THE EFFECTS OF PHYSICAL AND MENTAL HEALTH STATUS ON FUTURE LIVING ARRANGEMENTS OF MIDDLE-AGED AND OLDER CANADIANS - A LONGITUDINAL ANALYSIS

by

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This thesis is dedicated to John, who held the fort, and to Tatiana and Mercedes, who were and are amazing.

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ABSTRACT

Canada's population is aging rapidly, and understanding living arrangements and their determinants plays a critical role in supporting healthy aging. This thesis examined, using a population-based longitudinal survey, the Canadian Multicentre Osteoporosis Study, the effects of clinically-significant change in physical and mental health on future living arrangements, employing generalized estimating equations logistic regression models. Clinically-significant decline in SF-36 Physical Component Score (PCS) increased likelihood of not remaining community-dwelling, or "aging in place" over stable or improved scores by 41%. SF-36 Mental Component Score (MCS) did not show a statistically significant effect on aging in place. Older age and employment status of retired or unemployed increased likelihood of not aging in place, whereas living with a partner, pursuing moderate or vigorous physical activity, and having children increased the likelihood of aging in place. Study findings will inform social and health policy development to support aging in place in Canada and elsewhere.

LIST OF ABBREVIATIONS USED

CaMos	Canadian Multicentre Osteoporosis Study
GEE	generalized estimating equations
HRQOL	Health-related Quality of Life
MCS	Mental Component Score (SF-36)
OR	odds ratio
PCS	Physical Component Score (SF-36)
SF-36	Medical Outcomes Study (MOS) Short Form (SF-36) Questionnaire

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CHAPTER 1 INTRODUCTION

Similar to many industrialised nations, Canada is facing an aging population as the 'baby boomer' generation enter their senior years.[1-4] In 2011, 14.8% of Canadians were aged 65 years or older.[5] By 2025 more than 20% of Canadians are projected to be over the age of 65,[6] and seniors over 80 years of age (sometimes referred to as the elderly or oldest old) are the fastest-growing segment of the Canadian population.[4] How to support quality of life into these extended years is a growing health and social policy concern.[7-15]

The United Nations has identified living arrangements of older people as a critical worldwide issue.[16] The term "living arrangements" is used broadly in the literature to refer to dwelling type, cohabitants, and/or geographical location, but in the context of aging-related policy generally refers to dwelling type.[17, 18] In western nations such as Canada, adults prefer to remain living in their own homes in the community as they age, which is often referred to as "aging in place."[11, 15, 19-22] Aging in place is considered a key aspect of aging well.[17, 22-24] Canada, as a signatory to the 2002 International Plan of Action on Ageing, has committed to supporting independent living for its older citizens.[25] Understanding the factors that support and detract from aging in place is thus an important and timely topic to explore.[22, 24, 26-28]

Successful aging in place occurs when an individual is able to remain in their own home by adapting to increased needs for support or safety that may arise. The benefits accrued from remaining in familiar physical and social environments include: personal sense of well-being, self-determination, control, identity and independence; privacy; a personally-tailored environment; comfort and familiarity; and social connectedness and

social network stability.[11, 20-24, 28-39] In addition, living arrangements of older adults are important determinants of the need for and use of informal and formal community-based and institutional care as people age.[8, 11, 21-23, 36, 40-42]

Ability to age in place is influenced by a large number of factors including demographics, socioeconomics and social networks.[4, 8, 12, 15, 18, 22-24, 28, 36, 40, 42-51] Although health is recognised as key to maintaining autonomy and independence overall, its direct role in influencing aging in place is not yet fully explored.[23, 24, 28, 36, 49, 52] This gap is partly due to the literature tending to examine health as an outcome of living arrangements (institutionalisation, in particular) rather than a precursor.[12, 15, 31, 38, 53, 54] In addition, the few examinations (to date) of health as a precursor have been focused on one or two specific measures of health rather than investigating health as a holistic, multi-dimensional construct.[12, 23, 28, 48, 52, 55] In particular, roles played in aging in place by the two overarching physical and mental domains of health remain unanswered.[23, 25, 28, 52, 56-58]

This thesis explored, in a population-based sample of middle-aged and older Canadians, the relationship between health and aging in place. I first examined the current literature on living arrangements and aging in place to identify what is known and what is not known about the role of health in aging in place. Building on that literature, I then specifically examined the relationship of clinically-significant changes in physical and mental dimensions of health-related quality of life (HRQOL) on aging in place over ten years. Health as a multi-dimensional construct was captured with the Medical Outcomes Study Short Form Health Survey (SF-36), an HRQOL instrument that measures eight domains of health and generates population-standardised summary

measures of overall physical and mental health status. Living arrangements were captured as a dichotomous construct: dwelling in standard or in aging-specific housing.

This thesis is organized into 4 chapters. Chapter 2 contains the background, rationale, and objectives for the study. Chapter 3 is a stand-alone manuscript prepared for submission to a peer-reviewed academic journal. The manuscript summarises material covered in more detail in Chapter 2 and details the thesis study methods, results and discussion. Chapter 4 concludes the thesis with a brief discussion of the main findings, followed by a brief reflection on what I learned about aging and living arrangements during my thesis research, and how it changed my perspectives. The body of the thesis is followed by the full bibliography of references used throughout the thesis.

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CHAPTER 2 BACKGROUND and RATIONALE

The literature on living arrangements among older persons is diverse, and is found in the discourse of gerontology, healthy aging, aging in place, determinants of living arrangements, determinants of institutionalisation, late life migration, and others. Living arrangements is a term that is used, often interchangeably, in the literature to refer to dwelling type, cohabitants, and/or geographical location. In the context of aging in place, investigations about living arrangements generally