deprivation score. This demonstrates that both indices provide a statistically significant contribution to the model. The change in -2 LL indicates this model provides a large improvement from the previous null model X^2 (6, *N* = 10,427) = 81162.735 - 79728.395 = 1,434.34, $p < .001$, indicating that lower material and social deprivation, along with individual attributes, contribute to a predictive model of MCS scores.

At this point in the analyses, Hypothesis 1 can be supported as material and social deprivation at the neighbourhood level do negatively affect mental HRQoL in addition to personal attributes that include having a history of another health condition, having another existing health condition, being female, having reduced physical functioning and lower age. Following this model, I combined each of the Level 1predictors in an interaction term with each of the indices for Step 2c I also combined the two deprivation indices in an interaction term for a model with 25 parameters. Again, I considered all the alpha level values as one-tailed given the theoretical and empirical support for the direction of the relationship.

In this step, all of the Level 1 predictors had similar estimates to the previous models and all of the Level 1 predictors continued to be significant to $p < .001$ except for BMI. The estimate for DepindexS decreased from b = -.39 (t= -4.50), $p < .001$ to b = - .32 (t=- *4.33)*, $p < .001$ but remained significant. This indicates the social deprivation interaction terms explained some of the contribution of this variable to variance in the MCS. The estimate for DepindexM also decreased by .02, but also remained significant. Health condition history continued to have the largest parameter estimate b = -3.26 (t = -12.04), $p < .001$. Health condition history continued to provide the largest estimate even with all of the interaction terms in the model, again indicating the deleterious impact of coexisting health conditions on mental health life quality. There were small interactions between age and both deprivation indices and BMI and both deprivation indices; however, the estimates did not reach statistical significance. The DepindexM and DepindexS interaction term also had a value close to significance ($b = .12$, $t = -1.81$, $p < .05$). There continued to be a statistically significant variance in intercept at Level 2 in the model, indicating that the MCS mean continued to have high unexplained variance at the postal code level. The -2 LL was improved from the full model, model 2a; however, this was not a statistically significant improvement in model fit from the previous model, model 2b with all of the Level 1 and contextual variables at Level 2 X^2 (13, N = 10,427) = 79698.626 -79674.738 = 23.89, p = ns), indicating the additional 13 interaction parameters did not, in a substantive way, improve model fit. This indicates that in interaction, neighbourhood deprivation indices do not have an additional influence on MCS. The results of adding interaction terms to the model are presented in Table 9. However, given the potential to contribute further explanation in a paired down model I included the interaction fixed effects that indicated potential contribution to variance in MCS in my development and refinement of the parsimonious model.

Table 9

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of MCS, All Level 1 and Level 2 Predictors and Interaction Terms

Parameter	Step 2b all Level 1 and Level 2 estimates	Step 2c Level 1 and Level 2 estimates and interaction term estimates
	Fixed effects	
Intercept	51.27 (.17) [50.93-51.60]	51.27 (.17) [50.92-51.59]
Age	.08* (.01) [.05- - .10]	.07 * (.01) [.05-.09]
BMI	.05 (.02) + [.01- .08]	.04 (.02)+ [.01 - .07]
OKS	-.38* (.01) [-.40 - -.36]	-.38* (.01) [-.40- -.35]
Gender	-1.62* (.22) [-2.07- -1.18]	-1.62* (.22) [-2.06- -1.17]
Coexisting condition	-.99* (.25) [-1.47- -.50]	-.98* (.25) [-1.48- -.49]
Condition history	-3.30* (.27) [-38- -.2.77]	-3.26 *(.09) [-3.79- -2.72]
DepindexM	-.33* (.09) [-.51- - .15]	-.31* (.09) [-.50- -.13]
DepindexS	-.39* (.09) [-.56- -.22]	-.32* (.09) [-.54- -.20]
Age•DepindexM		.01+ (.01) [-.00 -. .02]
BMI•DepindexM		.02+ (.01) [-.001 - .02]
OKS•DepindexM		.01(.01) [-.01- .02]
Gender•DepindexM		.03(.16) [-.27- .37]
Co-existing condition•DepindexM		-.01 (.17) [-.36- .35]
Condition history•DepindexM		-.19 (.20) [-.56--.20]
Age•DepindexS		02+ (.006) [.01- .03]
OKS•depindex S		-.01 (01) [-.03-.01]
Gender•DepindexS		.06 (.16) [-.25- .37]
Coexisting condition•DepindexS		-.25 (.17) [-.59- .09]
Condition history•DepindexS		-.07 (.18) [-.44- .29]
DepindexM•DepindexS		-.12 (.06)+ [-.22-.01]
	Random parameters	
Residual	113.27* (1.98) [109.44- 117.27]	113.09* (1.98) [109.28 – 117.04]
Intercept/ forward sort Level 3	.56 (.30) [.19 – 1.62]	.48(.28) + [.15 – 1.50]
Forward sort/ full postal code Level 2	10.17* (1.6) [7.43- 13.92]	10.09* (1.6) [7.36 - 13.83]
AIC	79722.626	79724.738
-2 LL	79698.626	79674.738
Number of parameters	12	25

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. N = 10,427; AIC = Akaike Information Criterion, -2 LL = minus 2 log likelihood; • indicates an interaction between the two variables. * $p \leq$ 001, + $p \leq$ 05.

In this model refinement, I established a parsimonious model by removing insignificant variables and interaction terms. This approach started from the largest possible model—in this case with 17 parameters—and then proceeded with careful removal of insignificant variables one at a time for model comparison. Variables were considered if they had a significance of $p < .05$ for initial selection. Variables were removed based on size of estimate, from smallest to largest. If removals impacted the model substantively with changes in estimates or changed significance of other variables, then I returned them in the process of model refinement. This involved careful analysis of the impact of removing variables and interaction terms on other estimates by examining changes in estimates, -2 LL and AIC. Only the models with potential improvement in fit were considered.

Table 10 provides a summary of some of the models examined that provided a better fit and which I considered in model development. Again, I halved all of the *p* values for fixed effects, considering the expected direction of the relationship. Models not shown were compared on -2 LL and AIC values as well as changes to estimated fixed and random effects and residuals. The model fit was compared to the fullest model, Model 2d, with each subsequent model compared for fit considering change to -2 LL and change in parameter estimates, given degrees of freedom.

Table 10

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the MCS, Building the Parsimonious Model

Parameter	Step 2d	Step 2e	Step 2f	Step 2g	Step 2h parsimonious model
			Fixed effects		
Intercept	51.25* (.17) [50.93- 51.60]	51.25* (.16) [50.94-51.59]	52.82* (.21) [52.38- 53.24]	52. 81(.22)* [52.37-53.24]	52.78* (.17) [52.92- 53.21]
Age	.07 (.01)* [.05-.09]	.07* (.01) [.05-.09]	.08* (.01) [.05-.09]	.08* (.01) [. 06 - .10]	.07* (.01) [.05-.09]
BMI	.04 (.01)+ [.01-.07]	.04 (.02)+ [.01- .08]	.04 (.02)+ [.01-.08]	.05 (.02)+ [.01- .08]	
OKS	-.38* (.01) [-.41- -.36]	-.38* (.01) [-.41- -.36]	-.38* (.01) [-.40--.35]	-.38* (.01) [-.40--.35]	-.38* (.01) [-.40--.35]
Gender	-1.62* (.23) [-2.06—1.18]	-1.62* (.22) [-2.07- -.1.18]	-1.62* (.23) [-2.07—1.17]	-1.62* (.23) [-2.06--1.18]	-1.58* (.22) [-2.02- .1.13]
Coexisting condition	-.97*(.25) [-1.47- -.48]	-.98* (.25) [-1.47- -.48]	-.99* (.25) [-1.4- -.49]	-.99* (.25) [-1.47- .48]	-.96*(.25) [-1.45- -.46]
DepindexM	-.32* (.09) [-.50 - -.13]	-.32* (.09) [-.51 - -.13]	-.34* (.09) [-.52- -.15]	-.33* (.09) [-.52--.15]	-.32* (.09) [-.51- -.13]
DepindexS	-.39* (.08) [-.55- -.22]	-.39* (.09) [.56- -.22]	-.39* (.09) [-.56- -.23]	-.39*(.09) [-.56- -.23]	-.38*(.09) [-.55- -.21]
Age• DepindexM	.01+ (.01) [-.001 - .02]				
BMI• DepindexM	.02+ (.01) [.000 - .5]	.02+ (.01) [.0 00 - .05]			
Age• DepindexS	.02+ (.01) [.005 - .03]	.02+ (.01) [-.00 - .03]			
BMI• DepindexS	.02+ (.01) [.001- .04]	.02+ (.01) [.00- .05]			
DepindexM• DepindexS	-.11+ (.06) [-.23-.01]	-.11+ (.06) [-.23- .01]	-.11+ (.06) [-.23- -.01]		
DepindexM• DepindexS•Age			.00 (.004) [-.01 - .01]		
DepindexM• DepindexS•BMI			-.00 (.01) [-.02- .01]		

(continued)

Table 10 (continued)

Parameter	Step 2d	Step 2e	Step 2f	Step 2g	Step 2h parsimonious model
		Random parameters			
Residual	113.10* (.197) [109.29 - 117.05]	113.05* (1.98) [109.23 -116.99]	113.20* (1.98) [109.39 -117.16]	113.26* (1.98) [109-117.05]	113.40* (1.98) [109.57 -117.36]
Intercept/ forward sort Level 3	.56 (30) [.19- 1.6]	.56 (.30) [.19- 1.6]	.48 (.28) [.15- 1.5]	.56 (.30) [.19- 1.62]	.57(.31) [.20 -1.63]
Forward sort/ full postal code Level 2		10.16* (1.63) [7.41- 13-.91]	10.23* (1.63) [7.49-13.97]	10.17* (1.62) [7.43- 13.92]	10.09*(1.63) [7.35-13.85]
AIC	79714.630	79715.559	79724.337	79722.626	79726.212
-2 LL	79680.630	79683.559	79694.337	79698.626	79705.212
Number of parameters	17	16	15	12	11

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. N = 10,427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood; • indicates interaction between the two variables.
* $p \leq$ 001, + $p \leq$ 05.

In Steps 2d, 2e, and 2f, the interaction terms and BMI had small parameter estimates and were not significant. The contribution of other individual and the Level 2 variables continued to be similar to models 2a and 2b. The age and BMI interaction terms, DepindexM•DepindexS interaction term, and last, BMI did not have statistically significant estimates in model refinement. The 95% confidence intervals for the age and BMI interaction terms and BMI included 0, indicating the true estimate is small and there may be no effect. Comparing potential nested models on changes to -2 LL and AIC, to the initial full Model, Model 2a, Model 2h with five of the six Level 1 predictors and two Level 2 predictors, provided the best model fit with 11 parameters. Although removing BMI slightly reduced the estimates for a few of the other variables, there was an improvement to model fit compared to the full model, model 2a, X^2 (1, N =

10,427) = 79705.212 – 79728.395 = 23.18, $p < .001$. Similar to the full model, this is also an improvement from the intercept only model.

Model 2h provides the best fit for explaining variance in MCS within the three-level structure. This model includes five individual level variables (age, OKS, gender, coexisting health conditions now, health conditions history) and both deprivation indices. As in previous models, illness history continued to have the largest influence $b = 3.26$, ($t = -3.83$), $p < .001$).

This indicates that even when considering a number of other factors at both the individual and neighbourhood level, the likelihood of having a coexisting health condition contributes to, on average, a 3.26 decline in MCS. It is interesting to note that the interaction terms involving co-occurring history were not significant, indicating that this is a substantial direct contribution to reduced MCS that does not have additional impact in interaction with deprivation at the area level. There is a strong direct impact of having a history of another health condition on reduced MCS that presents a clinically important difference (Janzen et al., 2013).

This parsimonious model, model 2h, indicates that, having a history of another health condition, being female, having another condition now, having reduced physical functioning, living in a more socially deprived neighbourhood, living in a more materially deprived neighbourhood, and being younger were predictive of lower MCS. No interaction terms were maintained in a final model. Selected interaction terms were explored in more detail in Step 4 to examine the potential for modifying, mediating or additional interaction to the relationship and to provide further insight on the nature of the relationship between the interaction and MCS.

Step 3

In Step 3, I retested the parsimonious model to see if there could be improvement in model fit in comparison to four random slope random intercept models. In this step, I maintained significant fixed effects at Level I. I also continued to include material and social deprivation indices at Level 2 as fixed effects, and then added them to Level 2 as a random intercept and slope and then Level 3 as a random intercept and slope predictors.

This explored the contribution of the indices as both fixed and random effects to test Hypothesis 2, which focuses on whether the variance of area level deprivation further explains MCS. All four models are presented in Table 11 in a side-by-side comparison.

The intercept at Level 2 continued to be significant in each of the random slope and intercepts models: DepindexM varying at Level 2, and varying at Level 3, DepindexS varying at Level 2, and at Level 3. The biggest increase at this step in parameter estimates and improvement to model fit, and variance explained was the model allowing material deprivation index slope to vary at Level 2. However, this improvement was not a statistically significant improvement in model fit over the parsimonious model X^2 (2, N = 10,427) 7975.212 - 79702. 984 = 2.23, p = ns. In each of these models there was no additional contribution to the parsimonious model, indicating no additional improvement in model prediction from slope variance across postal codes or forward sortation areas. . However, the model allowing material deprivation to vary at Level 2 did provide the largest change in pseudo R^2 at Level 2 at .33 compared to .28 for the parsimonious model. This indicates that material deprivation slope and the strength of this relationship within second level units provided further explanation of MCS. However, this was an improvement in variance explained at Level 2 only as the parsimonious model continued to provide the best overall fit considering -2 LL and AIC.

Table 11

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of MCS, Parsimonious Model With Random Slopes Random Intercepts

Parameter	3a DepindexM random at Level 2	3b DepindexM random at Level 3	3c DepindexS random at Level 2	DepindexS random at Level 3	2h Parsimonious Model
			Fixed effects		
Intercept	51.27 (.17) [50.93-51.60]	51.26 (.17) [50.93-51.59]	51.27 (.16) [50.96- 51.62]	51. 27(.16) [50.93-51.59]	51.26 (.17) [50.92- 51.96]
Age	.07* (.01) [.05-.09]	.07* (.01) [.05-.09]	.07* (.01) [.05 - .09]	.07* (.01) [. 05 - .09]	.07* (.01) [.05-.09]
OKS	-.38* (.01) [-.40- -.36]	-.38* (.01) [-.41- -.36]	-.38* (.01) [-.40- -.36]	-.38* (.01) [-.40- -.35]	-.38* (.01) [-.40--.35]
Gender	-1.58* (.23) [-2.02- -1.14]	-1.58* (.23) [-2.02 -.1.14]	-1.58*(.23) [-2.02- -.1.13]	-1.58* (.23) [-2.02—1.14]	-1.58* (.22) [-2.02- .1.13]
Coexisting condition	-.96* (.27) [-1.46- -.47]	-.96* (.25) [-1.46- -.47]	-.96* (.25) [-1.45- -.47]	-.96 *(.25) [-1.47- .48]	-.96* (.25) [-1.45- -.46]
Condition history	-3.25* (.27) [-3.78- -2.73]	-3.25* (.27) [-3.78 - -2.73]	-3.26*(.25) [-3.79 - -2.73]	-3.26*(.27) [-3.78—2.72]	-3.25* (.27) [-3.78- -2.72]
DepindexM	-.33* (.10) [-.52 - -.14]	-.33* (10) [-.52 - -.14]	-.32* (.09) [-.51- -.14]	-.30* (.09) [-.49- -.12]	-.32* (.09) [-.51- -.13]
DepindexS	-.38*(.09) [-.55- -.22]	-.38* (.09) [.55- -.22]	-.40* (.09) [-.57- -.23]	-.39* (.09) [-.56- -.21]	-.38* (.09) [-.55- -.21]
			Random parameters		
Residual	113.37* (2) [109.54-117.34]	113.37* (2) 09.54- 117.34]	113.17* (1.99) [09.34-117.13]	113.39* (2.00) [109.55 -117.35]	
Intercept/ forward sort Level 3	.56 (.30) [.19 -1.62]	.56 (.30) [.19- 1.62]	.54 (.30) [.19 - 1.61]	.54 (.31) [.17- 1.71]	.57(.31) [.20 -1.63]
UN 2,1		.13 (.12) [-.09- -.35]		.10 (.09) [-.08 - .29]	
UN 2,2		.03 (.10) [1.18- -40.57]		.02 (.08) [5.78 – 61.92]	
Forward sort•full postal code Level 2	9.34* (1.68) [6.21- -14.08]	10.33* (1.66) [7.54-14.15]	9.76* (1.72) [6.91 -1379]	10.06* (1.64) [7.32 - 13.85]	10.09* (1.63) [7.35-13.85]
UN 2,1	.12 (.48) [-.81- 1.06]		.57 (.46) [-.33 – 1.48]		

(continued)

Table 11 (continued)

Parameter	3a DepindexM random at Level 2	3b DepindexM random at Level 3	3c DepindexS random at Level 2	DepindexS random at Level 3	2h Parsimonious Model

UN 2,2	.39 (.58) [.02- 7.27]		.24 (.37) [.01- 4.63]		
AIC	79729.252	79730.642	79728.984	79730.011	79726.212
-2 LL	79703.252	79704.642	79702.984	79704.011	79705.212
Number of parameters	13	13	13	13	11

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. *N* = 10,427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood; • interaction between variables, UN 2, 1 = covariance between intercept and slope; UN 2, 2 = variance in random slope.
* $p \leq$ 001, + $p \leq$ 05.

Allowing social deprivation slope and intercept to vary at Level 2 improved the change in R^2 indicating an improvement in variance explained at Level 2, however the extent of this improvement was not large enough to accommodate the additional 2 parameters from the parsimonious model. Therefore, the parsimonious random intercepts fixed slopes model was maintained as the best model fit. The AIC, -2 LL and change in R^2 for all of the models are presented in Table 12.

Given the contribution of the addition of variance explained by the social deprivation index and slope variance at Level 2, Hypothesis 2 is supported for the MCS. That is, there is a difference in predicting MCS score and improvements to variance explained by allowing the slope and intercept of social deprivation to vary at Level 2.

Table 12

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of MCS, Parsimonious Model With Dichotomous Interaction Terms

Parameter	Parsimonious model	Model with age and BMI groups
	Fixed effects	
Intercept	51.26 (.17) [50.92- 51.96]	51.26 (.16) [51.92 - 51.58]
Age	.07* (.01) [.05-.09]	.07* (.01) [.04 -.09]
OKS	-.38* (.01) [-.40--.35]	-.38*(.01) [-.40 - -.35]
Gender	-1.58* (.22) [-2.02- .1.13]	-1.58* (.23) [-2.02- -.1.14]
Coexisting condition	-.96* (.25) [-1.45- -.46]	-.95* (.25) [-1.44- -.46]
Condition history	-3.2* (.27) [-3.78- -2.72]	-3.25* (.27) [-3.78 - -2.72]
DepindexM	-.32* (.09) [-.51- -.13}	-.55* (.14) [-.83- - .28]
DepindexS	-.38* (.09) [-.55- -.21]	-.57* (.13) [-.83 - - .31]
DepindexM•BMI groups		.17 (.18) [-.19 - - .52]
DepindexS•BMI groups		.04 (.07) [-.19 - .12]
DepindexM•DepindexS•age groups		-.03 (.18) [-.19 - .52]
DepindexM•DepindexS•BMI groups		.09 (.11) [-.31- .12]
	Random parameters	
Residual confidence intervals	113.40* (1.98) [109.57 -117.36]	113.33* (1.99) [109.50–117.29]
Intercept/ forward sort Level 3 confidence intervals	.57 (.31) [.20 -1.63]	.52 (.29) [.17 -1.58]
Postal code/ forward sort Level 2 confidence intervals	10.09* (1.63) [7.35-13.85]	10.03* (1.63) [7.30-13.80]
AIC	79726.212	79728.121
-2 LL	79705.212	79694.121
Number of parameters	11	15

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. N = 10,427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood; • indicates an interaction between variables.
* $p \leq$ 001, + $p \leq$ 05.

Step 4

In Step 4, I looked in depth at selected interaction terms and further examined evidence to support Hypothesis 3. Also, there was a comparison of the parsimonious model and improvement from the null between the complete cases data set (*N* = 10,427) and the data set with missing value replacement estimated (*N* = 16,902). I compared changes from the null intercept only model and the parsimonious model and compared parameter estimates and confidence intervals for each of the predictors, intercepts, and residuals. This process further instilled confidence in the significance of findings, suitability of fit, and ensured that external validity was not threatened by eliminating cases with missing data.

I examined the interactions between age, BMI, and each deprivation index more closely by recoding age and BMI into dichotomous dummy variables to assess whether the deprivation indices had a differential impact on lower and higher age groups and lower and higher BMI groups. This allowed me to decompose the variables to determine if lower and higher age and BMI interact differently with the deprivation indices. As the mean BMI for this sample was in the obese Class I category with a BMI mean of 31.11 (SD = 6.48), I used the obese class II definition (Health Canada, 2003) to define the higher body weight group at a BMI ≥ 35. I defined the lower BMI group as a BMI ≤ 34.99. I dichotomized age with the younger age group of up to age 64 and the older age group of over 65 and older. Age 65 was selected as the older age group cut off, as this is the age in Canada when most citizens are considered to be seniors. I coded the groups as 0 for the under 65, 0 for lower BMI, 1 for the over age 65 group, and 1 for the higher BMI group.

Testing models with the new interaction terms did not advance the model fit and none of the estimates were significant. This model is presented in Table 12 beside the parsimonious model. Therefore, I determined that the parsimonious model provided the best set of predictors. This model included Level 1 and Level 2 variables as direct effects only.

A comparison of the intercept only models and parsimonious models between the no missing values data set (*N* = 10,427) and the complete data set with missing replaced by imputation (*N* = 16, 982) indicated that missingness did not interfere with overall results. All of the fixed effects fell within the 95% confidence intervals of the two parsimonious models.

However, at Level 2, the postal code area nested in Level 3 had a lower estimate in the missing values estimated file that was beyond the 95% confidence interval of the complete values data set. However, the change in variance explained was similar at pseudo $R^2 = .34$ for the complete values data compared to for the missing values estimated data at pseudo $R^2 = .37$. This indicates that in the missing values estimated file, the variance in MCS was slightly larger and therefore less was explained by the three level model. As this was the only difference and it represents a modest difference in change in $R^2$of .03, it can be concluded that the complete values data set is representative of the study population and the findings were not substantially compromised by using complete cases only. The two data set null and parsimonious models are provided in Appendix C, Table C1.

Although the interaction terms were not significant in the final model I examined the relationship between MCS and deprivation score and the grouping variables of age and BMI in graphs by gender and by comparing BMI and age group means in ANOVA to further explore sub population differences. This was pursued, as in the development of the final model they appeared to have some interaction with MCS. This exposed very interesting patterns in MCS based on the grouping category.

Age and deprivation. With age, the results had a counterintuitive trend with material deprivation influencing quality of life more for the under 65 age group. This group, on average, reported lower MCS than the older age adult age group at each quintile, with a sharper decline by deprivation level.

In the younger age group, material deprivation followed a steep decline from the least deprived to the most deprived group. In the under 65-age group living in the area with the highest material advantage was protective (*M* = 52.28, *SD* =11.62). As material deprivation increased, MCS decreased close to 1 point for each quintile with respondents in the most material deprived quintile reporting on average an MCS score mean of 49.01 (*SD* = 12.39). The mean MCS for the older age group was higher (better) in the most deprived quintile at 51.47 (*SD* = 11.87) with little variation from the most to least deprived quintiles. There is a substantial average difference of 3.27 points for the under 65 age group $F(4,10422) = 8.86$, p = < .001. Post hoc Tukey HSD and Games-Howel support a statistically significant difference between the least deprived and most materially deprived groups for the under 65 age group with a mean difference from the least deprived to the most deprived quintile of 3.27 points (.56), $p < .001$. As mentioned, this is a large enough difference to indicate clinical importance. Interestingly, no deprivation area differences were found in the over 65-age group.

In the older age group, there was a more modest decline with each step in deprivation quintile. The decline started in the middle quintile and was curvilinear, with little decline from the third quintile to the fifth for a difference in score between the highest and lowest deprivation of 1.02 (.52). This indicates a moderating effect of age on mental health subscore, with the under 65 age group being far more affected by area level deprivation.

In both age categories women had a lower MCS at each material deprivation quintile. The relationship trend was also different for men and women, with women having lower MCS at each step in both age and BMI groups. However, men had a statistically significant difference between quintiles. Using Tukey's HSD probability and Games–Howell Criterion there was a statistically significant 2.90 (.56) difference in mean score between the lowest and highest material deprivation quintile $F(4, 4488) = 6.71$, $p < .001$ for men. For social deprivation and age, the pattern was very similar. The younger age group reported a lower MCS at each step of deprivation from the least socially deprived group ($M = 51.96$, $SD = 11.70$) to the most deprived group ($M = 47.99$, $SD = 12.52$). Again, the relationship was more moderate for the over 65 age group. For the over 65 age group there was modest variability in the mean score, but it was not linear until the fourth quintile.

Both younger men and women followed a gradient by material deprivation quintile with women under 65 having the lowest average MCS of any group. The difference between the least and the most socially deprived areas MCS mean for the over 65-age group was 1.87 (.48), compared to 3.97 (.52) for the under 65 age group. In post hoc Tukey –HSD probability this was statistically significant difference $F(4, 4930) = 17.505$, $p < .001$. This indicates a clinically significant difference in MCS mean for the younger age group. Differences were also significant for the older age group between the least deprived and most deprived quintiles with a statistically significant difference in post hoc Tukey- HSD and Games Howell Criterion $F(4, 5487) = 4.837$, $p = < .001$, however the mean MCS difference was far smaller at 1.87 (.48). Given the larger difference in the under 65 age group it is evident that age also moderates this relationship. Younger respondents were more vulnerable to the impact of social deprivation and reporting lower MCS in the most deprived quintile compared to the older age group.

BMI and deprivation. When I compared means across material deprivation quintiles, I found that the lower BMI group followed a more expected pattern of negative linear relationship between deprivation and MCS decline with respondents in the least materially deprived neighbourhoods reporting, on average, a higher MCS ($M = 52.78$, $SD = 11.72$) with the lower BMI respondents in the most deprived quintile reporting, on average, a 2.39 (.44) point lower score (*M* = 50.39, *SD* = 12.17) than lower BMI respondent in the least materially deprived neighbourhoods. In post hoc tests using Tukey HSD significance and Games -Howell significance the differences across quintiles in MCS was significant for the lower BMI group only F (4, 7722) = 8.20, p < .001. At a 2.39 difference in MCS this indicates a potential risk for a clinical difference in MCS.

For the higher BMI group, the MCS mean was lower at each quintile in comparison to the lower BMI group; however, the group differences were not significant. Material deprivation had a more predictable, linear relationship on the MCS for the lower BMI group. This indicates that higher BMI, regardless of material deprivation index, results in lower MCS, with more of an impact of material deprivation on MCS for the lower BMI group. As well, for the lower BMI group there was a stepwise relationship indicating a more predictable negative relationship between quintile and BMI. This indicates a moderating effect of BMI on MCS, with BMI groups having different interactions with material deprivation index quintile. The material deprivation means by age and BMI groups for each gender are presented in Figure 2.

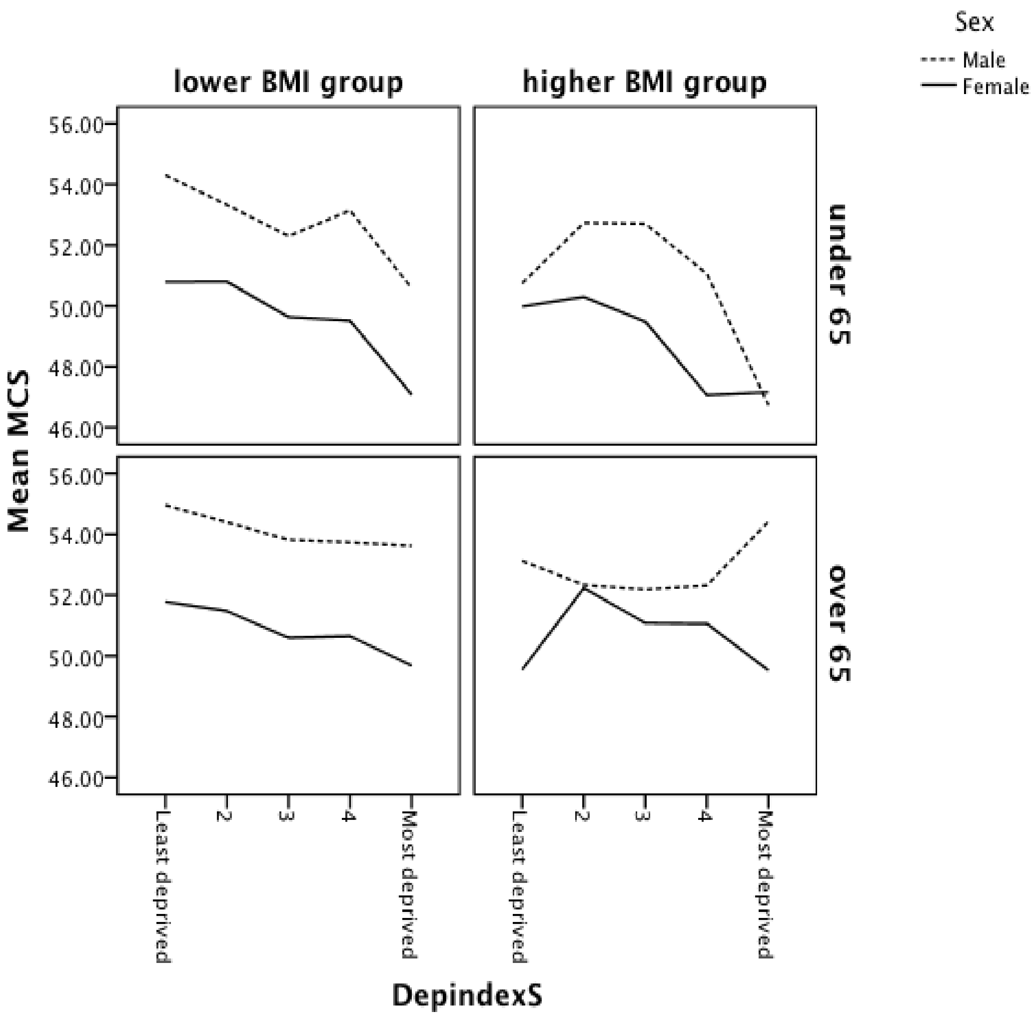


Figure 1. MCS: DependixS, age, and BMI groups by sex. Both BMI groups under age 65 experience reduced MCS. There is a sharp decline in the PCS most socially deprived areas for both genders.

There was also a different pattern for the social deprivation index and MCS by BMI. For the lower BMI group, the pattern was more predictable with the MCS having the expected negative linear relationship with social deprivation quintile. However, there was a sharp decline for the higher BMI group from the second quintile to the lowest quintile. Group differences were significant for both groups with the lower BMI group F (7, 7722) = 13.98, $p < .001$ having larger group differences than the higher BMI group F (4, 2695) = 6.01 = 6.02, $p < .001$. The difference between the least and most deprived quintile for the lower BMI group was 2.87 (.41), $p < .001$, while the Tukey –HSD and Games Howell post hoc tests supporting a difference between the second quintile and the least deprived quintile of 3.20 (.72), $p < .001$ from the higher BMI group.

The mean score at each social deprivation quintile for the higher BMI group was lower for all of the quintiles than for the lower BMI group, but the pattern was less predictable and curvilinear after quintile 3 for the higher BMI group. It is evident that participants in the most socially deprived quintile report the lowest MCS and there is a decline for both BMI groups under age 65.

The higher BMI group reported lower MCS at each quintile for both deprivation indices. However, the pattern was not as linear or predicatable for the higher BMI group. This indicates a modifying effect of BMI, with the different BMI groups experiencing different relationships between social deprivation and MCS. This variation in patterns by age, in combination with BMI group, importantly demonstrates the intersectionality of disadvantage and that the attributes do not have a unique contribution to MCS but rather a demarcated experience considering jeopardies that are more than additive (Veenstra, 2011). It is also noted that these interactions were not tested in a model with the other dependent variables. Although this kind of analyses is beyond the scope of this investigation the findings in Step 4 indicate a beginning point to acknowledge the complex interplay among gender, age, BMI, and deprivation.

To explore the interaction effects further, I examined the variables in partial correlations with other Level 1 dichotomous variables. When controlling for gender, coexisting health condition now, and co- existing health condition history separately, there was little difference in partial correlation and they did not exhibit a substantial change in the Pearson *r*. The partial correlations are presented in Appendix C, Table C2 and can be referred to for further review. In the graphic depiction in Figure 2 it is evident that gender appears to be the most influential variable with being female interacting with the deprivation indices to explain differences in the relationship of quality of life between age and BMI groups. However, I recognize that the interactions were not significant in the three level modeling and the trends observed are trends only and not valid inferences about the population. They provide an interesting decomposition of the sub populations that warrant further investigation.

Model comparison. Side-by-side model comparisons are presented in Table 13. The residual variance-co variance matrix for both individual and area level residual values indicates a large unexplained variance at each level. Following the process outlined by McCoach and Black (2004) for model fit comparisons, the -2 LL, AIC, and R^2 comparison at each step indicates the parsimonious model is an improvement over the null model and the full model. I examined the $R^{2,}$ as a pseudo R2 by exploring both proportional reduction in variance and proportional reduction in prediction error. This provides an analysis of effect size in comparing the null and subsequent models. This final examination is conducted by adding the residual/ variance at all three levels.

Table 13

MCS: Comparison of Models Step 1 to 4

	Model	Number of parameters	AIC	-2 LL	Changed in R^2 from null	Significant improvement from the null
1.	Null	4	81170.735	81162.735		
2.	Full Level 1	10	79748.395	79728.395	L1 .12 L2 .27 L3 .49	✓
3.	Full Level 1 and Level 2 predictors	12	79722.626	79698.626	L1 .12 L2 .27 L3 .76	✓
4.	Levels 1 and 2 and all interaction terms	25	79724.738	79674.738	L1 .12 L2 .28 L3 .76	✓
5.	Parsimonious model	11	79726.212	79705.212	L L1 .12 L L2 .28 L L3 .76	✓Best overall fit
6.	Random slope and intercept model Level 2 – DepindexM	13	79729.252	79703.252	L1 .12 **L2 .33** L3 .76	✓ Largest variance explained
7.	Random slope and intercept model Level 3 –DepindexM	13	79730.642	79704.642	L1 .12 L2 .30 L3 .77	✓
8.	Random slope and intercept model Level 2 – DepindexS	13	79728.984	79702.984	L1 .12 L2 .30 L3 .77	✓
9.	Random slope and intercept model Level 3 – DepindexS	13	79730.011	79704.011	L1 .12 L2 .28 L3 .77	✓
10.	Selected Interaction Terms	15	79728.121	79694.121	L1 .12 L2 .28 L3 .78	✓

Note. L1 = Level 1; L2 = Level 2; L3 = Level 3; *N* = 10,427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood.

By comparing the null model variance/ residual to the variance/ residual in all of the models, it was found that material deprivation random intercepts and slopes model provided the best overall proportion of explained variance R^2 = (1- (123.27/144.47) = .15). As shown in Table 13, changes in -2 LL and the AIC support this as the best fit considering all of the comparisons examined. However, Although There was more variance explained at Level 3 with the model allowing material deprivation slope and intercept to vary. The models in Step 3 did not result in improved model fit when introducing deprivation indices as random slopes.

Examining proportionate reduction in prediction error variance reduction in the three level model (Snijders & Bosker, 2012) the parsimonious model provided a 1- $(\frac{113.40+10.09+.57}{128.21+13.92+2.34})$ = .14 or 14% proportional reduction in residual variance. Allowing DepindexM 1- $(\frac{113.37+9.34+.56}{128.21+13.92+2.34})$ =.15 and DepindexS to vary at Level 2 1- $(\frac{113.17+9.76+.54}{128.21+13.92+2.34})$ =.15 or 15% reduction in prediction error for the random slope and intercept models. Although there was a reduction in residual variance and increase in variance explained, the improvements did not result in a large enough improvement in model fit, considering additional parameters.

The random intercept fixed slopes parsimonious model indicates that having a history of another health condition, being female, experiencing another health condition now, reduced physical functioning, living in a more socially deprived neighbourhood, living in a more materially deprived neighbourhood and being younger provide the best predictive model. This indicates that both material and social deprivation have an impact on mental health related quality of life in advanced arthritis. There are differences in intercepts at the postal code level in all models, indicating that average MCS varies across postal code areas, nested in forward sortation groupings. There is also a statistically significant residual and Level 1intercept indicating that there is room for model improvement and considerable unexplained variance at the individual and area levels.

As shown in Table 13, the change in pseudo R^2 at Level 2 for the model allowing material deprivation to vary at Level 3 shows the greatest improvement in explained variance at Level 2, indicating that considering variance in means across postal code areas provides further explanation for the relationship between material deprivation and MCS at the area level. However, this was not a large enough improvement to impact overall model fit or effect size. Adding Level 1 and Level 2 variables collectively improved effect size with the full model and all of the subsequent models demonstrating a large enough improvement to impact overall model fit and effect size. The impact of adding Level 1 and Level 2 predictors improved effect size with the full model and all of the subsequent models = .13. Following effect size guidelines provided in Tabachnik and Fidell (2013) this demonstrates that the impact of adding Level 1 and Level 2 variables to the model has a substantial impact on predicting MCS.

In Chapter 6, I provide a similar step-by-step analysis of the PCS, and I summarize key findings for the initial analysis and multilevel model building. In Chapter 7, I include a discussion and recommendations. Step 4 allowed me to look closely at interaction terms, and also further establish the validity of findings. I examined a total of 13 models to determine the best model fit for the PCS.

Chapter 6: Multilevel Modeling Results: Physical Component Score

As in Chapter 5, here I present a summary of the multilevel analyses of contributions related to physical aspects of health related life quality. In this chapter, I describe in detail each step in the model-building process across four steps, including analyses of the contribution of various parameters to the model, considering both fixed and random slopes.

As with the MCS, I examined 10,427 respondents in 4,880 postal codes at Level 2, within 70 larger geographic areas of forward sortation. I followed the same exploration process as the four steps described in Chapter 5 for the MCS. The variables are summarized in Chapter 4. As there are slight changes in each step to accommodate differences in the PCS, the 4 steps and models presented in each step are summarized specifically for the PCS in Table 14. The process continues with multilevel analysis of contributions to the PCS, building a model up and then down again. Briefly, this involves the steps previously identified: Step 1, the null intercept only model; Step 2, the random intercept models beginning with all six individual level variables, then adding the two Level 2 variables, then examining a model with all Level 1 and Level 2 variables and in interaction terms including an interaction term of the two Level 2 variables. In Step 2, I establish a parsimonious model; this is a model representing the best explanation for PCS scores with the fewest parameters, considering Level 1 and Level 2 variables.

Table 14

PCS Model Building Process

Step	Process	Variables
Step 1: Null intercept only model		
Step 2: Fixed effects models		
2a)	a) with Level 1 predictors	Age, BMI, OKS, gender, co-ill now, co-ill history
2b)	Level 1 and 2 predictors	Age, BMI, OKS, gender, co-ill now, co-ill history + DepindexM, DepindexS
2c)	Level 1 and 2 predictors and interactions	Age, BMI, OKS, gender, co-ill now, co-ill history, DepindexM, DepindexS, age•DemindexM, BMI•DepindexM, OKS•DepindexM, gender•DepindexM, co-ill now•DepindexM, co-ill history•DepindexM, age•DepindexS, BMI•DepindexS, OKS•DepindexS, gender•DepindexS, co-ill now•DepindexS, co-ill history•DepindexS, DepindexM•DepindexS
2d)	Building the parsimonious model	Age, BMI, OKS, gender, co-ill now, co-ill history, DepindexS, DepindexM, DepindexM•DepindexS, gender•DepindexM, BMI•DepindexS
2e)		Age, BMI, OKS, gender, co-ill now, co-ill history, Depindex M, DepindexS•BMI, gender•DepindexM
2f)		Age, BMI, OKS, gender, co-ill now, co-ill history, BMI•DepindexS, gender•DepindexM
2g)		Age, BMI, OKS, co-ill now, co-ill history, DepindexS, gender•DepindexM, BMI•DepindexS•DepindexS
Step 3: Random intercept random slopes models		
3a	DepindexM varying at Level 2	Age, BMI, OKS, co-ill now, co-ill history, DepindexS, gender•DepindexM, BMI•DepindexS + DepindexM random at Level 2
3b	DepindexM varying at Level 3	Age, BMI, OKS, co-ill now, co-ill history, DepindexS, gender•DepindexM, BMI•DepindexS + DepindexM random at Level 3
3c	DepindexS varying at Level 2	Age, BMI, OKS, co-ill now, co-ill history, DepindexS, gender•DepindexM, BMI•DepindexS + DepindexS random at Level 2
3d	DepindexS varying at Level 3	Age, BMI, OKS, co-ill now, co-ill history, DepindexS, gender•DepindexM, BMI•DepindexS + DepindexS random at Level 3
Step 4: Exploring interaction terms		
4a	Graphing group differences and comparing complete cases to missing values estimated data	Age, BMI, OKS, co-ill now, co-ill history, DepindexS, DepindexM•gender, DepindexS•BMI dichotomized to lower and higher BMI group

Note. Co-ill = coexisting illness.

In Step 3, I consider four models, examining the addition of random slope models, allowing the intercept and slope of the deprivation indices to vary at Level 2 and then at Level 3. In Step 4, I conduct a model refinement process and review selected dichotomized interaction effects and then more closely examine significant or close to significant interaction terms to asses specific grouping variable trends. Then, I compare changes from the null model to the parsimonious model between the complete values data set and the missing values data set with missing value estimated. In this final step I also review selected grouping variables to determine if there are any differences in trend for MCS mean by deprivation quintile for specific sub groups.

Step 1

The ANOVA for the PCS presented in Chapter 4 demonstrated minimal variance in the PCS index across areas and deprivation indices in the three-level structure. Unlike the MCS ANOVA, the PCS ANOVA did not present statistically significant differences in mean PCS across postal codes or forward sortation groupings. This indicates that there is less variance in PCS across these groupings, and the differences in means are not statistically significant. However, given the three-level structure the process continued employing multilevel modeling. In Step 1, the null intercept only model established the variance attributed to each level in the three-level structure.

I calculated the ICC for the three-level model using Equation 1 presented in Chapter 3. From the calculation, the proportion of variance between areas was, as expected, lower than for the MCS at [.301073/ (64.410458 + 3.996956 + .3010730)] = .004. The residuals at each level indicate a very modest contribution to difference in PCS by the structure of the data. The variance related to the three-level structures was .4%. As the value of p_1 = .004 indicates, a large portion of the total variance is attributed to individual characteristics. The variance between the postal codes nested within forward sortation areas was .097 or 10%, while the variance between subjects was .89 or 89%. The analysis continued with postal codes nested in forward sortation areas as random second-level units and forward sortation as random third-level units.

Similar to the MCS, the largest variance in PCS was at Level 1 with more variability at Level 2 than Level 3. In this null model, the intercept was significant in Level 2, but it was not significant at Level 3, indicating that PCS differences at the smaller geographic area account for some of the variability in PCS. This step provided a null model with no predictors to compare and discern the improvement in model fit by adding additional fixed effects and later random effects in the model refinement process.

Step 2

In Step 2, a random intercept fixed effects model with all six Level 1 variables vastly improved model fit. As with the MCS, this model development was theory driven, in that the direction of the relationships between the predictors and dependent variable was considered in the hypothesis, and the statistical tests were considered to be one-tailed with *p* values being halved to account for the hypothesized direction in the relationship. Results are presented as estimates, (standard error), and [CI]. Again all of the Level 1 and Level 2 predictors were grand mean centred for standardized slopes. This allowed for comparison of parameter estimates with the value being the same across variables. Table 15 is a summary of the model at Step 1 and Step 2a. Having another contemporary coexisting health condition made the largest contribution to the model (b = -1.21 t = -7.60, p < .001). This was followed by the OKS (b = -.46, t = -57.87, p < .001). This was not surprising given that both having another health condition and reduced functioning would interfere with physical components of HRQoL. This was followed by higher BMI and then older age. The estimates for BMI and age indicate a small relationship between higher BMI (*b* = -.11, *t* = -9.76, *p* <. 001) and higher age (b = -.05, *t* = -8.05, *p* < .001), and lower PCS. This demonstrates that older age and heavier body weight were predictive of a lower PCS score. Gender did not make a statistically significant contribution to the model.

Table 15

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of PCS, Null, and Level 1 Predictors

Parameter	Step 1 null model	Step 2a all Level 1 predictors
	Fixed effects	
Intercept	29.06* (.12) [.11-.82]	29.03* (.10) [28.86-29.24]
Level 1 (individual)		
Age		-.05* (.01) [-.07- -.04]
BMI		-.11* (.01) [-.13- -.09]
OKS		-.46* (.01) [-.48- -.44]
Gender		.03 (14) [-.25-.31]
Coexisting condition		-1.21* (.16) [-1.52- -1.0]
Condition history		-.34 (.17)+ [-.86 - .01]
	Random parameters	
Residual	64.40* (1.14) [62.20 – 66.69]	46.85* (.82) [42.27 – 48.90]
Intercept/ forward sort	.30 (15) [.11-.82]	.17 (.10) [.05- .52]
Forward sort/full postal code	4.00* (.9) [2.56- 6.24]	2.54* (.62) [1.56-4.12]
AIC	73609.092	70235.014
-2 LL	73601.092	70215.014
Number of parameters	4	10

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. *N* = 10,427, AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood.
* $p \leq$ 001, + $p \leq$ 05.

In this step, the Level 3 intercept was not significant. However, the Level 2 estimate remained significant, with a reduction in variance indicating that some of the variance in PCS scores at Level 2 was explained by the addition of individual level variables. The addition of

Level 1 fixed effects substantially improved the model with a large change in model fit X^2 (6, N = 10,427) = 73601.092 - 70215.014 - = 3,386.078, p < .001). This indicates that the fixed effects contribute to a model that explains variance in the PCS above the variability explained by postal code and forward sortation areas.

Following this initial model, I added the Level 2 variables, DepindexM and DepindexS, as fixed effects. These variables were also grand mean centred to provide standardized slopes for comparison. Both the material deprivation index and social deprivation index did not demonstrate statistically significant estimates. The addition of these two variables did not improve model fit in comparison to model 2a with Level 1 predictors or what is referred to as the full model X^2 (2, N = 10,427) = 70215.014 -70207.574 = 7.44, p = ns. See Table 16 for a summary of estimates for models 2b and 2c. Again, all of the significance levels were halved, given the theoretical support for the direction of the relationships.

Table 16

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of PCS, All Level 1 and Level 2 Predictors and Interaction Terms

Parameter	2b all Level 1 and Level 2 predictors	2c all Level 1 and Level 2 predictors plus interaction terms
	Fixed effects	
Intercept	29.05* (.09) [28.86- 29.24]	29.04* (.09) [28.85-29.23]
Age	-.05* (.01) [-.06- -.04]	-.05* (.09) [-.06 - -.04]
BMI	-.11* (.01) [-1.3- -.09]	-.11*(.01) [-1.3- -.09]
OKS	-.46* (01) [-.48 - -.44]	-.46* (01) [-.48--.44]
Gender	.01 (.14) [-.27- .29]	.01 (.14) [1.27- .29]
Coexisting condition	-1.22* (16) [-1.52- -.91]	-1.22* (.16) [-1.5- -.91]
Condition history	-.36+ (.17) [-.70 - .03]	-.38+ (.17) [.72- -.04]
DepindexM	.07 (.06) [-.04 - -.19]	.05 (.06) [-.04 - -.19]
DepindexS	.13+ (.05) [-.03- .23]	.13+ (.05) [.03-.23]
Age•DepindexM		-. 001 (.00) [-.01- .01]
BMI•DepindexM		-.01 (.01) [-.023 - .003]
Gender•DepindexM		,23 (.10)+ [.02-.43]
Gender•DepindexM		.23 (.10)+ [.02- .43]
Coexisting condition•DepindexM		-.03 (.16) [-.25 - .19]
Condition history•DepindexM		-.14 (.12) [-.10 - .38]
Age•DepindexS		.004+ (.00) [-.00 - .01]
BMI•DepindexS		.02+ (.01) [.01 - .03]
OKS•DepindexS		.001 (.001) [-.009 - .01]
Gender•DepindexS		.02 (.10) [-.17 - .23]
Coexisting condition•DepindexS		-.03 (.11) [-.24-.19]
Co-illness history•DepindexS		.04 (.11) [-.19- .27]
DeindexM•DepindexS		.06 (.04) [-.01 - .14]

(continued)

Table 16 (continued)

Parameter	2b All Level 1 and Level 2 predictors	2c All Level 1 and Level 2 predictors plus interaction terms
	Random parameters	
Residual	46.82 (.81) [45.25- 48.46]	46.73 (.82) [45.15 – 48.36]
Intercept/ forward sort	.13 (.09)	.12 (.09) [.03- .49]
Forward sort/ full postal code	2.55 (.62)* [1.57- 4.10]	2.55 (.62)* [1.58- 4.10]
AIC	70231.574	70434.585
-2 LL	70207.574	70184.585
Number of parameters	12	25

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. *N* = 10.427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood, • = interaction between the two variables.
* $p \leq$ 001, + $p \leq$ 05.

In this step coexisting condition, age, BMI, OKS, and coexisting health condition continued to have a statistically significant impact on PCS. Coexisting condition continued to have the largest impact on the PCS score at b = -1.22 (.16), followed by OKS, coexisting condition history, BMI, and then age. DepindexS continued to have a close to significant impact at b = .13 (.05) $p < .05$. Model 2c with cross-level interaction terms and the indices interaction term was not an improvement to the full model, the model with Level 1 predictors only, X2 (15, N = 10,427) = 70215.014 -70184.585 = 30.429, p = ns. However, some of the interaction terms, age•DepindexS, BMI•DepindexS, and gender•DepindexM had parameter estimates that were significant at $p < .05$. They were therefore included in model refinement. From this large model with all of the Level 1 and Level 2 predictors and interaction terms I started to build down to develop a parsimonious model. That is, a model that best explains variance in PCS given the least number of variables.

In the parsimonious model building process, I considered significant Level 1 predictors, DepindexS, and the interaction terms gender•DepindexM, BMI•DepindexS, and gender•DepindexS as they all had significant or close to significant slopes. I developed a parsimonious model considering all of the significant and close to significant main effects and interaction terms, and then I carefully removed insignificant variables. Building down the model involved analysis of the impact of removing variables and interaction terms on other effects and model fit. This included comparison of models with DepindexM as a fixed effect as it was implicated in an interaction term with gender.

I considered several removal options. I removed insignificant variables in order of lowest parameter estimate one by one to maximize improvement in model fit in the final parsimonious model. In both cases the estimate was very low and included 0. I began building down to the parsimonious model by starting with 2d, including variables from the previous model that had parameters close to $p < .001$ and were significant to $p < .05$. This included examining model 2f that entered the variables DepindexM, gender and DepindexS separately to ensure that the interaction terms were not a misspecification of these variables main effects. However, as demonstrated in Step 2f, the estimate for DepindexM was small and included 0. Therefore, model comparison continued removing DepindexM but continuing to include the variable in the interaction term with gender. Given the number of comparisons and little addition to model specification, DepindexM was eliminated from the final parsimonious model in Step 2g. DepindexS and DepindexM did not contribute to model fit independently nor did their removal impact the interaction term effects. The removal did not present errors with model misspecification (Balli & Sørensen, 2013). There was a better fit with the inclusion of the DepindexM and DepindexS interaction term than the inclusion of the indices as main effects alone. However, the interaction term did not contribute to the final model fit with the additional parameter and the deprivation interaction term was eliminated in the development of a final parsimonious model. In model 2f, testing the removal of the gender•DepindexM interaction term changed the parameter estimate and it was therefore re-entered in the development of the parsimonious model. In comparing the improvement in -2 LL and AIC, Model 2g with five individual variables, DepindexS as a direct effect, DepindexS in interaction with BMI and DepindexM in interaction with gender provided the best model fit, and was an improvement from the full model and model 2a, with only Level 1 predictors X^2 (2, N = 10,427) = 70215.014 – 70195.070=16.95, p < .001. Table 17 provides a summary of the parameter estimates and changes in model fit in building this final parsimonious model. The selected parsimonious model with the most prudent explanation of variance in PCS includes 12 parameters with the fixed effects in order of magnitude of estimate: coexisting condition now, OKS, contemporary coexisting health condition history, DepindexM in interaction with gender, DepindexS, BMI, age, and DepindexS in interaction with BMI.

Table 17

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of PCS, Building the Parsimonious Model

Parameter	Model 2d	Model 2e	Model 2f	Model2g
		Fixed effects		
Intercept	28.99* (.40) [28.20-29.77]	28.67* (.18) [28.85-29.23]	29.05* (.10) [28.86- 29.24]	29.04* (.09) [28.85 – 29.22]
Age	-.05* (.01) [-.07- -.03]	-.05* (.01) [-.07- -.4]	-.05* (.01) [-.07- -.04]	-.05* (.01) [-.07- -.04]
BMI	-17*(.01) [-.21- --.12]	-.17* (.01) [-.21- -.12]	-.11* (.02) [-.13- -.09]	-.17* (.02) [-.21--.12]
OKS	-.46* (01) [-.47- -.44]	-46* (.01) [-.47--.44]	-.46*(.01) [-.47 - -.44]	-46* (.01) [-.47--.44]
Gender	.01+ (.34) [-.26- -30]	-.01+ (.34) [-1.42- -.09]	.02 (.14) [-.27- .30]	
Coexisting condition	-1.22* (.16) [-1.52- -.91]	-1.21* (.16) [-1.53 - -.91]	-1.21* (.16) [-1.52- - .90]	-1.22* (.16) [-1.53--.91]
Condition history	-.37+ (.17) [-.70- -.03]	-.36+ (.17) [-.69 --.02]	-.34+ (.17) [-.67- -.01]	-.36+ (.17) [-.69 --.02]
Depindex S	.06+ (.12) [-.30 - .18]		.02+(.04) [.05- .44]	.12+ (.05) [.02-.23]
Gender•DepindexM	.24+ (.10) [.05- .44]	.03+ (.02) [.00 - .06]	.24+ (.10) [.04-.44]	.26+ (.10) [.06-.45]
BMI•Depindex S	.02+ (.01) [.01- .03]	.01+ (.01) [.01-.07]	.02+ (.01) [.01-.03]	.02+ (.01) [.01-.03]
DepindexM•DepindexS	.06+ (.04) [-.007- .13]			
		Random parameters		
Residual	46.75* (.82) [45.18 – 48.38]	46.77* (.82) [45.19 – 48.39]	46.77*(.82) [45.20 – 48.40]	46.77* (.82) [45.20 - 48.40]
Intercept/ forward sort	.13 (.09) [.03- .49]	.12 (.09) [.03- .49]	.12 (.09) [.03- .49]	.12 (.09) [.03- .49]
Forward sort•full postal code	2.54* (.62) [1.59- 4.11]	2.55* (.62) [1.59-.4.11]	2.56* (.62) [1.59 - 4.12]	2.56* (.62) [1.59- 4.12]
-2 LL	70190.234	70195.069	70198.086	70195.070
AIC	70220.234	70221.069	70224.086	70219.070
Number of parameters	15	13	12	12

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. *N* = 10,427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood, • = interaction between the two variables.
* $p \leq$ 001, + $p \leq$ 05.

As in other models, the biggest influence on PCS score was having a coexisting health condition at *b* = - 1. 22, *t* = -7.60, p < .001, indicating the likelihood of having a coexisting health condition contributing on average a 1.22 point decline in PCS.

Step 3

In Step 3, a series of random intercept and random slope models, allowing each deprivation index slope and intercept to vary within Level 2 and then Level 3 explored the impact of these contextual variables at the geographic level., This allowed me to explore the second hypotheses: subjects from more deprived neighbourhoods have a lower HRQoL mean score (intercept), and the strength (slope) of the relationship is more pronounced. This was also an opportunity to determine if allowing variance in slope contributed to model fit.

I maintained the parsimonious model with the five individual level variables and two interaction terms as fixed variables, with DepindexM and DepindexS as random intercepts and slopes in Level 2 and then Level 3. This established whether the random intercept and slope of the Level 2 variables contributed any further to model refinement.

In examining the random intercepts random slopes models that allowed material deprivation and social deprivation to vary at Level 2, I found there was no significant improvement to model fit in any of the models. The fixed effect parameter estimates remained similar to the original parsimonious model, and there was no improvement in model fit, no variance between intercept and slope, or contribution considering variance in slope. Table 18 provides a side-by-side comparison to the parsimonious random intercepts fixed slopes models.

In comparing AIC and -2 LL, there was no additional improvement to the parsimonious model with any of the random intercepts random slopes models.

Table 18

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of PCS, Parsimonious Model With Random Slopes Random Intercepts

Parameter	Model 3a DepindexM random at Level2	Model 3b DepindexM random at Level 3	Model 3c DepindexS random at Level 2	Model 3d DepindexS random at Level 3	Parsimonious model 2g
		Fixed effects			
Intercept	29.04* (.09) [28.85– 29.22]	29.03* (.09) [28.78 – 29.18]	29.14* (.09) [29.95-29.34]	29.12* (.11) [28.90- 29.34]	29.04* (.09) [28.85-29.23]
Age	-.05* (.01) [-.07 - -.04]	-.05* (.01) [-.07 - -.04]	-.05* (.01) [-.07 - -.04]	-.05* (.01)* [-.07 - -.04]	-.05* (.01) [-.07--.04]
BMI	-.11* (.01) [-.13- -.09]	-.11* (.01) [-.13 - -.09]	-.11* (.01) [-.13 - -.09]	-.11* (.01) [-.22 - -.12]	-.11* (.01) [-.13- -.09]
OKS	-.46* (.01) [-.47 - -.44]	-.46* (.01) [-.47 - -.44]	-.46* (.01) [-.47 - -.44]	-.46* (.01) [-.47 - -.44]	-.46* (.01) [-.47--.44]
Coexisting condition	-1.21* (.16) [-1.52 - - .90]	-1.22* (.16) [-1.52 - - .91]	-1.22* (.16) [-1.52 - - .91]	-1.22* (.16) [-1.52- - .91]	-1.2*2 (.16) [-1.53-- .91]
Condition history	-.36+ (.17) [-.69 - - .02]	-.36+ (.17) [-.70 - - .02]	-.36+ (.17) [-.70 - - .03]	-.36+ (.17) [-.69 - - .02]	-.36+ (.17) [-.69--.02]
DepindexS	.13+ (.05) [.02-.23]	.13+ (.05) [.03 – 2.3]	.14+ (.05) [.04-.24]	.12+ (.06) [.01-.23]	.12+ (.05) [.03- .24]
Gender• DepindexM	.26+ (.10) [.06 - .45]	.25 +(.10) [.06 - .45]	.25 (.10)+ [.06 - .45]	.25+ (.10) [.06 - .45]	.26+ (.10) [.06-.23]
BMI• Depindex S	.02(.01)+ [.01 - .03]	.02 (.0)+ [.00 - .01)	.02 (.01)+ [.01 - .03)	.02 (.01)+ [.01 - .03)	.02 (.01)+ [.01-.03]
		Random parameters			
Residual	46.69* (.82) [45.11 – 48.33]	46.75* (.82) [45.17 – 48.37]	46.55* (.82) [45.00 – 48.20]	46.56* (.82) [45.00 – 48.20]	46.77* (.82) [45.20 – 48.40]
Intercept/ forward sort	.12 (.09) [.03 - .48]	.12 (.08) [.03 - .49]	.17 (.07) [.01- .43]	.17 (.12) [.04- .65]	.12 (.09) [.03- .50]
UN 2,1		.01 (.03) [-.06 - .06]		-.06 (.05) [-.03 -.16]	
UN 2,2		.00 (.00)[a]		.02 (.03)[a]	
Forward sort/ full postal code {UN 1,1}	2.10 (.75)+ [1.04-4.25]	2.58* (.62) [1.61 – 4.15]	2.51* (.61) [1.56 – 4.02]	2.80* (.66) [1.76– 4.45]	2.57* (.62) [1. 59 – 4.13]
UN 2,1	-2.54(.18) [-.37 - .37]		.33 (.19) [-.04- .71]		
	.27 (.28) [.04– 2.10]		.04 (.00)[a]		

(continued)

Table 18 (continued)

Parameter	Model 3a DepindexM random at Level2	Model 3b DepindexM random at Level 3	Model 3c DepindexS random at Level 2	Model 3d DepindexS random at Level 3	Parsimonious model 2g
			Random parameters		
-2 LL	70194.138	70195.058	70193.022	70194.272	70195.070
AIC	70222.138	70223.058	70221.022	70222.272	70219.070
Number of parameters	14	14	14	14	12

Note. Standard errors are in parentheses, 95% confidence intervals are in square brackets. *N* = 10,427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood; UN 2, 1 = covariance between random intercept and slope; UN 2,2 = variance in random slope; • = interaction between the variables.
[a] The covariance statistic is redundant and very small.
* $p \leq$ 001, + $p \leq$ 05.

There was an improvement to the pseudo R^2 at Level 2 in the model allowing material deprivation to vary at Level 2. However, this did not improve the model to the point that it was a better fit considering the two additional parameters.

This indicates that material deprivation index variance in intercept and slope provided an improved variance estimation of intercept at the postal code area, but there was no improvement to overall fit. This lack of impact on model fit is not uncommon in multilevel modeling as the prediction is based on observed, not estimated, variables (Snijders & Bosker, 2012).

However, the model allowing material deprivation to vary at Level 2 did improve variance explained from the full and parsimonious model. The change in R^2 at Level 2 improved from .36 in the full and parsimonious model to .48 in the random intercepts random slopes model. However, like the MCS this was not enough of an improvement to impact overall model fit as demonstrated by the improved AIC and -2 LL in the parsimonious model. The parsimonious model continued to be the best model fit in comparison to model 3a at X^2 = (2, 10,427) 70199.694-70189.736 = 9.96, p = ns. The side-by-side comparison of model fit is presented in Table 18. From the findings, it can be determined that Hypothesis 2 can be supported for material deprivation in that the material deprivation does vary across postal code units. . These findings are similar to the MCS and provide support for the theoretical framework established at the outset of this work. I discuss this further in Chapter 7.

Step 4

In Step 4, I examined the interaction terms and potential influential intersecting grouping variables in closer view. I began with a dichotomized BMI variable to determine if I could provide any further insight into the influence of this individual variable in combination with Level 2 contextual variables (see Table 19).

This was also the opportunity to explore more closely where in the interaction the relationship was most pronounced. I graphed selected interactions to determine which sub groups were most affected by deprivation. For this review, I used the Level I variable BMI as group 0 with BMI ≤ 34.99 and the higher BMI group with a BMI ≥ 35 as 1. I reran the parsimonious model with the BMI dichotomous group variable by DepindexS as an interaction term. As can be seen in Table 18, the dichotomized interaction term provided a statistically significant estimate of b =.37 (t = 3.45), p < .001, indicating that, in interaction, BMI and social deprivation reduce PCS score.

The estimate in this dichotomized parsimonious model for the BMI interaction term was counterintuitive as the direction of the relationship was positive. This indicates that the higher BMI group exhibits less influence of social deprivation on PCS quality of life than in the lower BMI group. With BMI as a dichotomous variable, higher BMI in interaction with social deprivation continued to be positive and was stronger than the original interaction term. The -2 LL and AIC indicate that the dichotomous term improved model fit.

Table 19

Fixed Effects Estimates and Variance–Covariance Estimates for Models of the Predictors of PCS, Parsimonious Model With Dichotomous Interaction Terms

Parameter	Parsimonious model	4a parsimonious model with dichotomous BMI Interaction
	Fixed effects	
Intercept	29.04* (.09) [28.85-29.23]	29.03* (.09) [28.85 – 29.22]
Age	-.05* (.01) [-.07--.04]	-.05* (.01) [-.07- -.04]
BMI	-.11* (.01) [-.13- -.09]	-.11* (.01) [-.13- - .09]
OKS	-.46* (.01) [-.47--.44]	-46* (.01) [-.47--.44]
Co-condition now	-1.22* (.16) [-1.53-- .91]	-1.22* (.16) [-1.53- -.91]
Co-condition history	-.36* (.17) [-.69--.02]	-.36* (.17) [-.69- -.02]
DepindexS	.12+ (.05) [.03- .24]	**.03 (.06) [-.08 - .15]**
Gender•DepindexM	.26+ (.10) [.06-.23]	.26+ (.10) [.06- .45]
BMI•DepindexS	.02+ (.01) [.01-.03]	**D .37 (.10)* [.16- .59]**
	Random parameters	
Residual	46.77 (.82)* [45.20 - 48.40]	46.74 (.82)* [45.17- 48.37]
Intercept/forward sort	.12 (.09) [.03- .49]	.13 (.09) [.03 - .49]
Forward sort/ full postal code	2.56* (.62) [1.59- 4.12]	2.56* (.62) [1.59-.4.13]
AIC	70219.070	70214.972
-2 LL	70195.070	70190.972
Number of parameters	12	12

Note. Standard errors are in parentheses, 95% confidence intervals are in square brackets. *N* = 10,427; AIC = Akaike Information Criterion, -2 LL = minus 2 log likelihood; • = interaction between the two variables.
* $p \leq$ 001, + $p \leq$ 05.

This impacted the main effect of DepindexS, reducing the parameter estimate to .03 (.06), p = ns. This indicates that the interaction with BMI groups explains more of the impact on PCS than DepindexS alone. At the same number of parameters, this indicates an improved model $X^2 = (0, 10{,}427) = 70195.070 - 70190.972 = 4.098$, $p < .001$

The parsimonious model with the dichotomous interaction term indicates that in order of estimate size, PCS is impacted by contemporarily having a coexisting health condition, reduced physical functioning, lower BMI group in interaction with social deprivation, coexisting health condition history, gender in interaction with material deprivation, higher BMI, and higher age. In this new model DepindexS was no longer significant as a main effect.

As with the MCS I examined group mean differences in PCS and graphed all of the possible interactions to determine which groups indicated a stronger relationship between the deprivation indices and PCS. In doing this, several patterns emerged describing the relationship between BMI group by social deprivation and gender by material deprivation. There were also trends for the over and under 65 age grouping. I discuss each briefly in the next section.

BMI and social deprivation. By comparing group means across social deprivation quintiles it became apparent that there were differences in effect between the two BMI groups. For the higher BMI group, there was a statistically significant 1.90 (.47) decline in mean PCS between the least deprived quintile and the fourth quintile F (4, 2695) = 6.06, $p < .001$ with a statistically significant Tukey HSD, and Games- Howell Criterion ($p < .001$). In the least deprived area, the lower BMI group had a higher PCS (M = 29.88, SD = 8.29) than the higher BMI group (M = 26.60, SD = 7.64) by 3.28 points and this pattern continued for each quintile until the most deprived, when there was a far less difference with the lower BMI group having a mean of 29.17 (SD = 8.32) and the higher BMI group, a mean of 28.04 (SD = 8.12) only a 1.13 point difference.

Although the higher BMI group had reduced mean scores at each quintile, the lower BMI group's PCS declined in a more predictable stepwise pattern. In the lowest quintile, the PCS scores for both groups BMI groups were the lowest of all quintiles. This substantiates the findings in the multilevel modeling as the ANOVA indicates that social deprivation impacts PCS the higher BMI group and higher BMI is a predictor of lower PCS than in the lower BMI group. However, living in the most socially deprived areas demonstrated reduced PCS for both weight groups.

Graphic depictions provided further insight into this relationship. Women and men showed a different pattern by social deprivation quintile with women reporting lower PCS regardless of age or BMI group. The interaction of BMI group and social deprivation was further influenced by age group, with the under 65 age group explaining more of the relationship with a linear decline in PCS by deprivation quintile. For the under 65 age group experiencing a linear more pronounced difference in score between the least deprived and most deprived areas. Although higher BMI was a predictor of lower PCS score, there was less change by DepindexS quintile for the over 65 age group.

The relationship between social deprivation and PCS is modified by BMI group, with lower BMI respondents following a more linear negative relationship between PCS and social deprivation quintile. Figure 3 provides a depiction of the PCS, and DepindexS, BMI for men and women.

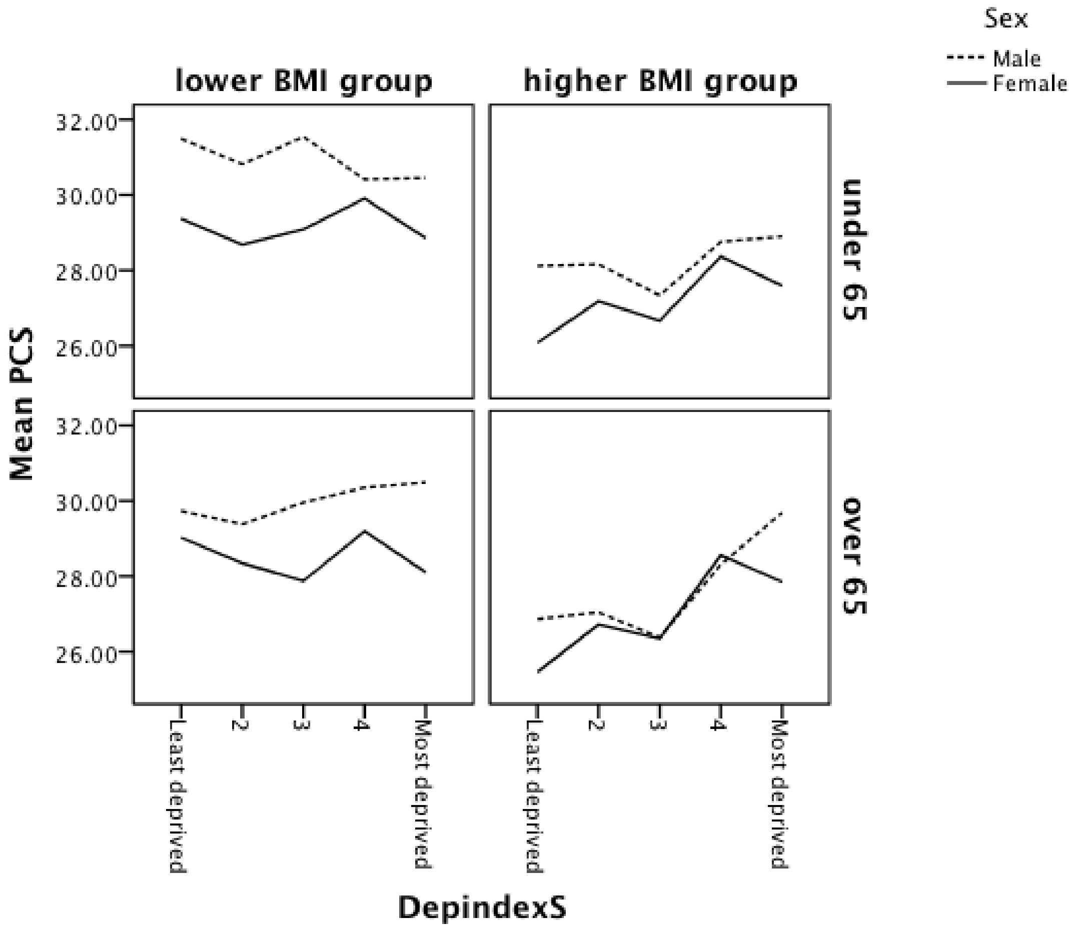


Figure 2. PCS: DepindexS, age, BMI groups by sex. Both men and women with higher BMI experience lower PCS.

Gender and material deprivation. For the DepindexM and gender interaction, there was a clear decline in PCS score for both genders by deprivation quintile, with the decline levelling off at the fourth quintile. Women had lower PCS scores at each quintile in comparison to men, but women's scores did not follow as sharp a decline with each step. For men in the least deprived neighbourhoods, the PCS average (*M* = 30.85, *SD* = 9.01) was higher than for women (*M* = 28.09, *SD* = 7.91). Men in the most materially deprived neighbourhoods had a mean of 29.93 (*SD* = 8.66) while women's scores did not vary as much from the highest to the lowest quintile. In the lowest quintile, there was a 1.65 point difference between men's and women's mean score as compared to a 2.76 point difference in the highest quintile. This indicates that in the lowest quintiles, material deprivation impacts both men and women, while living in a more materially advantaged area has a protective and significant impact on men. There was a significant difference between quintiles for men F (4,488) 5.43, $p < .001$. In post hoc comparisons using Tukey HSD and Games-Howell, the differences between the least and most deprived quintiles did not reach significance for women. In graphic depiction it is apparent that the relationship between material deprivation and PCS is influenced by gender, with men experiencing a more expected negative linear relationship between material deprivation and PCS.

In graphic display and group mean comparison, it is also apparent that similar to BMI and social deprivation, social deprivation was also influenced by age with the younger age group following a far more pronounced decline of PCS by material depindex quintile for both men and women. However, it is noted there was very little change in comparing partial correlations to the zero order correlation between PCS and DepindexM. In graphic depiction and comparing group means it is apparent that material advantage was protective for younger men, as those in the least deprived areas had the highest PCS scores of all of the groups. However, the difference was not at a level that would indicate clinical significance, as mentioned, greater than a three-point difference. Please see Figure 4 for a graphic depiction of the PCS mean variation for material deprivation by age, BMI and gender group. Similar patterns emerged for the PCS as for the MCS. Particularly for material deprivation there was a pronounced variation in PCS mean by gender, age and BMI group. This demonstrates the intersectionality of disadvantage and that the attributes have a differential impact based on gender, age and BMI.

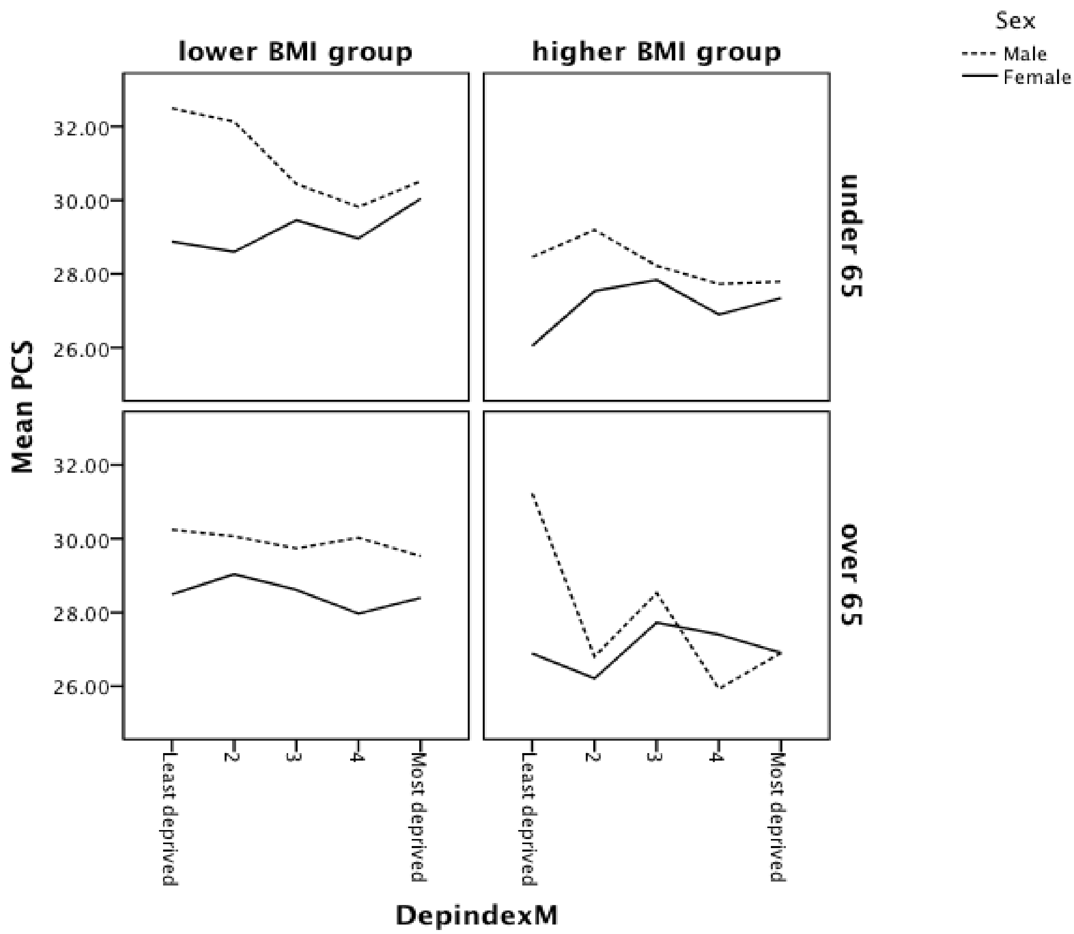


Figure 3. PCS: DepindexM, age, BMI groups by sex. Younger men with lower BMI experience a protective effect of less material disadvantage. There is a similar pattern for higher BMI men over 65.

Model Comparisons Original Data and Complete Data Set

In comparing the parsimonious model from the complete data set to the data with missing values imputed there was a similar improvement from the null in the -2 LL, AIC. As well, the changes in variance explained, R^2, were similar between the two data sets. Also, in both parsimonious models all of the parameter estimates were similar and within the same confidence

Table 20

PCS: Comparison of Models Step 1 to 4

Model	Number of parameters	AIC	-2 LL	Change in R^2 from null	Significant improvement From the null
1. Null	4	73609.092	73601.092		
2. Full - Level 1	10	70235.014	70215.014	L1= .27 L2= .36 L3= .30	✓
3. Full Level 1 and Level 2 predictors	12	70231.574	70207.574	L1= .27 L2=. 36 L3= .56	✓
4. Model Level and 2 with all interactions	25	70234.585	70187.585	L1 = .27 L2= .36 L3= .60	✓
5. Parsimonious model	12	702219.070	70195.070	L1=. 27 L2= .36 L3 =.60	✓
6. Random slope and intercept model Level 2-DepindexM	14	70222.138	70194.138	L1=. 27 L2= **.48** L3= .60	✓ Largest variance
7. Random slope and Intercept Level 3 - DepindexM	14	70223.058	70195.058	L1=. .27 L2 = .36 L3 = .60	✓
8. Random slope and Intercept Level 2- DepindexS	14	70221.022	70193.022	L1 =. 27 L2 = .37 L3 = .43	✓
9. Random slope and intercept Level 3- DepindexS	14	70222.272	70194.272	L1= .27 L2 =.30 L3= .43	✓
10. Final Parsimonious Model with Dichotomized BMI Interaction	12	70190.972	**70190.972**	L1= .27 L2= .36 L3 = .57	✓ Best overall fit

Note. L1 = Level 1; L2 = Level 2; L3 = Level 3; *N* = 10,427; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood.

confidence intervals estimated. See Appendix C for a summary of the results from the comparison of the complete values and missing values estimated data sets in Table C3. The findings indicate that data representativeness was maintained with the elimination of cases with missing data and this was not a threat to external validity.

In Table 20 results of model fit from each step are presented for a side-by-side comparison. Although there was some improvement at Level 2 and Level 3 with the introduction of random parameters, the best model fit was the random intercept fixed effects interaction model, including the dichotomous variable BMI and social deprivation interaction term.

The residual variance-co variance matrix, the change in -2 LL, and AIC information criteria at each step verified that the final parsimonious model with 11 parameters that included two interaction interaction terms with random intercepts and fixed slopes was the best fit. The changes in -2 LL and AIC indicate the best model fit and the residual variance co variance matrix provided comparable covariance estimates of residual errors for one subject for each model (Sniders & Bosker, 2012). This indicates that the best explanation for PCS in order of influence is having another contemporary health condition, lower functioning as indicated by OKS, BMI group in interaction with social deprivation, a health condition history, material deprivation in interaction with gender, higher BMI, and advancing age.

The parsimonious model allowing material deprivation to randomly vary at Level 2 explained the most variance with overall improvement to pseudo R^2 with proportional reduction in variance (64.10-46.69/64.10) =.27. This indicates that 27% of the variance in PCS can be attributed to these variables when material deprivation slope and intercept are allowed to vary across the postal code areas. However, the addition of the random slope and intercept was not a large enough improvement to impact overall model fit. This was also true for proportional reduction in residual variance as the models allowing deprivation to vary at Level 2 and Level 3 were also slightly improved at 1- ($\frac{46.69+2.10+.12}{64.10+4.00+.30}$) = .29 indicating a 29% reduction in residual error prediction. However the reduction in residual variance was not enough of an improvement to impact overall model fit to accommodate the additional 2 parameters.

The effect size of adding Level 1 and Level 2 predictors to the null model was also large for the PCS. The full model and all subsequent models including the final parsimonious model exhibited an effect size of $\eta^2 = \frac{64.10+46.74}{64.40} = .27$ indicating that a model with explanatory Level 1 variables and material deprivation in interaction with gender and social deprivation in interaction with BMI improves the ability to predict PCS.

Although this fixed effects random intercept model with two interaction terms provided the best model fit, there continued to be high, unexplained variance in PCS at both the individual and area levels. Similar to the MCS, the intercepts at Level 1 and residual at Level 2 were significant across all models. This indicates that there is a lot of opportunity to improve the model. I will discuss these and other findings and limitations further. Key results are also summarized in the next chapter. Chapter 7 includes a synopsis of key recommendations for clinical practice, policy, and health care service delivery. I present a synthesis of key discoveries along with recommendations for future research and investigation.

Chapter 7: Discussion

This section returns to the original research question and provides a comprehensive review of each of the three hypotheses for both the MCS and PCS. This includes a point form summary of key findings. I then discuss limitations with specific attention to statistical conclusion validity, construct validity, and external validity. This is followed by a presentation of study contributions and recommendations for practice, program development and policy. The discussion culminates with recommendations for future research.

I return to the original research question: Does neighbourhood deprivation have an independent negative influence on HRQoL for people living with arthritis? I also questioned if HRQoL was further influenced by advancing age, body weight, reduced physical functioning, gender, contemporaneous or past coexisting illnesses, and if there were interactions between these individual attributes and neighbourhood deprivation. This research supports an association between deprivation at the neighbourhood level and reduced mental and physical HRQoL, and this is influenced by other attributes such as the presence of coexisting health conditions, body weight, and physical functioning, and, yes, there are interactions between individual attributes and neighbourhood deprivation for physical HRQoL specifically. My findings for each dependent variable answer this foundational question.

Predictors of MCS

In order of impact: having a history of another health condition, being female, having another health condition now, decreased physical functioning, lower social deprivation, lower material deprivation, and younger age predicted lower MCS score. All of the individual attributes except for BMI were part of the predictive model. I found that having a history of other health conditions took more of a toll on mental health quality of life than physical health quality of life with this being the largest parameter estimate in the final model. Having a history of another health condition resulted in, on average, a 3.25 reduction in MCS score.

Both social and material deprivation had a small statistically significant independent influence on MCS with the deprivation quintile having a negative linear relationship with MCS score. This relationship remained after accounting for individual attributes. Interaction terms did not contribute to the final parsimonious model that best explained the relationship between these attributes and MCS. This indicates that each index has an impact on MCS directly beyond individual attributes.

There was a large variance in MCS at the postal code geographic area indicating even further variance to MCS that was not accounted for in this model. Some of this may be due to combinations of attributes with specific subgroups having a different relationship For example, in correlation plots of sub groups women under the age of 65 in the lower BMI category had the lowest MCS score of any of the subgroups.

MCS hypothesis 1. Hypothesis 1, which states that material and social neighbourhood deprivation negatively affect physical HRQoL in addition to personal attributes such as age, gender, health conditions, body weight and functioning, was supported by my study findings. The relationship between area level disadvantage and MCS was supported by a significant improvement in prediction of MCS in comparison to the null or empty model with no predictors. Deprivation indices did provide additional contributions to model fit, and this hypothesis was supported by study findings.

MCS hypothesis 2. Hypothesis 2, which states that the impact of material and social deprivation on HRQoL varies in mean score (intercept) and strength of the relationship (slope) across regional location was supported for material deprivation. For the MCS there was an improvement to model fit when allowing the variance in slope and intercept of material deprivation to vary at Level 2. Although, the random slope did not result in statistically significant improvement as indicated by significant changes in -2 LL, the improvement to variance explained at Level 2 requires acknowledgement. In the random intercepts random slopes model allowing material deprivation index intercept and slope to vary at Level 3, the improvement in R^2 from the empty model and in comparison to the parsimonious model indicates that more variance in MCS at Level 3 is explained by entering the random slope.

However, there was no significant additional improvement to the variance explained covariance between random intercept and slope, or variance in random slope in any of the configurations. This indicates that by allowing the material deprivation index slope to vary provided an improved estimation of MCS intercept at the postal code area, but there was no further contribution to the model provided by the estimated covariance in slopes and intercepts or variance in slope. This is not uncommon in multilevel modeling as the prediction is based on observed variables (Snijders & Bosker, 2012). This supports Hypothesis 2 for material deprivation in that modeling the variance in slope at Level 2 further explains variance in MCS.

The variance in MCS at Level 2 was significant in all of the models. This indicates a persistent association between small geographic area and mental health life quality that is not explained in this study. There was far more variance explained by the MCS than by the PCS. Geographic variance in HRQoL requires further investigation of modifiable factors at both the individual and neighbourhood level.

Hypothesis 3. Hypothesis 3, which says that individual and neighbourhood attributes and interaction effects between individual characteristics and reduced material and social deprivation contributes to variance in HRQoL is not supported in this investigation for the MCS. Therefore, hypothesis 3 cannot be supported and the null must be maintained. Interaction effects do not improve the final model that explains variance in MCS.

In summary, a model predicting MCS was vastly improved with the addition of having a history of another health condition, being female, having another health condition now, decreased physical functioning, lower social deprivation, lower material deprivation, and younger age were added to the model. Accounting for variance in material deprivation quintile at Level 3 further explained MCS score. Although this did not result in a statistically significant improvement to model fit it does this did indicate that the differences in slope and intercept at the postal code level further explained MCS variance. There was no further improvement when any interaction effects were included in a final model. Therefore, for MCS hypothesis 1 and 2 are supported and the null is maintained for hypothesis 3. The findings agree with support other investigations that found a relationship between lower MCS and younger age (K. D. Lawson et al., 2010), female sex and lower HRQoL (L. Wang & Hu, 2013) and the impact of more than one health condition on self-reported health (Menec et al., 2010).

These findings were primarily as hypothesized, however, there were some unexpected findings in the model development that I will quickly review. I was surprised that BMI did not have a main effect or interaction effect on MCS. This is contrary to other studies that found worse HRQoL outcomes associated with higher BMI (Fransen et al., 2014) and Sundmacher et al.'s (2011) findings that obesity contributes to worse HRQoL particularly for older people.

The correlation graphics do demonstrate a difference in the means across sub groups. This could be attributed to a number of factors. One is the high mean BMI for this study population. As the mean was in the class 1 obese category it can be stated that most of the participants were in a higher weight group and there was limited variance. There may have also been interactions with between level one variables that were not considered such as gender or age. There are also other health inequity intersections such as race and class that impact this relationship and were unfortunately beyond the scope of this study.

It was also counterintuitive that the relationship of MCS with age was positive. This may be influenced by a response shift and salutogenic outlook, according to which, as one ages one becomes settled with life quality and accepting of physical limitation. In reality this relationship is complex and multifaceted. This investigation does articulate the mental health related toll of arthritis on the under age 65 population similar to the findings of K. D. Lawson et al. (2013). This finding may also be related to the likelihood that young adults experiencing a higher illness burden during years of employment and family responsibilities.

Predictors of PCS

For the PCS, the research questions were also answered with social and material deprivation, in interaction, having an influence on PCS. Physical HRQoL was influenced by, in order of magnitude; having another current health condition; reduced physical functioning: higher BMI in interaction with social deprivation; having a history of another health condition; material deprivation in interaction with gender; higher BMI, and older age. Having another current health condition had the highest parameter estimate at 1.22 indicating that respondents with another coexisting health condition had, on average a 1.22 lower PCS score. As interaction terms, both indices contributed to the final model. Although material deprivation was not maintained as a fixed effect, it was apparent that the contribution of the interaction term was beyond the main effect of the index. This was also true for the social deprivation index, which was maintained in the final model due to its contribution in model fit. As with the MCS, variance explained was improved in a random intercept random slopes model, although for the PCS, the model allowing social deprivation, not material deprivation, to vary at Level 2 improved variance explained. Similar to the MCS, this improvement was not a statistically significant improvement in overall fit in comparison to the final random intercept fixed slopes parsimonious model. In the final model there continued to be a large residual at both the individual and area level indicating there is still a large amount of unexplained variance in this best model.

In closer examination of BMI group differences in PCS were found by social deprivation index quintile for the higher BMI group, and this group had lower scores at each quintile compared to the lower BMI group. It was also found that men experienced more of an impact of material deprivation with far higher PCS average scores in the least deprived areas compared to the most deprived areas. However, women had lower mean scores at each quintile. I tested three major hypotheses in this investigation and the results are briefly reviewed below

PCS Hypothesis 1. Hypothesis 1, which posited that material and social neighbourhood deprivation negatively affect physical HRQoL in addition to the personal attributes of age, gender, health conditions, body weight and functioning, was supported by my study findings. The relationship for physical health related life quality was supported by a significant improvement in prediction of PCS in comparison to the null or empty model with no predictors. All of the individual attributes accept for gender were maintained in a final model. Both deprivation indices did provide additional contribution to model fit as interaction terms, and this hypothesis was supported for PCS as both indices had a significant influence on reduced PCS score above the contribution of individual attributes. There was no support for the independent influence of material and social deprivation on lower PCS.

PCS Hypothesis 2. Hypothesis 2, which says that the impact of material and social deprivation on HRQoL varies in mean score (intercept) and strength of the relationship (slope) across regional location was supported for social deprivation in explaining variance in PCS. There was an improvement to variance explained when allowing the variance in slope and intercept of social deprivation to vary at Level 2. Although, the random slope did not make a statistically significant improvement in model fit, the improvement to variance explained at Level 2 requires acknowledgement.

As well, the variance in intercept at the postal code level was significant in all of the models. This indicates a persistent association between small geographic area and HRQoL, above the variance in material deprivation index that was accounted for as a fixed slope and a random intercept for area grouping at Level 2. There continues to be substantial variance in HRQoL at the geographic level that is not explained in this study. This relationship was not as pronounced as it was for MCS; however, the intercept remained significant in the final parsimonious model.

Hypothesis 3. Hypothesis 3, which says that individual and neighbourhood attributes and interaction effects between individual characteristics and reduced material and social deprivation contribute to variability in HRQoL is supported in this investigation for the PCS.

Gender in interaction with material deprivation and BMI in interaction with social deprivation both contributed to a final parsimonious model that explains variance in PCS. This was above the significant influence of each variable as a main effect. In further comparison of means and partial correlation plots, it was evident that men were far more protected from declining PCS in less deprived areas than women as they reported higher PCS scores compared to women in all quintiles. BMI, in interaction with social deprivation, influenced PCS at each decline in quintile for the lower BMI group. There was a less predictable pattern for the higher BMI obese class II group, however their average PCS score was lower at across deprivation quintiles. When comparing lower BMI and higher BMI groups, it became evident that obesity was associated with lower scores at each quintile, with weight becoming less of a factor in the most socially deprived areas.

Age group further explained this relationship with a more predictable inverse relationship between PCS and social deprivation quintile for normal weight respondents under 65.While being female contributed to lower PCS scores at each quintile, male gender in combination with material deprivation was predictive of PCS score. For men, living in the least deprived areas had a protective effect on PCS, with more of a decline from the least to the most deprived areas than for women. This was far more pronounced for the under 65 age group.

Hypothesis 3 is accepted as interaction terms further explained variance in PCS. Both social deprivation in interaction with BMI and material deprivation with gender contributed to a final parsimonious model that explained variance in PCS. This model was further improved with a dichotomized BMI term indicating that higher BMI had more of an interaction with social deprivation. I summarize the key findings for both the MCS and PCS next.

Similar to MCS, a model predicting PCS which included individual variables and deprivation indices in interaction with BMI group and gender greatly improved the final model explaining variance in PCS. In order of effect, a parsimonious model including, having another contemporary health condition; reduced physical functioning: higher BMI in interaction with social deprivation; having a history of another health condition; material deprivation in interaction with gender, higher BMI, and older age contributed to a final model. Given the improvement from the null model hypotheses 1 is supported for the PCS. As with the MCS, there was an improvement in variance explained with a random intercept random slopes model allowing material deprivation index to vary at Level 2. This indicates that, accounting for variation of material deprivation mean and the strength of the relationship at the postal code area further explains variance in PCS score. However, although this additional variance explained was not a statistically significant improvement to model fit this did indicate that the differences in slope and intercept at the postal code level further explained PCS variance. Therefore Hypothesis 2 is also supported for the PCS.

Interestingly, interaction terms were maintained in a final model and therefore hypothesis 3 is accepted as a final model supported the interaction effect of social deprivation and BMI group and material deprivation and gender. Closer examination of these interaction terms indicated that the lower BMI group was more impacted by social deprivation quintile. Although women reported lower PCS scores at each quintile, men a stronger relationship between PCS and material deprivation quintile. Although all three hypotheses were supported for the PCS, the improvement in model fit in the final parsimonious model was not as substantive as the improvement in MCS in the final model. Both models left a large residual and unexplained variance at the individual level and area levels.

The findings for the PCS were consistent with the hypotheses and similar investigations. It was somewhat surprising that deprivation indices impacted PCS only in interaction terms. The literature presented supports a strong direct relationship between health outcomes and deprivation (Fransen et al., 2014; Mõtus et al., 2012), and it is somewhat surprising that no direct effects were found for material deprivation particular. This may be due to other unmeasured attributes at both the individual and area level.

It was also interesting to note that gender did not have a direct impact on PCS; again this is contrary to other investigations (L. Wang & Hu, 2013). However, the interaction term is consistent with other studies that have found a gap by deprivation area, particularly for men (Ellaway et al., 2011). In the graphic depiction this trend was apparent, but there was a reverse of the pattern for older people than has been found elsewhere (Sundmacher et al., 2011; Ellaway et al., 2012). It is also very interesting to note the interaction term involved social deprivation. The impact of social factors, not material impacted PCS indicating the negative implications of social make up of a community. This indicates that factors such as isolation and community configurations that involve individual households impacts physical functioning in interaction with BMI. These findings present a beginning glimpse into the complexity of the relationship between obesity and deprivation. This relationship is likely influenced in interaction with other individual attributes such as age, gender and other social factors. This study provides a preliminary glimpse into this complex multifaceted relationship.

This limitation and others are discussed further in the next chapter. This is a beginning dialogue on the complex nature of community area deprivation and the differential impact for men and women. I have summarized key findings to articulate the more pertinent discoveries from this investigation.

Key Findings

- Neighbourhood material and social deprivation contribute to models that predict both physical and mental HRQoL
- Having a history or contemporaneous health condition were strong predictors of reduced MCS and PCS
- Women under the age of 65 were particularly vulnerable to reduced mental HRQoL as they report, on average, close to a four point lower MCS score than men and both men and women over 65.

- Material deprivation had a greater impact on mental HRQoL than on physical HRQol. This highlights the detrimental impact of indicators of poverty at the neighbourhood level on mental health.
- In comparison to standardized scores in the general population the PCS mean was particularly low in this investigation. This is concerning given the chronic nature of arthritis and the large number of younger adults in this investigation and in the population.
- BMI and gender modified the relationship between deprivation and PCS, with being male explaining a more linear relationship with material deprivation quintile, while being female was more predictive of a lower score at each quintile. Higher BMI was more predictive of lower PCS at each social deprivation quintile. There are intersecting considerations for BMI, age and gender and area level deprivation.
- There was a sizeable unexplained variance in both MCS and PCS at the postal code area.
- The findings support the theoretical framework provided by habitus and fundamental cause theories of health inequality. Both theories provide a backdrop that elucidate how embedded social and cultural grouping of individuals in the habitus and deprivation of resources influence differences in health outcomes.

This body of work supports the theoretical frameworks of habitus and fundamental cause with each providing depth and breadth in explaining the interface between body and place. Consistent with habitus theory, this investigation highlighted the detrimental influence of the social environment on health outcomes. Traditional biomedical approaches to health cannot ignore the independent additional influence of social deprivation on HRQoL. This is a substantial health care concern as the construct includes self-rated health, an important metric that is linked to longevity (Perruccio, Katz, & Losina, 2012). Self-rated health has even been considered a more accurate assessment of health conditions than physician-rated health in the primary care setting (Perruccio et al., 2012; Waller, 2015).

Bourdieu's (1984) habitus provides an explanation for the similarities and clustering of issues for people coming from the same area. This study connected HRQoL with where people live. The variance in both HRQoL measures at the geographic area and strong influence of the neighbourhood deprivation index on outcomes supports the teachings of Bourdieu regarding the embedded nature of culture and how the habitus forms behaviour and beliefs, in this case self-appraised HRQoL. The pattern of women's experience in particular demonstrates the permeated experience of poor life quality on structurally defined expectations based in this case on gender. The high level of men's self-reported mental health in wealthy areas is also testament to role expectations and structurally prescribed organizing principles to embody wealth and prosperity.

The interaction of deprivation indices with body weight and gender further substantiates this, confirming the permeation of area related characteristics on person level health outcomes. Bourdieu's (1984) framework provides a critical underpinning for asking why there is a forgetting of history, with an acceptance of class, gender, and other socially contrived power differences. There is an acceptance of the dominant narrative in how societies are organized and in what is valued (Webb, Schirato, & Danaher, 2002). There is a subversive acceptance of the relationship between poverty and obesity.

Distinguishing poverty at the area level and the lack of material goods are defended as fundamental causes of difference in HRQoL in this investigation. In particular, for MCS, material deprivation was a predictor of reduced score. In combination with gender, material deprivation also explained variance in PCS especially for women. Deprivation as a fundamental cause of health inequality is supported in this investigation and others, and provides an introductory premise to understanding disparities in health. Acknowledging the impact of material deprivation as a fundamental, root cause of disparity in health outcomes is integral to moving forward on social determinants of health.

For both the MCS and PCS introducing material deprivation as a random effect at Level 2 improved explained variance. This is noteworthy as random regression coefficients rarely improve explained variance as this is based on predicting the dependent variable by observed variables, and the specification of the random components generally provides only a very minor addition to this prediction (Snijders & Bosker, 2012). However, in both indices this was not enough of an improvement to change model fit; so this must be interpreted with caution. This study did find that material derivation has a substantive impact on explaining HRQoL as a main effect and in interaction with gender. This further supports fundamental cause theory as deprivation further impacts individual level MCS and PCS as residency in a specific deprivation quintile location further alters both MCS and PCS.

The impact of social deprivation on both scores corroborates the influence of social factors, deprivation beyond monetary resources, in reduced life quality. This is not fully explained by fundamental cause, but this finding can be further understood by employing Bourdieu’s (1984) explanation of structurally embedded norms created by disadvantaged environments, such as isolation and marginalization. The significant influence of social deprivation on both MCS and PCS also demonstrates the value of social capital, recognizing the non-monetary resources that are associated with abundance, and are important in caring networks through expending social influence to maintain wellness.

Much can be gleaned from the literature review, theoretical framework, and findings of this study. In spite of limitations, this investigation contributes to the literature in a number of important ways. This dissertation provides a novel and comprehensive examination of differences in the illness experience. Consistent with social work's orientation to the person in the social context, this study provides an expansive framework to grasp the complexity of living with a chronic health condition. By integrating fundamental cause and habitus in a conceptual model, this study provides a timely contribution to responsive arthritis care and research. To date, there is limited integration of place in arthritis research and few investigations have considered the influence of the geographic area in this and other chronic illness outcomes.

The study findings corroborate the documented relationship between coexisting conditions and a history of other health conditions and worse HRQoL. Having a history of another health condition was the strongest predictor of MCS and having a current health condition was the strongest predictor of the PCS. A history of another health condition was also a strong predictor of PCS. This corroborates the cumulative burden of coexisting conditions. This is similar to other investigations that document the impact of coexisting health concerns on arthritis in particular (K. D. Lawson et al., 2013).

Along with a history or contemporaneous health conditions, I was able to further substantiate the strong correlation between obesity and reduced PCS as an individual effect and in the context of neighbourhood deprivation. This supports other research on obesity and worse HRQoL (Fransen et al., 2014 Mork et al., 2012; Y. Wang et al., 2013) and in the examination of reduced life quality for women (Ashlstrand et al., 2015; Ellaway et al., 2012). The findings also demarcated the differential impact of obesity on physical and mental health related life quality that has been documented by Ul-Haq, Mackay, Fenwick, and Pell (2013). Consistent with other investigations, there was a more apparent impact of BMI on physical HRQoL. The differential impact acknowledges the complex interplay of life quality, weight, and place.

As with other investigations, there are many difficulties with population-based research. As well, there were acknowledged challenges with secondary data analyses. Next, I discuss some of the key limitations as they relate to this investigation.

Limitations

I discuss limitations in general and then across the considerations for statistical conclusion validity, and threats to internal validity, external validity, and construct validity. I follow this with a summary of limitations related to secondary data investigations.

As seen in this investigation, there is a large unexplained variance in the dependent variables when considering individual and area level influences on quality of life. A large variance was present at the individual and area levels as demonstrated by the significant intercept and significant area level residuals for both the MCS and PCS in the final models. This is in part a specification error as other variables not included in this investigation may account for some of this variance. This shortcoming could be addressed in follow-up studies that include other variables indicative of modifiable individual attributes such as tobacco use, level of exercise, social network information, and other correlates of better health and wellness. This additional information may fill out some of the variance in MCS and PCS scores that would point to modifiable attributes both at the individual and area levels that could be the target of public health and social service programs.

To date, little is known about how attributes in the area contribute to reduced life quality, and further research could fill in some of the unexplained variance at the regional level. Information on contextual community level indicators would also be important such as the proximity to area level health resources, as well as access to safe streets and public areas, green space, transportation, healthy food, and other community level indicators that are linked theoretically to wellness. Also, it would be interesting to replicate this investigation with a repository of clinical data involving other populations with other health conditions such as diabetes, cardiac conditions, and mental health disorders to determine if there are similar patterns.

There are difficulties in this kind of exploratory research with teasing out cause and effect, and the temporal relationship between reduced resources and lower life quality remains unknown. There is difficulty with the cross-sectional nature of the study design, and it is not possible to confirm causation. In this kind of investigation, it is not possible to establish the sequence of cause and effect. The question remains: Is it the area that impacts health, or does poor health result in segregating economic and employment opportunities?

It is also noted that there are limitations in using a joint replacement registry as a proxy for arthritis. There are joint replacement recipients who have deterioration as the result of injury and not a primary arthritic condition. In this secondary analysis there was no way of identifying respondents who had joint deterioration as the result of trauma or a sports injury. It is estimated that the number of individuals with replacements as the result of trauma would be extremely small. According to the medical director of the Hip and Knee Institute in Manitoba, traumatic replacements that are the result of an acute injury such as a hip fracture are conducted on an emergent basis and would not be part of the registry (E. Bohm, personal communication, January 7th, 2016). See Appendix D for further clarification from the registry medical director. This is a recognized shortcoming in study design as younger respondents are more likely to fall into this category. However, findings suggest a more deleterious impact on younger sample respondents, so regardless of the original cause of the deterioration; the impact on life quality is notable.

In a secondary analysis, it is not possible to compensate for selected measures, but rather to work in a practical way with the measures available. As this database was collected in a pen and paper survey, it is possible that individuals who were more disadvantaged may have had difficulty with item response due to limitations in intellectual capacity, limited formal education, or a language barrier (Paz, Liu, Fongwa, Morales, & Hays, 2009). There is also bias in both the registry and census data collection on how social phenomena are constructed and who in the population is included or excluded in the information (Smith, 2008). The registry questionnaires were available in English only; educational level or literacy was not measured, and there is no way to account for or address these barriers in communication.

Statistical conclusion validity. Statistical conclusion validity, that is, the extent to which conclusions about the association between variables based on statistical tests are accurate (Shadish, Cook, & Campbell, 2002) requires thoughtful consideration. Given the large sample size, there is a possibility that statistical conclusion validity was threatened. With the large *N*, there is a possibility of a type one error in interpreting the data, as statistical results may appear significant due to the large sample size and not represent true significant or meaningful differences in associations. I offset this threat by using a conservative alpha level at $p < .001$. The multilevel analysis also accounted for the non-independence of errors, further minimizing the risk of committing a type one error.

Also, not having individual SES measures limited the extent assumptions can be made about the construct of deprivation at an individual level. The construct of deprivation in this investigation is limited to neighbourhood compositional attributes. As well, the study did not capture deprivation at the individual level with a measure of individual or household income. Not having individual measures of income led to difficulty with confounding attributes of personal income with attributes of material neighbourhood deprivation. This may have contributed to an overestimation of the slopes for neighbourhood deprivation as individual and household income is likely positively associated with deprivation and negatively associated with both dependent variables. The relationship with this unmeasured variable is confusion as the direction of both deprivation indices was in the reverse direction of individual markers of income with higher values indicating higher wealth.

By using multilevel modeling and accounting for the between group variance, the methodological approach minimized the risk of an *ecological* or *atomistic fallacy*, that is, the potential to come to conclusions about findings at one level of analysis and attributing them to a higher or lower level of analysis. In this case, variables were clearly identified at the unit of analysis, the micro unit of the individual, and the macro unit of postal code. This prevented the ecological fallacy of concluding that findings at the community level represent individual level attributes (Hox, 2010). In this case, I can avoid assuming that material deprivation represents individual measures of wealth such as family income.

Construct validity. In my interpretation of findings, I carefully considered *construct validity*, the extent the measures represent the theoretical underpinnings of the concept. I measured the construct of deprivation using abstracted administrative data, and this represents an aggregate of objective compositional measures of deprivation that may or may not be indicitave of the subjective experience or situation for individual community members. There are acknowledged limitations with both the construct of neighbourhood and deprivation.

The measurement of neighbourhood for this type of investigation is also problematic. By using the Statistics Canada Census data defined area of neighbourhood, there is a bias related to what has been termed the *modifiable area unit problem* (Fotheringham & Wong, 1991) as the boundaries are delineated for administrative purposes and do not reflect the subjective perception of a person's neighbourhood. An area defined by dissemination or postal code may vary from how participants would perceive their actual geographic community. The land parcel may not accurately depict the actual space and area of influence one inhabits on a daily basis.

It is recognized that there was no ability to capture other contextual components of the neighbourhood such as enriching resources, access to goods and services, or the built environment. There was also no accounting for tenure in the neighbourhood and whether or not subjects were new to the area or had lived their entire life in the same household or surrounding community. This prevented the opportunity to assume neighbourhood deprivation represented more detailed elements accounting for lifetime exposure to the environment and how people appraise their neighbourhood.

Also, the construct of HRQoL used in this investigation was problematic. It is acknowledged that the SF-12-1 PCS and MCS (AHOC, 2005) capture a narrow view of life quality, focusing on functioning and self-rated health. I would also argue that the SF-12-1 is a widely used instrument that captures the experience of living with an illness, and not a measure of the broader elements that are often associated with life quality.

Although not considered to be an issue by others (Gandhi et al., 2001), it can be assumed that there was both a floor and a ceiling effect with the PCS, in particular. Other investigations have pointed out the floor and ceiling effect with most HRQoL measures, and in many clinical populations' subtle differentiation or variance from the mean (Hobart, Williams, Moran, & Thompson, 2002; Kosinski, Keller, Hatoum, Kong, & Ware, 1999). In a population of individuals with advanced arthritis awaiting joint replacement, the group presented a restricted range of experience, particularly for the PCS with a mean of 29.9 (*SD* = 8.27) as the expected standardized population mean is 50 with a standard deviation of 10 (AHOC, 2005).

The range of values in the variable BMI was also limited in this investigation. As the mean was high and actually in the obese class I category (*M* = 31.11, *SD* 6.47), there was a restricted range in this study population. Therefore, the construct of body weight was narrow as the sample had restricted variance in body weight, and there was therefore limited ability to demarcate higher and lower BMI across a range that would be found in the population. As the mean for the BMI was in the obese class I category, this also made it difficult to define obesity in a comparable metric to other investigations. Interestingly, difficulties with measuring obesity and establishing weight groups have been found in other investigations (Jiang, Chen, Manuel, Morrison, Mao, & Obesity Working Group, 2007). In this investigation the limited range of BMI restricted the variance of this attribute as an independent factor and in combination with neighbourhood attributes.

It is also unfortunate that a standardized measure of health conditions or generalized health was not available. This limits the full representation of the construct of coexisting health conditions as conditions throughout the life course may have been successfully treated or the reverse could be true. Also, a yes/no response to each condition did not take into consideration the severity of any existing conditions or the contributing symptoms that may be compounding and represent overall poor health. The items were not weighted, and there are substantial differences in impact of a more minor health condition than a life threatening condition, such as cancer, that may have resulted in sustained differences in overall health and functioning. Also, standardized measures of comorbidity, or a standardized measure of generalized health, as opposed to a lifetime occurrence of a chronic health condition, would have allowed for more accurate comparison of findings to other investigations. Self reported health and comorbity are important determinants of health outcomes that warrant further attention in future research (Perruccio, Katz, & Losina, 2012)

In spite of limitations with this construct, both currently having another health condition and a history of a health condition proved to be robust indicators of both MCS and PCS and are important in considering the impact of overall health in the lived experience of individuals presenting for specialty care. This study demonstrated the profound impact of having other health conditions on both MCS and PCS. This warrants further attention in both practice and research.

Focusing on one illness, arthritis in this case, unfortunately discounts the cumulative impact of poor physical health over the lifetime, and multiple concerns can be overlooked or minimized in this type of investigation. The focus on one condition is narrow and can underrepresent the negative impact of poverty and social conditions on health (White, O'Campo, Moineddin, & Matheson, 2013). More refined risk assessment tools are necessary to reflect the accumulation of health threatening influences. For example, indices such as the Generalized Health Impact Index (GHI) provide a tool to explore the consequences of adverse environments on people's lives (White et al., 2013). This would be a valuable addition to patient population repositories, such as the registry which provided data for this investigation.

External validity. There were threats to external validity with selection bias, that is, bias related to how the sample was established. Many individuals with advanced arthritis may not be candidates for joint replacement surgery and, therefore, not be represented in this study. As well, it is likely that more disabled individuals, individuals with less ability to communicate in English, and the more aged, may have had difficulty completing the questionnaire and being registered in the repository. As previously mentioned, there are SES differences in who is considered a candidate for joint replacement and who is referred to an orthopedic surgeon for the procedure (Hawker et al., 2002). These selection biases may further limit variance and the generalizability of findings to the broader advanced arthritis population.

The investigation was also limited to individuals waiting for lower extremity joint replacements. This eliminates subjects with upper extremity joint degeneration and others with polyarthritis disease that has not involved joint degeneration as well as those who are, for a number of other reasons, not considered candidates for surgery.

Contributions of this Study

In spite of acknowledged limitations, this investigation contributes to current knowledge in a number of ways. It supports other investigations that have found a relationship between reduced quality of life in arthritis and socioeconomic markers, and contributes to the literature in important ways. By employing a large data set and evidence-based measures of HRQoL and social and material deprivation, this study confirms a substantive relationship between deprivation at the neighbourhood level and reduced HRQoL, directly, and in interaction with gender and BMI. The analytic approach accounted for variance at the neighbourhood level and provided a series of models to examine a number of factors in explaining the variance of both mental and physical HRQoL. This is an important frontier for social work with implications for practice, health service delivery, and policy.

As demonstrated in this study, the surrounding environment and the material and social elements in the area impact life quality. For clinicians, this is evidence that a broader view of health and place can influence practice and the decision-making required for health care planning and support for adults. Social work needs to continue to advance knowledge and theory regarding health and place. Social workers in health care are encouraged to consider the broader context of the environment people live in and how the neighbourhood influences life quality. Also, this investigation points out how this experience can be different in the presence of co occurring conditions, across levels of mobility, BMI, age and gender, confirming the differential impact of deprivation. These findings argue for specific attention to those more vulnerable populations due to the impact of coexisting health issues, gender, higher body mass, and reduced physical functioning.

Practice Implications

Before discussing practice implications I want to acknowledge that poverty is a social determinant of health and by presenting practice suggestions I do not want to detract from the structural and economic barriers to good health and life quality. It is important for social workers to continue to advocate for the eradication of poverty and promote initiatives to bring government transfer benefits to a subsistence level. As many social workers practice with individuals in formal health care settings we are able to continue to promote the need for broader changes in social welfare policies.

Social work practice in health care is primarily centered on individuals in the context of their environment and social arena. However, there is little recognition of the experience of people living in socially and materially deprived neighbourhoods and their interaction with the health care system. Loignon et al. (2015) pointed out the silence of health care professionals in addressing poverty issues in health care practice. Social workers are in the position to advocate for more inclusive and integrative services that are accessible and comfortable for all Canadians. By considering the habitus people live in and the impact of material and social limitations on health in social work assessments and interventions, social workers will be able to heighten awareness of the root source of limited access to health sustaining practices. It is important to include social indicators as a routine part of social work assessment and intervention (Hudson & Gehlert, 2015). There is also the opportunity to acknowledge elements in the area that further disadvantage those with chronic health conditions (Price & Walker, 2015). Social workers need to continue to advocate for empathic and just services for all clients.

Social workers are in a position to advocate for more vulnerable populations and adequately identify structural barriers as part of routine practice in team-based care. Asking questions such as “Where do you live? What is that like for you? What can you tell me about your neighbourhood?” will begin this necessary dialogue. There is often shame and stigma related to living in undesirable parts of a city, being on welfare, and experiencing other prejudicial personal circumstances that are necessary to acknowledge in a clinical practice relationship.

It is also necessary to take a closer look at the modifiable risk factor of obesity as a practice issue. Obesity is a complex mix of social, psychological, and behavioural factorswhich often influence body weight. This investigation corroborated a significant relationship between higher BMI and lower PCS. This investigation also found a complex interrelationship between BMI and social deprivation, beyond the influence of BMI directly. It is important to recognize the complex nature of interrelationships and how they further impact body weight, such as access to healthy food sources, walkability of areas, and even housing options. In clinical practice, the psychological impact of overeating and a sedentary lifestyle in the context of area deprivation requires further assessment of the environmental contributions to obesity and the physical sequelae of being overweight.

This study provides further support for recognizing the deleterious impact of social deprivation. The indicators from Census Canada used in the construction of the deprivation index include the proportion of lone parent households and the number of people living alone in the area. It can be assumed that these constellations of neighbourhoods also reflect the extent of exclusion and isolation within the area. Loneliness and isolation are important contributions to mental and physical health, and this is a concern in itself, and also a further risk for people who are poor (Loignon et al., 2015; Hudson & Gehlert, 2015). In this investigation, I have highlighted the detrimental impact of social deprivation on quality of life for both physical and mental health, and how this impacts different populations. This underlines the necessity of identifying the cultural and social composition of neighbourhoods (F. Lawson et al., 2015). When speaking to social work clients about housing options and relocation, it is important to consider the social configuration of housing options and neighbourhoods. Also, social workers and other care providers need to consider interventions to enhance social contact and networks, such as congregate meal programs, drop in centres and cultural gateways to help develop social capital for residents. These social resources can offset the impact of living alone for seniors especially. The profession needs to advocate for safe neighbourhoods with ample opportunity for socialization.

In the dominant biomedical paradigm, there is little integration of mental health and wellness strategies in the trajectory of the progress of illness. To date, social work has been silent on the experience of chronic physical illness (Price & Walker, 2015). There is a need to enhance social work practice to develop competencies in chronic illness adaptation and recovery. As well, there is a need to further integrate mental health supports in the illness management and recovery care plan. This thesis demonstrates that mental health related life quality is strongly influenced by physical attributes and how influence is different in composition from physical HRQoL. This sturdy provides evidence for comprehensive social work and mental health support in chronic illness assessment and intervention. As well, there is support for the development of assessment tools to identify and intervene with more vulnerable populations, particularly patients in high deprivation neighbourhoods.

Generating thoughts about the future state of one's life quality in supportive practice can be integral to assisting older adults in successful ageing (McKee et al., 2015). This and other life quality enhancing strategies are important correlates of progressive social work practice in primary health and other points of contact. Social workers are in a position to assist patients with life transitions and to develop coping strategies to mitigate the impact of chronic illness. This can include a vast array of psychological interventions that assist patients with enhanced self-management and self-efficacy strategies. There is a need in counselling to encourage positive psychological thoughts and behaviours in successful ageing adjustment and adaptation. Much can also be learned in emphasizing an enhanced perception of quality of life in chronic illness management. There is broad agreement that a robust psychological state influences health and eventual decline. By encouraging older adults in particular to anticipate their future quality of life social workers can enhance healthy adjustment to changes in independence and vitality (McKee et al., 2015).

In summary, much can be gleaned from this investigation for social work practice. The investigation underlines the importance of an expansive person within her or his environment for assessment, including the area she or he lives in, as well as the importance of continued advocacy for patients who are poor and stigmatized. Social work can also enhance clinical support for patients and clients struggling with obesity, mental health issues and chronic illness symptom management, especially in deprived areas. As well, social work practice can assist individuals with resources to combat loneliness and social isolation. A comprehensive assessment of clients/ patients is necessary to advance changes in these modifiable risk factors.

Service Delivery Implications

Although Canada has universal health care, there continues to be significant barriers to equitable care (Loignon et al., 2015). As well, I would argue that there can be stigma related to residing in deprived areas of the city or addresses widely recognized as public housing complexes. Deprivation is often the impact of cascading disadvantage, as less money often results in living in less advantaged area and residency in less advantaged areas further reduces health and opportunity. Clients and patients who have limited income or income replacement, the poor and those who live in disadvantaged areas, often come up against divisive attitudes and structural and institutional barriers to care. Due to these barriers and others, arthritis has a differential impact across the social strata, and people from more disadvantaged areas often access care later in the trajectory and may receive sub-optimal care (Mingo et al., 2014). There are also differences across the social strata in access to specialty care and allied health professionals, with more disadvantaged individuals receiving less adequate access to allied health resources (Yang et al., 2015). In addition, there is less access to prevention and health promotion for specific subpopulations (Hudson & Gehlert, 2015). Patient care at all points of access should include comprehensive assessment and intervention strategies for individuals at greater risk for poorer outcomes. Strategies to mitigate obesity, reduced physical functioning, and suboptimal pain management are imperative. There are ample opportunities for intervention earlier in the disease trajectory across every point of care.

The impact of experiencing more than one health condition must be considered in providing comprehensive services. In practice and service delivery, there is a need for more integrated mental health services in primary care and specialty chronic disease management (Mingo et al., 2014; Mujica-Mota et al., 2015). Strategies to reduce mental health distress and manage depression and anxiety are necessary in this chronic illness and others. Service strategies are necessary to consider interventions to improve mental health outcomes at the population and individual levels (Mingo et al., 2014).

In this study I did not investigate racism or cultural differences in the illness experience. Some of the unexplained variance in model refinement is likely attributable to the impact of interlocking oppressions such as those based on race, cultural heritage, gender and age that often coexist with deprivation and marginalization. Also, institutional barriers and other health care service provider barriers continue in current mainstream services. There is often differential treatment based on race and social position (Hudson & Gehlert, 2015; Steele, 2010). There continues to be institutional racism and that pervades health care practices. When race is talked about in the health service arena, it is usually talked about in regard to the racial other, not in regard to the dominant cultural groups and privilege (Durey, 2015).

There is also a pattern of what Tang et al. (2015) and colleagues have called *underclassism*, a critical view of how health care practices and services intersect with wider dominant cultural patterns to reinforce class-based discrimination, racism and social exclusion. Health care service providers need to have ongoing dialogue regarding institutional barriers to care, such as exhibiting racism, othering marginalized groups or individual patients and disregarding aspects of care, such as health literacy in patient communication.

In most health care jurisdictions there is also limited professional education on the social determinants of health and institutional barriers to care. In a study in Quebec, Canada, Loignon et al. (2015) found that many health care service providers lacked information and knowledge on the unhealthy living conditions of clients/patients and the impact of these conditions have on health. They also found that disadvantaged clients/patients found the health care system unable to meet many of their complex needs. In spite of universal health care, there continues to be many issues regarding equitable access to services across the socioeconomic continuum. Professional education is necessary in the health care professions and social work, in particular, on the impact of neighbourhood deprivation on individual residents, and complex nature of area level factors in determining quality of life. Extensive professional education and service development are also needed to enhance strategies to reduce the influence of the social determinants on health.

A beginning point can be the integration of health equity audits in program evaluation. Health equity audits provide a structure to review accessibility related barriers to programs and services (Rodney & Hill, 2014). These audits can also include targets at the neighbourhood level by integrating neighbourhood deprivation indices as part of the environmental scan and ensuring that resources are equally accessible to all areas and all area residents in the same way. They can help identify specific barriers to the full range of health services and can be a beginning point for service reform that is more responsive and innovative in considering hard to reach populations. There is inequitable access to services based on area level disadvantage (Schuurman et al., 2008). An audit is not only a way to identify population health needs but also an opportunity to define and measure accessibility to universally provided health services (Rodney & Hill, 2014).

Current care strategies that rely on individuals to coordinate their own care in a complex system leave the onus on the individual and can therefore be suboptimal. Often strategies to reduce barriers to care in the health system are limited or absent (Tang et al., 2015). Approaches are necessary in education and service delivery that examine approaches to reduce social distance and provide programs and facilities that are welcoming to all who need service.

Innovative intervention programs that target obesity will also support best practices in arthritis care (Fransen et al., 2014; Y. Wang et al., 2013). There is a double disadvantage of obesity and area deprivation that warrants novel approaches to secondary prevention. For populations living in deprived neighbourhoods, there are many unrecognized additional environmental and macro barriers to healthier lifestyles, access to health enhancing resources such as green space, recreation activities, and access to healthy food. Psychological and behavioural interventions for weight reduction should be available, affordable, and accessible as part of healthy living to prevent and reduce obesity. Multidisciplinary arthritis clinics may be Multidisciplinary arthritis clinics may be located close to more advantaged areas and are often designed for patients with higher health literacy and access to a car to attend appointment (Davis, Kitchlu, MacKay, Palaganas & Wong (2010). Mobile allied health resources or drop-in clinics may be more suited to hard-to-reach populations who require physiotherapy, recreation therapy, and dietician or social work consultation.

Mental health services in primary care are also important as access to counseling and psychiatric assessment in close geographic proximity has been linked to lower risk of developing depression for people with chronic health conditions (Gariepy et al., 2014). Integrating public health interventions targeting geographic areas would go a long way in advancing responsive service delivery. This should include targeted strategies that integrate affordable, accessible, and relevant mental health services in primary care and in arthritis clinics (Gariepy et al., 2014; Mingo et al., 2014). Identifying those most at risk and acting to lower risk will have an impact on the disease burden of arthritis (Barlow, 2009).

Multi-sector initiatives could also enhance primary chronic illness management. Health clinics could partner with food banks to provide affordable healthy food alternatives for people who rely on food banks to supplement their food budget. It is my observation that there are often few lower calorie, healthy choices available to food bank recipients. There is a strong need for multi-sector planning and decision-making. Differences in health outcomes bleed into other arenas, with a burden experienced by other sectors as the result of problems such as early exit from the work force and increased health costs for modifiable health conditions.

There are ample opportunities to look beyond health care to enhance health at the neighbourhood level. Study findings reinforce the need for accessible and innovative health services for harder to reach populations. It is important to consider prevention and health promotion strategies that integrate individual considerations and area level poverty indicators in health promotion.

There is a continued challenge to identify factors at the individual and community level that are modifiable and susceptible to interventions to promote the health of all citizens and reduce variability across the SES spectrum. This study supports the need to advance programs geared to modify differences in clinical outcome and reduce disparities in the experience. Several suggestions such as enhanced professional education, routine health equity audits, access to mental health resources in primary care, and interventions across sectors could reduce disparity in the illness experience.

Policy Implications

Similar to practice and service delivery, social welfare and health policies fall short in reducing poverty and social isolation. Current federal and provincial social welfare programs continue to leave a group of Canadians with an income that is substantially lower than the low income cut off for the area (Tweddle, Battle & Torjman, 2014; Bazel & Mintz, 2014; Raphael, 2011). Income assistance programs and the Guaranteed Income Supplement do not provide enough benefits to help all Canadians afford basic necessities. Needed improvements include housing in stable neighbourhoods, enriching social welfare programs and initiatives to eradicate child poverty. There is a ghettoization of the poor in Canadian inner cities as often housing stock for welfare recipients and seniors with limited income replacement are often clustered in inner city undesirable neighbourhoods. Investigations such as mine demonstrate the heavy burden of social and material disadvantage.

The findings of this investigation support the need for strategies for building and sustaining healthy communities. Mixed housing neighbourhoods and affordable and suitable rent geared to income and senior housing options continue to be important considerations in urban planning. There continue to be areas of deprivation in both rural and urban centers, with a concentration of low-income areas and areas within inner city neighbourhoods with concentrations of less expensive single residences and public housing. Most often poor neighbourhoods are overrepresented with lone parent households and single residents.

Public health policy continues to be incongruous with the social determinants of health. There is a continued focus on individual behaviours and risk identification. The dominant discourse remains apolitical and decontextualized. Public health initiatives need to focus on the epistemological basis for informing decisions and assumptions that address marginalization (Brassolotto et al., 2014). This requires a broader intersectoral mandate to truly address the social determinants of health.

Research Implications

In this study I was able to corroborate the importance of including area related groupings and contextual descriptors of neighbourhoods in health research. Further research is needed to identify modifiable factors at both the individual and neighbourhood level.

This investigation distinguishes the impact of social deprivation on mental HRQoL and points to the growing need to more fully understand the relationships in the changing social context. As more Canadians live alone and live in neighbourhoods with a high proportion of single household dwellers and lone parent families, this is a growing area of concern. Social deprivation is an important predictor of reduced health outcomes and should be formally considered a determinant of health (Ross et al., 2013).

This study provides further support for research on the additional impact of obesity and coexisting health conditions on reduced health outcomes (K. D. Lawson et al., 2013; Sundmacher et al., 2011). Future research should examine area level deprivation and the causal pathways of multiple health conditions and obesity in longitudinal studies to further understand how they actually influence life quality.

As well, it would be valuable to move beyond the dominant health inequity paradigm and consider more broadly other dynamics that contribute to differences in the illness experience (Brassolotto et al., 2014; Gehlert et al., 2008; Sundmacher et al., 2011). Other epistemological paradigms are necessary to examine documented, yet unexplained, differences. There continues to be significant unexplained variance in this study and others that warrants further exploration. For example, it would be worthwhile to examine deprivation and poverty at the individual level, as well as area level, and the individual and joint influence they have on health outcomes. This would reduce some of the difficulties with isolating deprivation and poverty by having measures at two levels and having a fuller picture of both advantage and impoverishment.

This information is complementary to other methodologies that provide more detailed explanations of the experiences of impoverishment and life quality in the presence of chronic illness. Inquiry into the lived experience and how the habitus and poverty are experienced and embodied would provide very valuable context to further explain these findings. This would be particularly valuable in understanding the experience of younger people living in more deprived areas. As well, the unique experiences of women and how the impact of neighbourhood deprivation is so different for them remains unexplained. Very little is known about the differential impact of deprivation on women with arthritis, and this warrants further investigation. There is also a continued need to consider the cumulative and multiplicative contributions of marginalized identities. There are gaps in the literature on the multiple combinations of inequality (Veenstra, 2011).

It would also be interesting to further study area level differences, such as the impact of more heterogeneous forward sortation geographic areas compared to forward sortation areas that have more homogeneous postal code units. This could be examined by using aggregated variables that consider the mix of smaller area units within a larger area (Heck et al., 2013). Exploring the influence of deprivation within the larger geographic area of forward sortation would add additional depth in analysis of the broader geometric space people inhabit in work and activities of daily living. This may also point to specific areas that provide a buffer to poor outcomes or are anomalies in the relationship between area disadvantage and HRQoL. Further investigations could also examine urban rural comparisons, inner city poverty, and other unique geographic compositions that may influence HRQoL. There are marked differences between geographic areas that are not captured in this investigation.

This investigation provides an important example of theory-driven HRQoL research that can be replicated for other chronic illness populations. Multilevel analysis is a popular approach to research involving clustered data, and this example provides an easily replicated investigation, as the deprivation indices are readily available to other researchers through the INSPQ. Many health and social service programs have extensive patient and client repositories that have valuable patient/client information that could be used in secondary analysis involving additional community level information. Ideally this information is treated as complementary to other methodologies, and provides an opportunity to extend research pluralism in social work (Smith, 2008). This investigation provides a blueprint for future research in other chronic health conditions and the integration of area level indicators.

Continued exploration of the habitus and HRQoL could also include longitudinal studies that capture the life course influences and the impact of childhood and early life poverty on HRQoL in the middle and older adult years. This could shed light on what mechanisms make specific populations more vulnerable to environment-level deprivation.

Conclusion

Through this dissertation, I have opened the dialogue to place the social environment, individual attributes, and HRQoL in the context of chronic illness. Although social work has a longstanding appreciation for the social milieu of people, little attention to date has been paid to these intersecting considerations. Social work scholarship needs to continue to draw attention to the confluence of health and place. There is also opportunity to advance knowledge in social work’s role in chronic illness (Price & Walker, 2014) and health disparities (Gehlert et al., 2008).

There is robust support for the empirical evidence that links area level factors with reduced health outcomes. This research furthers current knowledge by identifying specific individual and neighbourhood attributes that contribute to differences in physical and mental HRQoL. My findings point to the particular vulnerability of women and middle-aged and younger obese adults who live in disadvantaged areas. This substantiates the theoretical construct of habitus as an integral influence in health and equity in life quality. In addition, the impact of material disadvantage is substantiated in this study, explaining material resources as a fundamental cause of disparity in health. However, the findings call for an expansion of fundamental cause theory to recognize the deleterious impact of social factors on differences in health outcomes. Further investigation is warranted to move forward on the social determinants of health and determinants of health inequality in the universal health care context. Through this study, I ask new questions about area level deprivation and living with arthritis.

References

Ackerman, I. N., Graves, S. E., Wicks, I. P., Bennell, K. L., & Osborne, R. H. (2005). Severely compromised quality of life in women and those of lower socioeconomic status waiting for joint replacement. *Arthritis and Rheumatism, 53*(5), 653–658. doi:10.1002/art.21439

Aguinas, H., Gottfredson, R. K., & Culpepper. (2013). Best-practice recommendations for estimating cross-level interaction effects using multilevel modeling. *Journal of Management, 3*(6), 490–1528. doi:10.1177/0149206313478188

Alishiri, G. H., Bayat, N. Ashtiani, A. F., Tavallaii, S. A., Assari, S., & Moharamzad, Y. (2008). Logistic regression models for predicting physical and mental health-related quality of life in rheumatoid arthritis patients. *Modern Rheumatology*, *18*, 601–608. doi:10.1007/s10165-008-0092-6

Almeida, D. M., Neupert, S. D., Banks, S. R., & Serido, J. (2005). Do daily stress processes account for socioeconomic health disparities? *Journals of Gerontology*, *60* (B Special Issue II), 34–39. doi:10.1093/geronb/60.Special_Issue_2.S34

Alonso, J., Ferrer, M., Grandek, B., Ware, J. E., Aaronson, N. K., Masconi, P., . . . & Lepaige, A. (2004). Health related quality of life associated with chronic conditions in eight countries: Results from the international quality of life assessment (IQOLA) project. *Quality of Life Research*, 13, 283–298. Retrieved from Ebscohost

Alviar, M. J., Olver, J., Brand, C., Tropea, J., Hale, T., . . . & Kahnm, F. (2011). Do patient reported outcomes measure in hip and knee arthroplasty rehabilitation have robust measurement attributes? A systemic review. *Journal of Rehabilitation Medicine, 43*, 572–583. doi:10.2340/16501977-0828

Antonovsky A. (1967). Social class, life expectancy and overall mortality. *Milbank Mem Fund Q*. *45*(2). 31–73. Retrieved from http://www.jstor.org/stable/3348839

Arthritis Society, Arthritis Community Research and Evaluation Unit. (2013). *Arthritis in Canda*. Retrieved from https://www.arthritis.ca/document.doc?id=903

Ashing-Giwa, K. T., & Lim, J. W. (2008). Predicting health related quality of life: Testing the contextual model using structural equation modeling. *Applied Research Quality of Life*, *3*(3), 215–230. doi:10.1007/s11482-009-9057-y

Ashlstrand, I., Björk, M., Thyberg, I., & Falkmer, T. (2015). Pain and difficulties performing valued life activities in women and men with arthrtis. *Clinical Rheumatology*, 1–10. doi:10.1007/s10067-015-2874-5

Australian Health Outcomes Collaboration. (2005). *SF-12® Health Survey (Version 1.0) Instrument Review* [Measurement instrument]. Centre for Health Service Development University of Wollongong. Australian population study. *International Journal of Public Health*, *54*, 1–10. doi:10.1007/s00038-009-7113-x

Badley, E. M., Canizares, M., Perruccio, A. V., Hogg- Johnson, S., 1984& Gignac, M. A. (2014). Gains associated with improved SES offset by losses associated with increased obesity: Age, period and cohort effects in the prevalence of arthritis 1994–2010 – a longitudinal population-based study. *Osteoarthritis and Cartilage*, *22*(Suppl.), S205–S206. doi:10.1016/j.joca.2014.02.394

Balli, H. O., & Sørenson, B. E. (2013). Interaction effects in econometrics. *Emperical Economics*, *45*(1), 583-603. doi:10.1007/s00181-012-0604-2

Barlow, J. (2009). *Living with arthritis.* Oxford, UK: BPS Blackwell.

Bartley, M. (2004). *Health inequality: An introduction to theories, concepts and methods.* Cambridge, UK: Polity Press.

Basta N. E., Matthews, F., Chatfield, M., & Brayne, C. (2008). Community-level socio-economic status and cognitive and functional impairment in the older population. *European Journal of Public Health*. *18*(1), 48–54. doi:10.1093/eurpub/ckm076

Bayliss, E. A., Ellis, J. L., & Steiner, J. F. (2007). Barriers to self-management and quality of life outcomes in seniors with multimorbidities. *Annals of Family Medicine, 5(*5), 395–402. doi:10.1370/afm.722

Bazel, P., & Mintz, J. (2014). Income adequacy among seniors: Helping singles most. *School of Public Policy SPP Research Papers, 7*(4)1–17. Retrieved from http://www.policyschool.ucalgary.ca/sites/default/files/research/mintz-bazel-seniors-income.pdf

Bell, N., Schuurman N., & Hameed, S. M. (2008). Are injuries spatially related? Join-count spatial autocorrelation for small-area injury analysis. *Injury Prevention, 14*(6), 346–353. doi:10.1136/ip.2008.018903

Bell, N., Schuurman, N., Oliver, L., & Hayes, M. V. (2007). Towards the construction of place specific measures if deprivation: A case study from the Vancouver metropolitan area. *The Canadian Geographer*, *51*(4), 444–461. Retrieved from http://www.sfu.ca/gis/schuurman /cv/PDF/2007_CG_indices.pdf

Bernard, P., Charafeddine, R., Frohlich, K. L., Daniel, M., Kestens, Y., & Potvin, L. (2007). Health inequalities and place: A theoretical conception of neighbourhood. *Social Science Medicine*, *65*, 1839–1852. doi:10.1016/j.socscimed.2007.05.037

Bourdieu, P. (1977). Cultural reproduction and social reproduction. In J. Karbel & A. H. Halsey (Eds.), *Power and ideology in education* (pp. 487–511), New York, NY: Oxford University Press.

Bordieu, P. (1984). *Distinction*. London, UK: Routledge.

Bourdieu, P. (1993). *The field of cultural production: Essays on art and literature.* New York, NY: Columbia University Press.

Bourdieu, P., & Wacquant, L. (1992). *An invitation to reflexive sociology*. Cambridge, UK: Polity Press.

Bowling, A. (2000). *Measuring disease: A Review of disease specific quality of life measurement scales.* Philadelphia, PA: Open University Press.

Braveman, P., & Gottlieb, L. (2014). The social determinants of health: It's time to consider the causes of the causes. *Public Health Reports*, *129* (Supplement l 2), 19–31. Retrieved from http://www.publichealthreports.org/issueopen.cfm?articleID=3078

Brassolotto, J., Raphael, D., & Baldeo, N. (2014). Epistemological barriers to addressing the social determinants of health among public health professionals in Ontario, Canada: A qualitative inquiry. *Critical Public Health*, *24*(3), 321–336. doi:10.1080/09581596 .2013.820256

Breeze, E., Jones, D. A., Wilkinson, P., Bulpitt, C. J, Grundy, C., . . . & Fletcher, A. E. (2005). Area deprivation, social class, and quality of life among people aged 75 years and over in Britain. *International Journal of Epidemiology*, 34, 276–283. doi:10.1093/ije/dyh328

Bullinger, M. (2002). Assessing health related quality of life in medicine: An overview over concepts, methods and applications in international research. *Restorative Neurology and Neuroscience*, *20*, 93–101.

Burns, J. K. (2015). Poverty, inequality and a political economy of mental health. *Epidimeology and Psychiatric Sciences*, *24*(2), 107–113. doi:10.1017/S2045796015000086

Burrows, S., Auger N., Gamache, P., St-Laurent, D., & Hamel, D. (2011). Influence of social and material individual and area deprivation on suicide mortality among 2.7 million Canadians: A prospective study. *Biomedical Central Public Health*, *11*(577). Retrieved from http:// www.biomedcentral.com/content/pdf/1471-2458-11-577.pdf

Callahan, L. F., Remmes Martin, K., Shreffler, J., Kumar, D., Schoster B., Kaufman, J. S., & Schwartz, T. A. (2011).Independent and combined influence of homeownership, occupation, education, income and community poverty on physical health in persons with arthritis. *Arthritis Care and Research*, *63*(5), 643–653. doi:10.1002/acr.20428

Callahan, L. F., Shreffler, J., Mielenz, T. T., Kaufman, J. S., Schoster, B., . . . & Weinberger, M. (2009). Health -related quality of life in adults from 17 family practice clinics in North Carolina. *Preventing Chronic Disease*, *6*(1), 1–12. Retrieved from http://www.cdec.gov /pcd/issues /2009/jan/07_0215.htm

Callahan, L. F., Shreffler, J., Mielenz, T., Schoster, B., Kaufman, J. S., & Xiao C. (2008). Arthritis in the family practice setting: Associations with education and community poverty. *Arthritis and Rheumatism, 59*, 1002–1008. doi:10.1002/art.23834

Canada Post. (2014). *Addressing guidelines*. Government of Canada: Canada Post. Retrieved from https://www.canadapost.ca/business/tools/pg/manual/PGaddress-e.pdf

Cañizares, M., Power, J. D., Perruccio, A. V., & Badley, E. M. (2008). Association of regional /racial cultural context and socioeconomic status with arthritis in the population: A multilevel analysis. *Arthritis Care and Research*, *59*(3), 399–407. doi:10.1002/art.23316

Claes, C., van Hove G, van Loon, J., Vandevelde, S., & Schalock, R. L. (2010). Quality of life measurement in the field of intellectual disabilities: eight principles for assessing quality of life-related personal outcomes. *Social Indicators Research*, *98*(1), 61–72. doi:10.1007/s11205-009-9517-7

Clark, C. R., Kawachi, I., Ryan, L., Ertel, K., Fay, M. E., & Berkman, L. F. (2009). Perceived neighbourhood safety and incident mobility disability among elders: The hazards of poverty. *Bio Med Central Public Health, 9*(162). doi:10.1186/1471-2458-9-162

Clough, J. D. (2009). *The Cleveland Clinic Guide to Arthritis*. NewYork NY: Kaplan

Cobos, R., Latorre, A., Aizpuru, F., Guenaga, J. I., Sarasqueta, C., . . . & Herrera-Espiñeira, C. (2010). Variability of indication criteria in knee and hip replacement: An observational study, *Biomedical Central, Musculoskeletal Disorders, 11*, 249. Retrieved from http://www .biomedcentral.com/1471-2474/11/249 .doi:10.1186/1471-2474-11-249

Coburn, D. (2000). Income inequality, social cohesion and the health status of populations: The role of neoliberalism. *Social Science and Medicine*, *51*, 135–146. Retrieved from http:// web.pdx.edu/~nwallace/GHS/Ineqsoc.pdf

Coburn, D. (2004). Beyond the income inequality hypothesis: Class, neo-liberalism, and health inequalities. *Social Science and Medicine*, *58*, 41–56. doi:10.1016/S0277-536(03)00159-X

Cohen, S., Kaplan, G. A., & Salonen J. T. (1999). The role of psychological characteristics in the relationship between socioeconomic status and perceived health. *Journal of Applied Social Psychology*, *29*(3), 445–468. Retrieved from http://repository.cmu.edu/cgi /viewcontent.cgi?article=1288&context=psychology

Conaghan, P. G., Emerton, M., & Tennant, A. (2007). Internal construct validity of the Oxford knee scale: Evidence from Rarsch measurement. *Arthritis Rheumatology*, *57*(8), 1363–1367. doi:10.1002/art.23091

Cummins, S., Curtis, S., Diez-Roux, A., & Macintyre, S. (2007). Understanding and representing 'place' in health research: A relational approach. *Social Science and Medicine, 65*, 825–1838. doi:10.1016/j.socscimed.2007.05.036

Daniels, N. 2008. *Just health: Meeting health needs fairly*. New York, NY: Cambridge University Press.

Davis, A. M., Kitchlu, N., MacKay, C., Palaganas, M., & Wong, R. (2010). *Models of Care Delivery for People With Arthritis.* Toronto ON: Arthritis researcha and evaluation unit. Retrieved from http://modelsofcare.ca/pdf/10-04.pdf

Dawson. J., Fitzpatrick, R., Murray, D., & Carr, A. (1998). Questionnaire on the perceptions of patients about total knee replacement. *British Editorial Society of Bone and Joint Surgery, 80*(B), 63–69. Retrieved from http://www.boneandjoint.org.uk/highwire /filestream/16348/field_highwire_article_pdf/0/63.full-text.pdf

Day, H., & Jankey, S. G. (1996). Lessons from the liberature: Toward a holistic model of quality of life. In R. Revwick, I. Brown, & M. Nagler (Eds.). *Quality of life in health promotion and rehabilitation: Conceptual approaches issues and applications* (pp. 39–50). Thousand Oaks, CA: Sage.

Desmeules, F., Dionne, C. E., Belzile, E., Bourbonnais, R., & Frémont, P. (2009). Waiting for total knee replacement surgery: Factors associated with pain, stiffness, function and quality of life. *Biomedical Central Musculoskeletal Disorder, 10*(52) 1-10. Retrieved from http://www .biomedcentral.com/1471-2474/10/52. doi:10.1186/1471-2474-10-52

Department of Health and Social Security. (1980). *Inequalities in health. The black report: Report of a working group*. London, UK: Author. Retrieved from http://www.sochealth.co.uk /history/black.htm

Diez-Roux, A. V., & Mair, C. (2010). Neighbourhoods and health. *Annals of the New Work Academy of Sciences, Issue: The Biology of Disadvantage, 1186*, 125–145. doi:10.1111/j.1749-6632.2009.05333.x

Di Gallo, A., Felder-Puig, R., & Topf, R. J. (2007). Quality of life from research and clinical perspectives: An example from paediatric psycho-oncology. *Clinical Child Psychology* and Psychiatry, *12*(4), 599–610. doi:10.1177/1359104507080995

Draper, P., & Thompson, D. R. (2001). The quality of life: A concept for research and practice. *Nursing Times Research, 6*, 648–657. doi:10.1177/136140960100600303

Drukker, M., & van Os, J. (2003). Mediators of neighbourhood socioeconomic deprivation and quality of life. *Social Psychiatry and Psychiatric Epidemiology*, *38*(12), 698–706. doi:10.1007/s00127-003-0690-8

Dupont, M. A., Pampalon, R., & Hamel, D. (2004). *Deprivation and cancer mortality among Quebec women and men, 1994-1998*. Institut National De Santé Publique Du Québec. Retrieved from http://www.santecom.qc.ca/bibliothequevirtuelle/hyperion/2550433912 .pdf

Durey, A. (2015). Antonio Gramsci and Pierre Bourdieu: “Whiteness” and indigenous health care in health care. In F. Collyer (Ed.), *The Palgrave handbook of social theory in health, and medicine* (pp. 191–206). New York, NY: Macmillan Palgrave. doi:10.1057/9781137355621

Ellaway, A., Benzeval, M., Green, M., Leyland, A. & Macintyre, S. (2012). “Getting sicker quicker”: Does living in a more deprived neaighbourhood mean your health deteriorates faster? *Health and Place, 18*(2), 132–137. doi:10.1016/j.healthplace.2011.08.005

Elliot, R. A. (2008). Poor adherence to medication in adults with rheumatoid arthritis: Reasons and solutions. *Disease Management and Outcomes, 16*(1), 13–17. doi:10.2165/00115677-200816010-00003

Eriksson, M., & Lindström, B. (2006). Antonovsky’s sense of coherence scale and the relation with health: A systemic review. *Journal of Community Epidemiology*, *60*, 376–381. doi:10.1136/jech.2005.041616

Ethgen, O., Bruyère, O., Richey, F., Dardennes, C., & Reginster, J. Y. (2004). Health-related quality of life in total hip and total knee arthroplasty. *The Journal of Bone and Joint Surgery, 86*, 963–974. Retrieved from http://jbjs.org/content/86/5/963

EuroQol. (1990). EuroQol: A new facility for the measurement of health-related quality of life. The EuroQol Group. *Health Policy, 16*, 199–208.

Feeny, D. H., Furlong, W. J., Boyle, M., & Torrance, G. W. (1995). Multi-attribute health status classification systems: Health utility index. *Pharmaco Economics*, 7, 490–502.

Ferrans, C. E., Zerwick, J. J., Wilbur, J. E., & Larson, L. L (2005). Conceptual models of health-related quality of life. *Journal of Nursing Scholarship*. *37*(4), 336–342. doi:10.1111/j.1547-5069.2005.00058.x

Fortin, M., Lapointe, L., Hudon, C., Vanasse, A., Ntetu, A., & Maltais, D. (2004). Multimorbidity and quality of life in primary care: A systemic review. *Health and Quality of Life Outcomes*, *2*(51), 1–12. doi:10.1186/1477-7525-2-51

Fotheringham, A. S., & Wong, D. W. S. (1991). The modifiable areal unit problem in multivariate statistical analysis. *Environment and Planning*, *23*(7), 1025e–1044. Retrieved from http://www.envplan.com/abstract.cgi?id=a231025

Fransen, M., Simic, M., & Harmer, A. R. (2014). Determinants of MSK health and disability: Lifestyle determinants of symptomatic osteoarthritis, *Best Practice & Research Clinical Rheumatology*, *28*(3), 435–460. doi:10.1016/j.berh.2014.07.002

Fried, L. P., Ferrucci, L., Darer, J., Williamson, J. D., & Anderson, G. (2004). Untangling the concepts of disability, frailty, and comorbidity: Implications for improved targeting and care. *Journal of Gerontology and Biological Science and Medical Science*, *59*(3), 255–263. Retrieved from http://www.sld.cu/galerias/pdf/sitios/gericuba/untangling_frailty_concepts.pdf

Frohlich, K. L., Ross, N., & Richmond, C. (2006). Health disparities in Canada today: Some evidence and a theoretical framework. *Health Policy*, *79*(2), 132–143. doi:10.1016/j.healthpol.2005.12.010

Frohlich, N., & Carriere, K. C. (1997). *Issues in developing indicators for needs-based funding*. Winnipeg, MB: Manitoba Centre for Health Policy and Evaluation.

Frohlich, N., & Mustard, C. (1996). A regional comparison of socioeconomic and health índices in a Canadian Province. *Social Science and Medicine, 42*(9), 1273–1281. Retrieved from http://www.sciencedirect.com/science/article/pii/0277953695002200

Furlong, W., Barr, R. D., Feeny, D., & Yandow, S. (2005). Patient-focused measures of functional health status and health-related quality of life in pediatric orthopedics: A case study in measurement selection. *Health and quality of life outcomes, 3*(3), 1–15. doi:10.1186/1477-7525-3-3

Gandek, B., Ware, J. E., Aaronson, N. K., Apolone, G., Bjorner, J. B., Brazier, J. E., . . . & Sullivan, M. (1998). Cross validation of item selection and scoring for the SF-12 Health Survey in nine countries: Results from the IQOLA Project, International Quality of Life Assessment. *Journal of Clinical Epidemiology, 51*, 1171–1180. doi:10.1016/S0895-4356(98)00109-7

Gandhi, S. J., Salmon, J. W., Zhao, S. Z., Lumbert, B. L., Gore, P. R., & Conrad, K. (2001). Psychometric evaluation of the 12-item Short-Form Health Survey (SF-12) in osteoarthritis and rheumatoid arthritis clinical trials. *Clinical Therapeutics, 23*(7), 1080–1098. Retrieved from http://www.clinicaltherapeutics.com/article/S0149-2918(01)80093-X/abstract

Gariepy, G., Blair, A., Kestens, Y., & Schmitz, N. (2014). Neighbourhood characteristics and 10 year risk of depression in Canadian adults with and without a chronic illness. *Health and Place, 30,* 279–286. doi:10.1016/j.healthplace.2014.10.009

Garratt A. M., Brealey, S., Gillespie W. J., & the DAMASK Trial Team. (2004). Patient-assessed health instruments for the knee: A structured review. *Rheumatology*, *43*, 1414–23. doi:10.1093/rheumatology/keh362

Gehlert, S., Mininger, C., Sohmer, D., & Berg, K. (2008). (Not so) gently down the stream: Choosing strategies to ameliorate health disparities. *Health and Social Work*, *33*(3), 163–167. doi:10.1093/hsw/33.3.163

Godley, J., Haines, V. A., Hawe, P., & Shiell, A. (2010). Small area contextual effects on self-reported health: Evidence from Riverside, Calgary. *BMC Public Health 2010, 10*, 264. doi:10.1186/1471-2458-10-264

Guillemin, F., Carruthers, E., & Li, L. C. (2014). Determinants of MSK health and disability-social determinants of inequities in MSK health. *Best Practice and Research Clinical Rheumatology, 28*, 411–433. doi:10.1016/j.berh.2014.08.001

Hammell, K. W. (2004). Exploring quality of life following high spinal cord injury: A review and critique. *Spinal Cord, 42*, 491–502, doi:10.1038/sj.sc.3101636

Harris, K. K., Dawson, J., Jones, L. D., Beard, D.J., & Price, A. J. (2013). Extending the use of PROMs in the NHS—using the Oxford Knee Score in patients undergoing non-operative management for knee osteoarthritis: a validation study. *British Medical Journal Open, 3*(e003365), 1–11. doi:10.1136/bmjopen-2013-003365

Harrison, M. J., Farragher, T. M., Clarke, A. M., Manning, S. C., Bunn, D. K., & Symmons, D. P. (2009). Association of functional outcome with both personal-and area-level socioeconomic inequalities in patients with inflammatory polyarthritis. *Arthritis Care and Research, 61*(10), 1297–1304. doi:10.1002/art.24830

Harrison, M. J., Tricker, K. J., Davies, L., Hassell, A., Dawes, P., Scott, D. L., . . . & Symmons, D. P. (2005). The relationship between social deprivation, disease outcome measures, and response to treatment in patients with stable, long standing rheumatoid arthritis. *The Journal of Rheumatology*, *32*(12), 2330–2336. Retrieved from http://www.jrheum.org /content/32/12 /2330.full.pdf

Hawker, G. A., Wright, J. G., Glazier, R. H., Coyte, P. C., Harvery, B., Williams, J. I., & Badley, E. M. (2002). The effect of education and income on need and willingness to undergo total joint arthroplasty. *Arthritis & Rheumatism*, *46*(12), 3331–3339. doi:10.1002/art.10682

Hawthorne, G., J. Richardson, & Osborne, R. (1999). “The assessment of quality of life (AQoL) instrument: A psychometric measure of health related quality of life.” *Quality of Life Research, 8*, 209–224. Retrieved from: http://link.springer.com/article/10.1023%2FA%3A1008815005736

Health Canada. (2003). *Canadian guidelines for body weight classification in adults*. Ottawa, ON: Minister of Public Works and Government Services Canada.

Heck, R. H., Thomas, S. L., & Tabata, L. N. (2013). *Multilevel and longitudinal modeling with IBM SPSS* (2nd ed.). Retrieved from http://www.eblib.com

Hobart, J. C., Williams, L. S., Moran, K., & Thompson, A. J. (2002) Quality of life measurement after stroke: Uses and abuses of the SF-36. *Stroke, 33*, 1348–1356. doi:10.1161/01.STR.0000015030.59594.B3

Hox, J. J. (2010). *Multilevel analysis techniques and applications* (2nd ed.). New York, NY: Routledge Taylor and Francis.

Hudson, D. L., & Gehlert, S. (2015). Considering the role of social determinants of health in Black–White breast cancer disparities in R. Bangs & L.E. Davis (Eds.), *Race and social problems: Restructuring inequality* (pp. 227–246). New York NY: Springer. doi:10.1007/978-1-4939-0863-9_15

Huguet, N., Kaplan, M. S., & Feeny, D. (2008). Socioeconomic status and health-related quality of life among elderly people: Results from the joint Canada/United States survey of health. *Social Science & Medicine, 66*, 803–810. doi:10.1016/j.socscimed.2007.11.011

Janzen, W., Turpin, K. V., Warren, S. A., Marrie, R. A., & Warren, K. (2013). Changes in the health related quality of life of multiple sclerosis patients over five years. *International Journal of MS Care,15* (1) 46-53, doi:10.7224/1537-2073.2012-020

Jiang, Y., Chen, Y., Manuel, D., Morrison, H., Mao, Y., & Obesity Working Group. (2007). Quantifying the impact of obesity category on major chronic diseases in Canada. *The Scientific World Journal*, *17*(7), 1211–1221. doi:10.1100/tsw.2007.216

Jocham, H. R., Dassen, T., Widdershoven, G., & Halfens, R. (2006).Quality of life in palliative care cancer patients: A literature review. *Journal of Clinical Nursing*, *15*(9), 1188–1195. doi:10.1111/j.1365-2702.2006.01274.x

Kaptein, S. A., Gignac, M. A., & Badley, E. M. (2009). Differences in the workforce experiences of women and men with arthritis disability: A population health perspective. *Arthritis Care and Research*, *61*(5), 605–613.doi:10.1002/art.24427

Kawachi, I., & Kennedy, B. P. (1997). Socioeconomic determinants of health 2: Health and social cohesion. Why care about income inequality? *British Journal of Medicine*, *314*, 1037–1040. Retrieved from http://www.bmj.com/content/314/7086/1037

Kirwan, J. R., & Reeback, J. S. (1986). Health assessment questionnaire modified to assess disability in British patients with rheumatoid arthritis. *British Journal of Rheumatology*, *25*, 206–209. doi:10.1093/rheumatology/25.2.206

Kosinski, M., Keller, S. D., Hatoum, H. T., Kong, S. X., & Ware, J. E. (1999). The SF-36 Health Survey as a generic outcome measure in clinical trials of patients with osteoarthritis and rheumatoid arthritis. *Medical Care, 37*(Suppl. 5), MS10–MS22. Retrieved from http://www.jstor.org/discover/10.2307/3767287?uid=3739408&uid=2&uid=3737720&uid=4&sid=21106383413091

Krieger, N., Chen J. T., Waterman, P. D., Soobader, M. J., Subramanian S. V., & Carson, R. (2002). Geocoding and monitoring of US socioeconomic inequalities in mortality and cancer incidence: Does the choice of area-based measure and geographic level matter? *Journal of Epidemiology, 156*(5), 471–482. doi:10.1093/age/kwf068

Lang, I. A., Llewellyn, D. J., Langa, K. M., Wallace, R. B., & Melzer, D. (2008). Neighbourhood deprivation and incident mobility in older adults. *Age and Aging*, *37,* 403–410. doi:10.1093/ageing/afn092

Lawson, F., Schuurman, N., Amram, O., & Nathens, A. B. (2015). A geospatial analysis of the relationship between neighbourhood socioeconomic status and adult severe injury in greater Vancouver. *Injury Prevention*, *21,* 260–265. doi:10.1136/injuryprev-2014-041437

Lawson, K. D., Mercer, S. W., Wyke, S., Grieve, E., Guthrie, B., Watt, G. C., & Fenwick, E. A. (2013). Double trouble: The impact of multimorbidity and deprivation on preference-weighted health related quality of life a cross sectional analysis of the Scottish health survey. *International Journal for Equity in Health*, *12,* 67. doi:10.1186/1475-9276-12-67

Lebel, A., Riva, M., Pampalon, R., & Thériault, M. (2009). The geography of overweight in Québec: A multilevel perspective. *Canadian Journal of Public Health*, *100*(1), 18–23. Retrieved from http://journal.cpha.ca/index.php/cjph/article/view/1731/1916

Lemstra, M., Neudorf, C., & Opondo, J. (2006). Health disparity by neighbourhood income. *Canadian Journal of Public Health, 97*(6), 435–439. Retrieved from http://journal.cpha .ca/index.php/cjph/article/view/783/783

Li, X. Gignac, M. A., & Anis, A. H. (2006). Workplace, psychosocial factors, and depressive symptoms among working people with arthritis a longitudinal study. *The Journal of*

Rheumatology, *33*(9), 1849–1855. Retrieved from http://www.jrheum.org/content /33/9 /1849.long

Lindström, B., & Eriksson, M. (2010). A salutogenic approach to tackling health inequalities. In A. Morgan, E. Zigilo, & M. Davies (Eds.), *Health assets in a global context: Theory, methods, action* (pp. 17–39). London, UK: Springer. doi 10.1007/978-1-4419-5921-8_2

Link, B. G., & Phelan, J. C. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior*, *35*(extra issue), 80–94. Retrieved from http://www.jstor .orgdiscover/10.2307/2626958?uid=3739408&uid=2&uid=3737720&uid=4&sid=211063 83413091

Link, B. G., & Phelan, J. C. (2002). McKeown and the idea that social conditions are fundamental causes of disease. *American Journal of Public Health*, *92*(5), 730–731. Retrieved from http://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.92.5.730

Locker, D. (2008). Living with chronic illness. In G. Scrambler (Ed.), *Sociology as applied medicine* (pp. 83–96.). London, UK: Saunders Elsevier.

Loignon, C., Hudon, C., Goulet, E., ÉBoyer, S., De Laat, M., Fournie, N., Grabovschi, C., & Bush, P. (2105). Perceived barriers to healthcare for persons living in poverty in Quebec, Canada: The EQUIhealThY project. *International Journal for Equity in Health, 14*(4), 1–11. doi:10.1186/s12939-015-0135-5

Lynch, J. W., Davey Smith, G., Harper, S., Hillemeier, M., Ross, N., Kaplan, G.A., & Wolfson, M. (2004). Is income inequality a determinant of population health? Part 1 a systemic review. *Milbank Quarterly, 82*(1), 5–99. Retrieved from http://www.ncbi.nlm.nih.gov /pmc/articles /PMC2690209/pdf/milq0082-0005.pdf

Lynch, J. W., Davey Smith, G., Kaplan, G. A., & House, J. S. (2000). Income inequality and mortality: Importance to health of individual income, psychosocial environment, or material conditions. *British Medical Journal, 320,* 1220–1224. doi:10.1136/bmj.320.7243.1200

Maempel, J. F., Clement, N. D., Brenkel, I. J., & Walmsley P. J. (2015). Validation of a prediction model that allows direct comparison of the Oxford knee score and American knee society clinical rating system. *The Bone and Joint Journal*, *97*(b), 503–509. doi:10.1302/0301-620X.97B4. 34867

Mair, C. Diez-Roux, A. V., & Galea S. (2010). Are neighbourhood characteristics associated with depressive symptoms? A review of evidence. *Journal of Epidemiology and Community Health*, *62*, 940–946. doi:10.1136/jech.2007.066605

Malmstrom, M., Johansson S. E., & Sundquist, J. (2001). A hierarchical analysis of long-term and mortality in socially deprived areas. *Social Science and Medicine*, *53*, 265–275. Retrieved from http://www.sciencedirect.com/science/article/pii/S0277953600002914

Mansyur, C. L., Amick, R. B., Franzini, L., & Roberts, R.E. (2009). The cultural production of health inequalities: A cross-sectional, multilevel examination of 52 countries. *International Journal of Health Services*, *39*(2), 301–319. doi:10.2190/HS.39.2.e

Marmot, M. (2006). Introduction. In M. Marmot & R. Wilkinson (Eds.), *Social determinants of health* (pp. 1–6). Oxford, UK: Oxford University Press.

Marmot, M., & Brunner, E. (2005). Cohort profile: The Whitehall II study. *International Journal of Epidemiology*, *34*(2), 251–256. doi:0.1093/ije/dyh372

Marmot, M., & Wilkinson, R. G. (2001). Psychosocial and material pathways in the relation between income and health: A response to Lynch et al. *British Medical Journal*, *322*(19), 1233–1236. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1120336/pdf/1233.pdf

Marra, C. A., Lynd, L. D., Esdaile, J. M., Kopec, J., & Anis, A. (2004). The impact of low family income on self-reported health outcomes in patients with rheumatoid arthritis within a publically funded health-care environment. *Rheumatology*, *43*, 1390–1397. doi:10.1093/rheumatology/keh334

Masters R. K., Link B. G., & Phelan, J. C. (2015). Trends in education gradients of 'preventable' mortality: A test of fundamental cause theory. *Social Science and Medicine, 127*, 19–28. doi:10.1016/j.socscimed.2014.10.023

Mascarenhas, R. (2009). The Manitoba arthroplasty waiting list: Impact on health-related quality of life and initiatives to remedy the problem. *Journal of Evaluation in Clinical Practice, 15*(1), 208–211. doi:10.1111/j.1365-2753.2008.00985.x

Matheson, F. I., Moineddin, R. Dunn, J. R., Creatore, I, M., Godzdyra, P., & Glazier, R. H. (2006).Urban neighbourhoods, chronic stress, gender and depression. *Social Science and Medicine*, *63*, 2604–2616. doi:10.1016/j.socscimed.2006.07.001

Matheson, F. I., Moineddin, R., & Glazier R. H. (2008). The weight of place: A multilevel analysis of gender, neighbourhood material deprivation and body mass index among Canadian adults. *Social Science and Medicine, 66*, 675–690. doi:10.1016/j.socscimed.2007.10.008

Matheson, F. I., White, H. L., Moineddin, R., Dunn, J. R., & Glazier, R. J. (2010). Neighbourhood chronic stress and gender inequalities in hypertension among Canadian adults: A multilevel analysis. *Journal of Epidemiology and Community Health, 64*(8), 705–13. doi:10.1136/jech.2008.083303

McCoach, D. B., & Black A. C. (2008). Evaluation of model fit and accuracy. In D. B. McCoach & A. A. O'Connell (Eds.), *Multilevel modeling multilevel modeling of educational data* (pp. 245–271). Charlotte, NC: Information Age.

Mckee, K. J., Kostela, J., & Dahlberg, L. (2015). Five years from now: Correlates of older people's expectations of quality of life. *Research on Ageing*, *37*(1), 18–40. doi:10.1177/0164027513520329

McKewen, B. E. & Mirsky, A. E. (2002). How socioeconomic status may "get under the skin" and affect the heart. *European Heart Journal*, *23*, 1727–1728. doi:10.1053/euhj.2002.3283

McGrail, K. M., van Doorslaer, E., Ross, N. A., & Sanmartin, C. (2009). Income-related health inequalities in Canada and the United States: A decomposition analysis. *American Journal of Public Health*, *10*, 1856–63. doi:10.2105/AJPH.2007.129361)

Menec, V. H., Shooshtari, S., Nowicki, S., & Fournier, S. (2010). Does the relationship between neighborhood socioeconomic status and health outcomes persist into very old age? A population-baseded study. *Journal of Aging and Health*, *22*(1), 27–47. doi:10.1177/0898264309349029

Miller, C. W., Lames, N. T., Fos, P. J., Zhang, L., Wall, P., & Welch, C. (2008). Health status, physical disability, and obesity among adult Mississippians with chronic joint symptoms or doctor-diagnosed arthritis: Findings from the behavioral risk factor surveillance system, 2003. *Preventing Chronic Disease*, 5(3), 1–9. Retrieved from www.cdc.gov/pcd/issues/2008 /jul/07_0088.htm

Mingo, C. A., Martin, K. R., Shreffler, J., Schoster, B., & Callahan, L. F. (2014). Individual and community socioeconomic status: Impact on mental health in individuals with arthritis. *Arthritis, 24*, 1–10. doi:10.1155/2014/256498

Mork, P. J., Holtermann, A., & Nilsen, T. I. L. (2112). Effect of body mass index and physical exercise on risk of knee and hip osteoarthritis: Longitudinal data from the Norwegian HUNT study. *Journal of Epidemiology and Community Health, 66*, 678–683. doi:10.1136/jech-2011-200834

Morris, R., & Carstairs, V. (1991). Which deprivation? A comparison of selected deprivation indices. *Journal of Public Health*, *13*, 318–326.

Mõtus, R., Gale, C., Starr, J. M., & Dreary, I. J. (2012). 'On the street where you live': Neighbourhood deprivation and quality of life among community-dwelling older people in Edinburgh, Scotland. *Social Science and Medicine*, *74*(9), 1368–1374. doi:10.1016/j.socscimed.2011.12.050.

Mujica-Mota, R. E., Roberts, M., Abel, G., Elliott, M., Lyratzopoulos, G., Roland, M., & Campbell, J. (2015). Common patterns of morbidity and multi-morbidity and their impact on health-related quality of life: Evidence from a national survey. *Quality of Life Research*, *24*(4), 909–918. doi:10.1007/s11136-014-0820-7

Muntaner, C., Chung, H., Murphy, K., & Ng, E. (2012). Barriers to knowledge production, knowledge translation, and urban health policy change: Ideological, economic, and political considerations. *Journal of Urban Health*, *89*(6), 915–924. doi:10.1007/s11524-012-9699-1

Pampalon, R., Hamel, D., & Gamache, P. (2008). Recent changes in the geography of social disparities in premature mortality in Québec. *Social Science & Medicine*, *67*(8), 1269–1281. doi:10.1016/j.socscimed.2008.06.010

Pampalon, R., Hamel, D., Gamache, P., Philibert, M. D., Raymond, G., & Simpson, A. (2012). An area-based material and social deprivation index for public health in Québec and Canada. *Canadian Journal of Public Health*, *103*(Suppl. 2), S17–S22. Retrieved from http://journal.cpha.ca/index.php/cjph/article/viewFile/3156/2663

Pampalon, R., Hamel, D., Gamache, P., Simpson, A., & Philibert, M.D. (2014). Validation of a deprivation index for public health: a complex exercise illustrated by the Quebec index. *Chronic Deseases and Injuries in Canada*, *34*(1), 12–24. Retrieved from http://www.phac-aspc.gc.ca/publicat/hpcdp-pspmc/34-1/assets/pdf/CDIC_MCC_Vol34_1_3_Pampalon_E.pdf

Pampalon, R., & Raymond, A (2000). Deprivation index for health planning in Canada. *Chronic Diseases in Canada*, *21*(3), 104–113. Retrieved from http://www.phac-aspc.gc.ca /publicat/cdic-mcbc/29-4/pdf/CDIC_MCC_Vol29_4_ar_05-eng.pdf

Paz, S. H., Liu. H. Fongwa, M. N., Morales, L. S., & Hays, R. D. (2009). Readability estimates for commonly used health-related quality of life surveys. *Quality of Life Research*, *18*, 889–900. doi:10.1007/s11136-009-9506-y

Perruccio, A., Katz, J. N., Losina, E. (2012). Health burden in chronic disease: Multiborbidity is associated with self-rated health more than medical comorbidity alone. *Journal of Clinical Epidemiology*, *65*(1), 100–106. doi:10.1016/j.jclinepi.2011.04.013

Phelan, J. C., &. Link, B. G. (2005). Controlling disease and creating disparities: A fundamental cause perspective. *The Journals of Gerontology, 60B* (special issue II), 27–33. Retrieved from http://psychsocgerontology.oxfordjournals.org/content/60/Special_Issue_2 /S27.full.pdf+html

Phelan, J. C., Link, B. G., Diez-Roux, A, Kawachi, I., & Levin, B. (2005). "Fundamental causes" of social inequalities in mortality: A test of the theory. *Journal of Health and Social Behavior, 45,* 265–285. Retrieved from http://deepblue.lib.umich.edu/bitstream/handle /2027.42/57746/Fundamental%20Causes%20of%20Social%20Inequalities%20in%20Mortality%20A%20Test%20of%20the%20Theory%20.pdf?sequence=1

Philibert, M. R., Pampalon, R., Hamel, D., Thouez, J. P., & Loiselle, C. (2007). Material and social deprivation and health and social services utilization in Québec: A local-scale evaluation system, *Social Science & Medicine*, *64*, 1651–1664. doi:10.1016/j.socscimed.2006.12.010

Phillipson, C. (2007). The 'elected' and the 'excluded': Sociological perspectives on the experience of place and community in old age. *Ageing and Society*, *27*, 321–342. doi:10.1017/S0144686X06005629

Plummer, M., & Molzhan, A. E. (2009). Quality of life in contemporary nursing theory: A concept analysis. *Nursing Science Quarterly, 22*, 134–140. doi:10.1177/0894318409332807

Price, L. & Walker, L. (2015). *Chronic Illness, vulnerability and social work.* Oxon, UK: Routledge.

Public Health Agency of Canada. (2010). *Life with arthritis in Canada: Ongoing challenges*. Ottawa, ON: Government of Canada. Retrieved from http://www.phac-aspc.gc.ca/cd-mc/arthritis-arthrite/lwaic-vaaac-pdf/arthritis-2010- eng.pdf

Raphael, D. (2006). Social determinants of health: Present status, unanswered questions and future directions. *International Journal of Health Services*, *36*(4), 651–677. Retrieved from http://brendanpalmer.wikispaces.com/file/view/5.pdf

Raphael, D. (2009). *Social determinants of health: Canadian Perspectives* (2nd ed.). Toronto, Canada: Canadian Scholars' Press.

Raphael, D. (2011). Poverty in childhood and adverse health outcomes in adulthood. *Maturitas, 69,* 22–26. doi:10.1016/j.maturitas.2011.02.011

Raphael, D., Brown, I., Renwick, R., & Rootman, I. (1996). Quality of life indicators and health: Current status and emerging conceptions. *Social Indicators Research*, *39*, 65–88.

Rapley, M. (2003). *Quality of life research: A critical introduction*. London, UK: Sage.

Raudenbush, S. W., & Bryck, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Resnick, B., & Parker, R. (2001). Simplified scoring and psychometrics of the revised 12-item Short-Form Health Survey. *Outcomes Management for Nursing Practice*, *5*, 161–166.

Rhemmes-Martin, K. R., Sheffler, J., Schoster, & Callahan, L. F. (2010). Associations of perceived neighbourhood environment on health status outcomes in persons with arthritis. *Arthritis Care and Research*, *62*(11), 1602–1611. doi:10.1002/acr.20267

Robert, S. A., Cherepanov, D. Palta, M., Cross Dunham, N., Feeny, D., & Fryback, D. G. (2009). Socioeconomic status and age variations in health-related quality of life: Results from the national health measurement study, *Journal of Gerontology*, *64B*(3), 378–389. doi:10.1093/geronb/gbp012

Robert, S. A., & Lee, K. Y. (2002). Explaining race differences in health among older adults, *Research on Aging*, *24*, 654–683. doi:10.1177/016402702237186

Robert, S. A., & Li, L. W. (2001). Age variation in the relationship between community socioeconomic status and adult health. *Research on Aging*, *23*, 234–259. doi:10.1177/0164027501232005

Robert, S. A., & Ruel, E. (2006). Racial segregation and health disparities between Black and White older adults. *Journal of Gerontology*, *61*, 203–211. Retrieved from http://psychsocgerontology.oxfordjournals.org/content/61/4/S203.full.pdf+html

Rodney, A. M., & Hill, P. S. (2014). Achieving equity within universal health coverage: A narrative review of progress and resources for measuring success, *International Journal for Equity in Health, 13*(72). Retrieved from http://www.equityhealthj.com /content/13/1/72

Roos, N., Fransoo, R., Carrière, K. C., Frohlich, N., Bogdanivic, B., Kirk, P., & Watanabe, M. (1997). Needs based planning: The case of Manitoba. *Canadian Medical Association Journal*. *157,* 1215–1221. Retrieved from http://www.cmaj.ca/content/157/9/1215.full .pdf+html

Rosenbaum, P. L., Livingston, M. H., Palisano, R. J., Gallupi, B. F., & Russell, D. J. (2007). Quality of life and health-related quality of life of adolescents with cerebral palsy. *Developmental Medicine and Child Neurology*, *49*(7), 516–521. doi:10.1111/j.1469-8749.2007.00516.x

Ross, N. A., Oliver, L. N., & Villeneuve, P. S. (2013). The contribution of neighbourhood material and social deprivation to survival: A 22-year follow-up of more than 500,000 Canadians, *International Journal of Environmental Research and Public Health, 10*, 1378–1391; doi:10.3390/ijerph10041378

Saffari, M., Meybodi, M. K. E., Ghanizadeh, G., & Koenig, H.G. (2014). Determinants of health status among patients with knee or hip osteoarthritis: The role of demographic, clinical and health related quality of life variables *Journal of Musculoskeletal Research*, *17*(1), 1450004–1450017. doi:10.1142/S0218957714500043

Saint-Jacques, N., Dewar, R., Cui, Y., Parker, L., & Dummer, T. J. (2014). Premature mortality due to social and material deprivation in Nova Scotia, Canada. *International Journal of Equity in Health*, *13*(94), 112. Retrieved from http://www.equityhealthj.com/content/13/1/94

Schuurman, N., Bell, N., Hameed, S. M., & Simons, R. A. (2008). Model for identifying and ranking need for trauma service in non-metropolitan regions based on injury risk and access to services. *Journal Trauma, 65*(1), 54–62.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi experimental designs and generalized causal inferrence*. Boston, MA: Houghton Mifflin.

Shim, J. K. (2010). Cultural health capital: A theoretical approach to understanding health care interactions and the dynamics of unequal treatment. *Journal of Health and Social Behavior, 51*, 1–15. doi:10.1177/0022146509361185

Silva-Ayçaques, L. Suárez-Gil, P. C., & Fernández-Somoano, A. (2010). The null hypothesis statistical testing in health sciences research (1995–2006): Statistical analysis and interpretation. *Biomedical Central Medical Research Methodology, 10*(44), 1–9. Retrieved from http://www.biomedcentral.com/1471-2288/10.44

Singh-Manoux, A., & Marmot, M. (2005). The role of socialization in explaining social inequalities in health. *Social Science and Medicine, 60*, 2129–2133. doi:10.1016/j.socscimed.2004.08.070

Smith, E. (2008). Using secondary data in social research. (2008) In H. Torrance (Ed.) *Conducting educational research* (pp. 1–100). Maidenhead UK: McGraw Hill. Retrieved from http://web.a.ebscohost.com

Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). London, UK: Sage.

Sprangers, M. A. J & Schwartz, C. E. (1999). Integrating response shift into health-related quality of life research: a theoretical model. *Social Science and Medicine, 48*(11), 1507–1515. Retrieved from Elsevier.

Statistics Canada. (2013). *Postal code conversion file reference guide*. Ottawa, ON: Government of Canada. Retrieved from http://www.statcan.gc.ca/pub/92-195-x/2011001/other-autre/pc-cp/pc-cp-eng.htm

Steele, C. M. (2010). *Whistling Vivaldi.* New York. NY: Norton and Comapany

Strand, V., & Khanna, D. (2010). The impact of rheumatoid arthritis and treatment on patients' lives. *Experimental Rheumatology, 28*(Suppl. 59), S32–S40. Retrieved from http://www.clinexprheumatol.org/abstract.asp?a=957

Sundmacher, L., Scheller-Kreinsen, D., & Busse, R. (2011). The wider determinants of inequalities in health: A decomposition analysis. *International Journal for Equity in Health, 10*(1), 30–42. doi:10.1186/1475-9276-10-30

Tabachnik, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). New Jersey, NY: Pearson.

Tabiasz- Adamczyk, B. (2013). The genesis of health: Evolution of the concept of health related quality of life. In K. Kawecka-Jaszcz, M. Klocek, B. Tobiasz-Adamczyk, & C. J. Bulpitt (Eds.), *Health related quality of life in patients with cardiovascular disease* (pp. 1–8). Milan, Italy: Springer.

Taillefer, M. C., Dupuis, G., Roberge, M., & LeMay, S. (2003). Health-related quality of life models: Systemic review of the literature. *Social Indicators Research, 64*, 293–323. Retrieved from the Proquest database.

Tang, S., Brown, A. J., Mussell. B., Smye, V. L., & Rodney, P. (2015). 'Underclassism' and access to health care in urban centres. *Sociology of Health and Illness, 37*(5), 1–17. doi:10.1111/1467-9566.12236

Terashima, M. (2011). *Geographical epidemiology of health and deprivation: A population-based, spatio-temporal analysis of health and social inequality in Nova Scotia, Canada* (Doctoral dissertation). Dalhousie University, Halifax, Canada.

Terwee, C., Bot, S., de Boer, M., van der Windt, D., Knol, D., . . . de Vet, H. (2007). Quality criteria were proposed for measurement properties of health status questionnaires. *Journal of Clinical Epidemiology, 60*, 34–42. doi:10.1016/j.jclinepi.2006.03.012

Townsend, P. (1987). Deprivation. *Journal of Social Policy, 16*(2), 125–146. doi:10.1017/S0047279400020341

Townsend, P., Davidson, P., & Whitehead M. (1988). *Inequalities in health*. London UK: Penguin.

Townsend, P., Phillimore, P., & Beattie, A. (1988). *Health and deprivation: Inequality and the North*. Kent, England: Croom Helm.

Tweddle, A., Battle, K., & Torjman, S. (2014). *Welfare in Canada 2013*. Caledon Institute of Social Policy, Caledon Institute. Retrieved from http //www.caledoninst.org/Publications /PDF/1057ENG.pdf

Ul-Haq, Z., Mackay, D., Fenwick, E., & Pell, J. P. (2013). Meta-analysis of the association between body mass index and health-related quality of life among adults, assessed by the SF-36. *Obesity, 2*(3), E322–E327. doi:10.1002/oby.20107

Veenstra, G. (2011). Race, gender, class, and sexual orientation: Intersecting axes of inequality and self-rated health in Canada. *International Journal for Equity in Health 10*(3), 1–2. Retrieved from http://www.equityhealthj.com/content/10/1/3

Vilagut, G., Forero, C. G., Pinto- Meza, A., Haro, J. P., de Graff, R., . . . Alonso, J. (2013). The mental component of the short-form 12 health survey (SF-12) as a measure of depressive disorders in the general population: Results with three alternative scoring methods. *Value in Health 16*(4), 564–573. doi:10.1016/j.jval.2013.01.006

Waller, G. (2015). Self-rated health in general practice: a plea for subjectivity. *British Journal of General Practice, 65*(632), 110–111. doi:10.3399/bjgp15X683833

Wang, L., & Hu, W. (2013). Immigrant health, place effect and regional disparities in Canada. *Social Science & Medicine, 98*, 8e17. doi:10.1016 /j .socscimed.2013.08.040

Wang, Y., Wluka, A. E., Simpson, J. A., Giles, G. G., Graves, S. E., de Steiger, R. N., & Cicuttini, F. M. (2013). Body weight at early and middle adulthood, weight gain and persistent overweight from early adulthood are predictors of the risk of total knee and hip replacement for osteoarthritis. *Rheumatology*, *52*(6), 1033–1041. doi:10.1093/rheumatology/kes419

Ware, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-item short-form health survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care*, *34*, 220–233. Retrieved from Pubmed.

Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item Short-Form Health Survey (SF-36): Conceptual framework and item selection. *Medical Care*, *30*(6), 473–483.

Webb, J., Schirato, T., & Danaher, G. (2002). *Understanding Bourdieu*. London, UK: Sage.

Webster, K. E., & Feller, J. A. (2016). Comparison of the short form-12 (SF-12) health status questionnaire with the SF-36 in patients with knee osteoarthritis who have replacement surgery. *Knee Surgery, Sports Traumatology, Arthroscopy,* 1–7. doi:10.1007/s00167-015-3904-1

Weiss, C. (2011). Frailty and chronic disease in older adults. *Clincial Geriatric Medicine, 27*, 39–25. doi:10.1016/j.cger.2010.08.003

White, H. L., Matheson, F. I., Moineddin, R., Dunn, J. R., & Glazier, R. H. (2010). Neighbourhood deprivation and regional inequalities in self-reported health among Canadians: Are we equally at risk? *Health & Place, 17*, 361–369. doi:10.1016/j.healthplace.2010.11.016

White, H. L., O'Campo, P., Moineddin, R., & Matheson, F. I. (2013). Modeling the cumulative effects of social exposures on health: Moving beyond disease-specific models. *International Journal of Environmental Research in Public Health*, *10*(4), 1186–1201. doi:10.3390/ijerph10041186

Whitehouse, S. L., Blom, A. W., Taylor, A. H., Pattison, G. T. R., & Bannister, G. L. (2005). The Oxford knee score: Problems and pitfalls. *The Knee, 12*, 287–291. doi:10.1016/j.knee.2004.11.005

Widdifield, J., Paterson, J. M., Bernatsky, S., Tu, K., Thorne, J. C., . . . Bombardier, C. (2014). Access to rheumatologists among patients with newly diagnosed rheumatoid arthritis in a Canadian universal pubic healthcare system, *British Medical Journal, 4*(1), 1–8. doi:10.1136/bmjopen-2013-003888

Wilkinson, R. (2005).*The impact of inequality: How to make sick societies healthier*. London, UK: Routledge.

Williams, S., Calnan, M., & Dolan, A. (2007). Explaining inequalities in health: Theoretical, conceptual and methodological agendas. In E. Dowler & N. Spencer (Eds.), *Challenging health inequalities from Acheson to 'choosing health*' (pp. 47–68). Bristol, UK: Policy Press.

World Health Organization. (1996). *WHOQOL-BREF: Introduction, administration, scoring and generic version of the assessment.* Retrieved from http://www.who.int/mental_health /media/en/76.pdf on

World Health Organzation. (1997). *WHOQOL measuring quality of life*. Retrieved from http:// www.who.int/mental_health/media/68.pdf

World Health Organization. (2007). *International classification of diseases* -10. Retrieved from http://www.who.int/classifications/apps/icd/icd10online/

World Health Organization. (2012). *Rio political declaration on social determinants of health*. World Conference on the Social Determinants of Health. Retrieved from http://www.who .int/SDhconference/declaration/Rio_political_declaration.pdf

Xie, F., Ye, H., Zhang, Y., Liu, X., Lei, T. & Li, S. C. (2011). Extension from inpatients to outpatients: Validity and reliability of the Oxford knee score in measuring health outcomes in patients with knee osteoarthritis. *International Journal of Rheumatic Diseases, 14*(2), 206–210. doi:10.1111/j.1756-185X.2010.01580.x

Yang, G., Boire, G., Hitchon, C. A., Thorne, J. C., Tin, D., Haraoui, B., . . . Zimmer, M. (2015). Does socioeconomic status affect outcomes in early inflammatory arthritis? Data from a Canadian multisite suspected rheumatoid arthritis inception cohort. *Journal of Rheumatology, 42*(1), 46–54. doi:10.3899/jrheum.131382

Yao, L., & Robert, S. (2008). The contributions of race, individual socioeconomic status, and neighbourhood socioeconomic context on the self-rated health trajectories and mortality of older adults. *Research on Ageing, 30*(2), 251–273. doi:10.1177/0164027507311155

Yen, I. H., Michael, Y. L., & Perdue, L. (2009). Neighborhood environments in studies of health of older adults: A systematic review. *American Journal of Preventive Medicine, 37*, 455–463. doi:10.1016/ j.amepre.2009.06.022

Yoon, E., & Doherty J. (2008). Arthritis pain. *Journal of Gerontological Social Work, 50*(Suppl.), 79–103. doi:10.1080/01634370802137819

Young, H., Grundy, E., O' Reilly, D., & Boyle, P. (2010, Spring). Self-rated health and mortality in the UK: Results from the first comparative analysis of the England and Wales, Scotland and Northern Ireland studies. *Population Trends*, *139*, 11–36. doi:10.1057/pt.2010.3

Appendix A: WRHA Joint Replacement Registry Patient Sheet and Consent Form

Winnipeg Regional Health Authority | Office régional de la santé de Winnipeg

WRHA Joint Replacement Registry

PATIENT INFORMATION SHEET AND CONSENT FORM

What is the Joint Replacement Registry (JRR)?

You can help your orthopaedic surgeon improve the quality of joint replacement surgeries in Manitoba. The Winnipeg Regional Health Authority (WRHA) has launched a registry to capture information on joint replacement surgery. This effort is supported by the orthopaedic surgeons in Manitoba.

The main purpose of the registry is to help orthopaedic surgeons in Manitoba gather information about joint replacements to improve patient outcomes. Specifically, the registry will provide information on particular implants, the most appropriate surgical methods, long-term outcomes and how adverse events might be minimized.

You Can Help Provide Important Information

We hope that you agree to participate in the Registry by signing the attached patient consent form. If you agree, information such as the type of implant used, the hospital in which the surgery was done and any treatments used to prevent infection of other types of complications will be collected and sent to the registry. We will also be forwarding your name, date of birth, sex, provincial health care number, patient chart number, admission and discharge dates to the Registry. The information is important to contact you in the future as a result of the knowledge gained through the Registry and so we can link your surgery data with your hospital stay data. The time frame to your actual surgery date is also very significant. Therefore these dates will be sent to the WRHA Joint Replacement Registry. Data from questionnaires will also be collected in in the registry.

Version 3 January 28, 2010

Additionally, we will ask you to complete health questionnaires before the operation and afterwards, on a yearly basis. Your answers to these questions will be stored in the WRHA registry, and will provide information on the effectiveness of joint replacement surgery.

Quality Improvement and Research

For quality improvement, research and statistical purposes, the type of implant, surgical technique and identifying information that is collected through the WRHA Registry will also be sent to the Canadian Joint Replacement Registry at the Canadian Institute for Health Information. This information may also be linked to other data sources in Manitoba, the Canadian Institute for Health Information, Statistics Canada, and Health Canada.

In addition to providing quality reports on joint replacement surgeries, the WRHA and Canadian Joint Replacement Registry data may be used in publications in scholarly journals or presentations at professional meetings. Names, addresses, or other identifiers will not be revealed in publications or presentations and patient's confidentiality will be protected. All the information in the Registries will be maintained in a secure setting that can only be accessed by authorized members of the WRHA Joint Replacement Registry and the Canadian Institute for Health Information. You may keep this information sheet for your records. Your choice to participate in these registries will not affect the treatment you receive. You may revoke this consent at any time by contacting the Orthopaedic Coordinator.

If you have any questions about these Joint Replacement Registries, please call the Orthopaedic Coordinator. At 1-866-849-3517.

About the Canadian Institute for Health Information (CIHI)

The Canadian Institute for Health Information is an independent national, not-for-profit organization responsible for coordinating the development and maintenance of a comprehensive and integrated approach to health information. To this end, CIHI provides accurate and timely information that is needed to establish sound health policies, manage the Canadian health system effectively and create public awareness of the factors affecting good health. CIHI was established in 1994 by Canada's health ministers.

About Statistics Canada

Statistics Canada is authorized under the Statistics Act to collect, compile, analyze, abstract and publish statistics related to the health and well-being of Canadians. The Health Statistics Division's primary objective is to provide statistical information and analysis about the health of the population, determinants of health, and the scope of utilization of Canada's health care sector.

Version 3 January 28, 2010

Winnipeg Regional Health Authority
Office régional de la santé de Winnipeg

JOINT REPLACEMENT REGISTRY CONSENT FORM SIGNATURE PAGE

I have read this form and/or had it explained to me by my orthopaedic surgeon or his/her delegate. I understand the reasons for the WRHA and Canadian Joint Replacement Registries and what they hope to achieve in terms of quality improvement and research into joint replacement surgery as described in the information sheet.

I agree to allow the following information to be submitted to the WRHA Joint Replacement Registry (JRR) at the time of surgery: my name, address, sex, date of birth, provincial health care number, the type of implant used, information on my general health, information about my procedure and treatments used to prevent complications, and information from the questionnaires. I understand that I may be contacted after my surgery in regards to my progress and that WRHA JRR will send me questionnaires to complete and return. I understand that my medical information may be reviewed for the purpose of contacting me to participate in other research. I also understand that I may withdraw my permission at any time as outlined in the information sheet.

I understand that most of this information will also be given to the Canadian Joint Replacement Registry (CJRR) that is managed by the Canadian Institute of Health Information. I also understand that I may withdraw my permission at any time as outlined in the information sheet.

Patient Last Name (Please Print)

Patient First Name (Please Print)

Patient Signature____________________ __ __ / __ __ / __ __ __ __

D D M M Y Y Y Y

Version 3 January 28, 2010

Winnipeg Regional Health Authority   Office régional de la santé de Winnipeg

WRHA
Joint Replacement Registry

Problems with your Hip

During the past 4 weeks...

✓ tick **one** box for **every** question.

Today's Date

Day Month Year

1. During the past 4 weeks.......
How would you describe the pain you **usually** had from your hip?

○ None ○ Very Mild ○ Mild ○ Moderate ○ Severe

2. During the past 4 weeks.......
Have you had any trouble with washing and drying yourself (all over) **because of your hip**?

○ No trouble at all ○ Very little trouble ○ Moderate Trouble ○ Extreme Difficulty ○ Impossible to do so

3. During the past 4 weeks.......
Have you had any trouble getting in and out of a car or using public transport (whichever you tend to use) **because of your hip**?

○ No trouble at all ○ Very little trouble ○ Moderate Trouble ○ Extreme Difficulty ○ Impossible to do so

4. During the past 4 weeks.......
Have you been able to put on a pair of socks, stockings or tights?

○ Yes, Easily ○ With Little Difficulty ○ With Moderate Difficult ○ With Extreme Difficulty ○ No, Impossible

5. During the past 4 weeks.......
Could you do household shopping **on your own**?

○ Yes, Easily ○ With Little Difficulty ○ With Moderate Difficult ○ With Extreme Difficulty ○ No, Impossible

Version 1 June 24, 2004

Note: Oxford Hip Score – Activity and Participation (OKS-APQ), © Isis Innovation Ltd. Reproduced with permission.

Winnipeg Regional Health Authority Office régional de la santé de Winnipeg

WRHA
Joint Replacement Registry

Problems with your Knee

During the past 4 weeks...

✓ tick **one** box for **every** question.

Today's Date

Day Month Year

1. During the past 4 weeks.......
How would you describe the pain you **usually** had from your knee?

○ None	○ Very Mild	○ Mild	○ Moderate	○ Severe

2. During the past 4 weeks.......
Have you had any trouble with washing and drying yourself (all over) **because of your knee**?

○ No trouble at all	○ Very little trouble	○ Moderate Trouble	○ Extreme Difficulty	○ Impossible to do so

3. During the past 4 weeks.......
Have you had any trouble getting in and out of a car or using public transport (whichever you tend to use) **because of your knee**?

○ No trouble at all	○ Very little trouble	○ Moderate Trouble	○ Extreme Difficulty	○ Impossible to do so

4. During the past 4 weeks.......
For how long have you been able to walk before **pain from your knee** becomes severe? (with or without a cane)

○ No pain / More than 30 minutes	○ 16 - 30 minutes	○ 5 - 15 minutes	○ Around the house only	○ Not at all - pain severe on walking

5. During the past 4 weeks.......
After a meal (sat at a table), how painful has it been for you to stand up from a chair **because of your knee**?

○ Not at all painful	○ Slightly painful	○ Moderately painful	○ Very painful	○ Unbearable

Version 1 June 24, 2004

Note: Oxford Knee Score – Activity and Participation (OKS-APQ), © Isis Innovation Ltd. Reproduced with permission.

Winnipeg Regional Health Authority Office régional de la santé de Winnipeg

WRHA Joint Replacement Registry

Medical History

Your Gender	What is your weight?	What is your height?	Today's Date
◯ MALE	______ POUNDS or	______ FEET/INCHES or	______
◯ FEMALE	______ KILOGRAMS	______ CM	Day Month Year

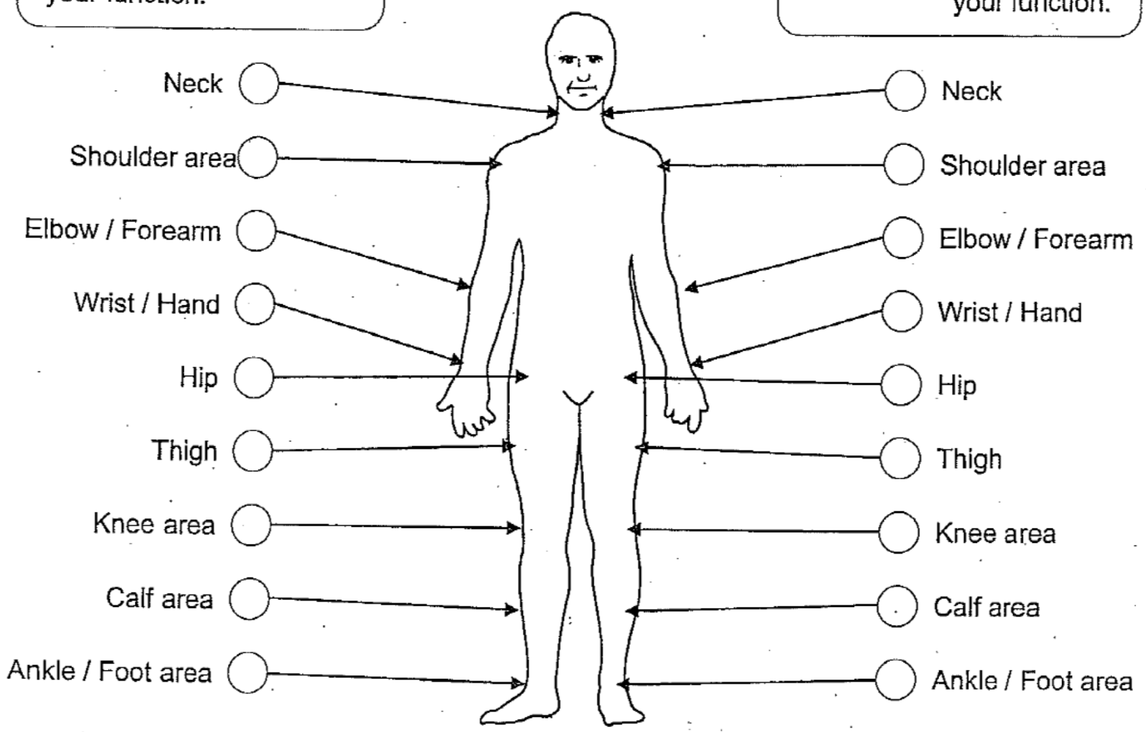
Place a check mark in the box **if you have** the condition.		**If you have** the condition, does it limit any of your activities?	
Heart Disease	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
High Blood Pressure	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Lung Disease	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Diabetes	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Ulcer or Stomach Disease	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Kidney Disease	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Liver Disease	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Anemia or Other Blood Disease	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Cancer	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Depression	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Osteoarthritis or DegenerativeArthritis **other than your hip or knee**	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Back Pain	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Rheumatoid Arthritis	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities
Other Medical Problem Please specify:______	◯ **YES** I have this condition	◯ **YES** it limits my activities	◯ It does **NOT** limit my activities

◯ I **do not have** any of the medical conditions listed above.

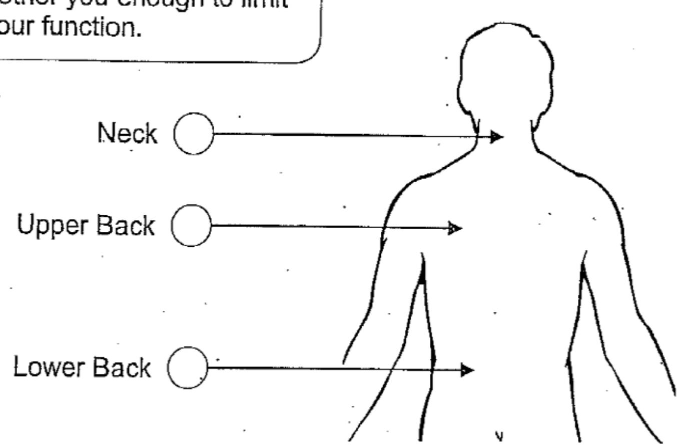
Version 1 June 24, 2004

For your **right side** please indicate those areas that bother you enough to limit your function.

For your **left side** please indicate those areas that bother you enough to limit your function.



For your **back** please indicate those areas that bother you enough to limit your function.



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

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Accomplished less than you would like	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b Were limited in the kind of work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

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

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Accomplished less than you would like	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b Did work or other activities less carefully than usual	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

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

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

6. These questions are about how you feel and how things have been with you <u>during the past 4 weeks</u>. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the <u>past 4 weeks</u>...

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Have you felt calm and peaceful?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b Did you have a lot of energy?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Have you felt downhearted and depressed?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

7. During the <u>past 4 weeks</u>, how much of the time has your <u>physical health or emotional problems</u> interfered with your social activities (like visiting with friends, relatives, etc.)?

All of the time	Most of the time	Some of the time	A little of the time	None of the time
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Thank you for completing these questions!

Correspondence A1: Email correspondence from University of Manitoba Psychology /Sociology Research Ethics Ethics Board

Good morning Nora,

RE: PhD Thesis: The Impact of Neighbourhood Deprivation on Health Related Quality of Life in a Population with Advanced Arthritis

Dr. Vorauer has reviewed your request and has agreed that this research does not require PSREB approval.

Good luck with your research!

Laurine Harmon (for)
Margaret (Maggie) Bowman
Human Ethics Coordinator
Office of the Vice-President (Research), University of Manitoba
208 – 194 Dafoe Road
Crop Technology Centre
204-474-7122 tel
204-269-7173 fax
e-mail: Margaret.Bowman@ad.umanitoba.ca
www.umanitoba.ca/research
"Bringing Research to Life"

Appendix B: Multiple Correlation and Variance Porportion Condition Index and other Additional Tables Including Forward Sortation Groupings B: Colinearity Diagnostics and

ANOVA Table B1

MCS: Multicolinearity Diagnostics: Squared Multiple Correlations, Variance Proportion Condition Index for All Variable MCS

Variable	SMC	Variance proportion condition index
Age	.003	**12**
BMI	.002	9.72
OKS	.111	9.8
Gender	.017	2.63
Coexisting condition now	.018	2.96
Condition history	.03	1.89
DepindexM	.003	.09
DepindexS	.007	.12

Note. *N* = 10,427; SMC = squared multiple correlations.

Table B2

PCS: Multicolinearity Diagnostics: Squared Multiple Correlations, Variance Proportion Condition Index for All Variable MCS

Variable	SMC	Variance proportion condition index
Age	.06	**12**
BMI	.014	9.72
OKS	.26	9.18
Gender	.01	2.67
Condition now	.02	1.00
Condition history	.01	.99
DepindexM	.00	4.62
DepindexS	.00	4.12
MCS	.02	8.72

Note. *N* = 10,427; SMC = squared multiple correlations.

Table B3

Forward Sortation Grouping

Forward sort *(combined with another area)*	Frequency	Location
(P0T)	(2)	Ignace area, ON, combined with POV
P0V	26	Ear Falls area, ON
P0W	19	Emo, ON
P0X	27	Keewatin area, ON
(P0Y)	(3)	Ingolf, ON, combined with POX
(P6A)	(1)	Sault Ste. Marie, ON, combined with P8N
(P7B)	(4)	Thunder Bay, ON, combined with P8N
P8N	7	Dryden, ON
(P8T)	(9)	Sioux Lookout, ON, combined with Ear Falls POV
P9A	17	Fort Frances, ON
P9N	71	Kenora, ON
R0A	286	Niverville, MB
R0B	125	Berens River, MB
R0C	586	Arbourg, MB
R0E	532	Anola, MB
R0G	461	Elm Creek, MB
R0H	122	Alonsa, MB
R0J	227	Sandy Lake, MB
R0K	248	Alexander Rivers, MB
R0L	258	Roblin, MB
R0M	148	Hamiota, MB
(R1A)	(7)	Selkirk, MB, combined with R1N
R1L	(3)	Lockport, MB, combined with R0K
R1N	*129*	Portage la Prairie, MB
R2C	333	Transcona, Winnipeg, MB
R2E	106	East St. Paul, Winnipeg, MB
R2G	385	North Kildonan area, Winnipeg, MB
R2H	128	Norwoor, St. Boniface area, Winnipeg, MB
R2J	263	Windsor Park, Winnipeg, MB

(continued)

Table B3 (continued)

Forward sort *(combined with another area)*	Frequency	Location
R2K	338	Elmwood, Winnipeg, MB
R2L	95	St. Vital, Rowandale, Winnipeg, MB
R2M	399	St. Vital, Winnipeg, MB
R2N	218	River Park South, Winnipeg, MB
R2P	192	Maples, Winnipeg, MB
R2R	67	Garden City, Winnipeg, MB
R2V	322	North End Winnipeg, MB
R2W	141	North End McAdam area, Winnipeg, MB
R2X	115	Downtown, Winnipeg, MB
R2Y	282	Crestview, Winnipeg, MB
R3A	14	Central Winnipeg, Winnipeg, MB
R3B	41	China Town- Higgins, Winnipeg, MB
R3C	128	Central, Forks area, Winnipeg, MB
R3E	76	Sargent Park, Winnipeg, MB
R3G	146	West end, St. Mathews, Winnipeg, MB
(R3H)	*(3)*	St. Mathews Ave., Winnipeg, MB, combined with R2G
R3J	318	St. James, SW, Winnipeg, MB
R3K	163	St. James SE, Winnipeg, MB
R3L	164	River Heights East, Winnipeg, MB
R3M	178	Crescentwood Central, Winnipeg, MB
R3N	143	River Heights West, Winnipeg, MB
R3P	204	Fort Gary NW, Tuxedo, Winnipeg, MB
R3R	307	Assiniboine South, Winnipeg, MB
R3S	7	Wilkes South, Winnipeg, MB
R3T	415	Fort Gary University of Manitoba, Winnipeg, MB
R3V	50	Fort Gary South, Winnipeg, MB
R3W	51	Grassie, Peguis, Winnipeg, MB
R3X	74	St. Boniface/ St. Vital, Winnipeg, MB
R3Y	48	Fort Gary West, Winnipeg, MB
R4A	27	West St. Paul, MB
R4H	12	Headingly East, MB
R4J	14	Headingly West, MB

(continued)

Table B3 (continued)

Forward sort *(combined with another area)*	Frequency	Location
(R4K)	(10)	Cartier, MB, combined with R5A
(R4L)	(14)	St. Francois, Xavier, MB, combined with R4J
R5A	32	St. Adophe, MB
R5G	120	Steinbach, MB
R5H	76	St. Anne, MB
R6M	291	Morden, MB
R6W	99	Winkler, MB
R7A	91	Brandon East, MB
R7B	93	Brandon South, MB
R7C	11	Brandon Northwest, MB
R7N	115	Dauphin, MB
R8A	73	Flin Flon, MB
R8N	56	Thompson, MB
R9A	67	The Pas, MB
S0A	24	Esterhazy-Yorkton area, SK
S0C	10	Southeastern rural area, SK
S0G	14	South central rural area SK
(S0P)	(7)	Creighton area, SK, combined with SOA
X0A	12	Qikiqtaaluk region, NU
X0C	49	Kivalliq Region Baker Lake area, NU

Table B4

ANOVA Between and Within Group Variance of MCS and PCS for Deprivation Indices

Indices	*DF*	*F*	N^2	*p*
MCS- DepindexM	10426	8.44*	*.003*	.000
PCS- DepindexM	10426	3.02	*.001*	.017
MCS- DepindexS	10426	18.71*	*.007*	.000
PCS- DepindexS	10426	2.80	*.001*	.024

Note. N = 10,427.
*Significant p < = .001

Table B5

ANOVA Between and Within Group Variance in PCS and MCS for Level 2 and Level 3

Indices	*DF*	*F*	N^2	*p*
MCS Level 2	10426	1.21	.03	.017
MCS Level 3	10426	2.10*	.01	.000
PCS Level 2	10426	1.31*	.03	.001
PCS Level 3	10426	2.10*	.01	.000

Note. *N* = 10,427.
*Significant *p* < = .001

Appendix C: Comparison of Complete Values and Missing Values Estimated

Table C1

MCS: Comparison of Complete Data and Missing Values Estimated Data

Parameter	Null model estimates	Parsimonious model	Null model large file	Parsimonious model large file
		Fixed effects		
Intercept	51.14* (.25) [50.64-51.64]	51.26* (.17) [50.92 – 51.96]	51.29* (.24) [50.81-51.76]	51.40* (.18) [51.09 - 51.76]
Age		.07* (.01) [.05-.09]		.07* (.01) [.05-.09]
OKS		-.38* (.01) [-.40--.35]		-.38* (.01) [-.40 - -.36]
Gender		-1.58* (.22) [-2.02- .1.13]		-1.69* (.20) [-2.09- -.1.28]
Coexisting condition		-.96* (.25) [-1.45- -.46]		-.88* (.23) [-1.35- -.36]
Condition history		-3.25* (.27) [-3.78- -2.72]		-3.13 * (.26) [-3.67 - 2.59]
DepindexM		-.32* (.09) [-.51- -.13]		-.22+ (.08) [-.37 - -.07]
DepindexS		-.38* (.09) [-.55- -.21]		-.29* (. 08) [-.45- -. 12]
		Random parameters		
Residual	128.07* (1.94) [124.32- 131.94]	113.40 * (1.98) [109.57 -117.36]	136.56* (2.02) [132.46- 140.66]	119.54* (1.6) [116.20- 122.88]
Intercept/ forward sort	2.34* (.71) [1.29-.22]	.57 (.31) [.05- 1.63]	1.73* (.51) [.73-2.73]	.53 (.26) [.02 - 1.04]
Forward sort•full postal code	13.92* (2) [10.50-18.45]	**10.09* (1.63)** **[7.35- 13.85]**	8.78* (1.50) [5.75- 11.79]	**5.75* (1.22)** **[3.29- 8.20]**
AIC	81170.735	79726.212	13,2043.803/ 13, 1941.878/ 13, 1912.308	12,4354.954 / 12,4298.201/ 12,4152.437
-2 LL	81162.735	79705.212	132035.803/ 131941.878/ 13, 1904.308	12,4332.954 / 12,4276,201 / 12,4150.437
Number of parameters	4	11	4	11

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. Complete data is N = 10,427; missing values estimated data is N = 16,902; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood. * $p \leq$ 001, + $p \leq$ 05.

As with the MCS, all of the parameter estimates for the fixed effects are within the confidence intervals of the larger file. Each of the estimates for the random effects for the complete data set was within the confidence intervals of the original data set (see Table C2).

Table C2

MCS Pearson's R Partial Correlations With Deprivation Indices, Controlling for Age, Gender, and BMI

Variable	DepindexM	DepindexS
MCS	-.05*	-.08*
Controlling for age	-.05*	-.08*
Controlling for age group	-.05*	-.08*
Controlling for BMI	-.05*	-.08*
Controlling for BMI group	-.05*	-.08*
Controlling for gender	-.05*	**-.07***

Note. N = 10,424.
*p < .001

Table C3

PCS, Comparison of Complete Data and Missing Values Estimated Data

Parameter	Null model complete data	Parsimonious model	Null model missing estimated file	Parsimonious model missing estimated large file
Fixed effects				
Intercept	29.06* (.12) [28.82-29.30]	29.04* (.09) [28.85-29.23]	29.38* (.10) [29.18- 29.58]	29.36* (.08) [29.19 - 29.52]
Age		-.05* (.01) [-.07- -.04]		-.06* (.01) [-.07- -.05]
BMI		-.11* (.01) [-.13- -.09]		-.11* (.01) [-.15 - -.07]
OKS		-.46* (.01) [-.47- -.44]		-.45* (.01) [-.46- -.43]
Coexisting condition		-1.22* (.16) [-1.53- -.91]		-1.08* (.13)* [-1.34- -.82]
Condition history		-.36 +(.17) [-.69- - .02]		-.52+ (.16) [-.86- -.18]
DepindexS		.12+ (.05) [.02-.23]		.11+ (.05+ [.01-.23]
Gender•DepindexM		.26+ (.10) [.06 - .45]		.21+ (.09)+ [.04 - .40]
BMI•DepindexS		.02+ (.01) [.01 - .03]		.01 (.01) [.00 - .03]
Random parameters				
Residual		46.77* (.82) [45.20 – 48.40]	67.27* (1.04) [65.08 - 69.45]	48.15* (.67) [46.83- 49.47]
Intercept/ forward sort	.30 (15) [.11 - .82]	.12 (.09) [.03 - .49]	.24 (.12) [.01-.46]	1.42 (.37) [-.09 - .32]
Forward sort•full postal code	4.00* (.9)	2.56* (.62) [1.59-.4.12]	3.49* (.87) [1.51 – 5.46]	1.76 +(.53) [.60 – 2.92]
AIC	7,3609.092	7,0209.070	11,9831.743/ 12,0010.425/ 11,9769.720	10,9383.534/ 10,9454.079/ 109214.199
-2 LL	7,3601.092	70195.070	11,9831.743/ 12,0002.425/ 11,9769.720	10,9361.534/ 10,9432.079/ 10,9192.199
Number of parameters	4	12	4	12

Note. Standard errors are in parentheses; 95% confidence intervals are in square brackets. N = 16,902; AIC = Akaike Information Criterion; -2 LL = minus 2 log likelihood; • = interaction between variables.
* $p \leq$ 001, + $p \leq$ 05.

Table C4
PCS Pearson's R Partial Correlations with Deprivation Indices controlling for Age, Gender, and BMI

Variable	DepindexM	DepindexS
PCS	-.03+	.00
Controlling for age	-.03+	.01
Controlling for age group	-.03+	.01
Controlling for BMI	**-.02**	.01
Controlling for BMI group	**-.02**	.01
Controlling for gender	-.03+	.01

Note. N = 10,427.
**p* < .001

For the MCS there was an impact on the relationship between MCS and social deprivation when controlling for gender. When gender was controlled, the relationship between social deprivation and MCS was stronger, moving from r (10,245) = -.08, $p < .001$ to r (10,245) = - .07, $p < .001$. The relationship remained significant and the correlation for this and the other variables. For the PCS, there was a change in the strength of the correlation between PCS and material deprivation when controlling for body weight from r (10,425) = - .03, $p < .001$ to r (10,425) = - - .02, p = ns. and for BMI group 2 (10,425) = -1.02, p = ns. indicating that the relationship between material deprivation and PCS is stronger when accounting for BMI.

Appendix D: Letter From Director of Hip and Knee Registry

Concordia JOINT REPLACEMENT GROUP
Suite 301-1155 Concordia Avenue
Winnipeg, MB R2K 2M9
T +1 (204) 926-1212
F +1 (204) 231-1432
www.cjrg.ca

Concordia HIP & KNEE INSTITUTE
UNIVERSITY OF MANITOBA

January 8, 2016

Hi Nora,

It is safe to assume that all those receiving total knee replacement surgery had advanced arthritis (arising from osteoarthritis, rheumatoid arthritis, post traumatic arthritis, etc).

As for hip replacement surgery, those receiving a partial hip replacement would have (in almost all instances) received surgery for acute hip fracture in the emergency (i.e. Non elective) setting.

Any patient that has either pre or post-operative PROMS (oxford 12, SF-12, satisfaction) would have undergone elective hip replacement surgery for advanced arthritis (for similar causes to total knee replacement).

Regards,

Eric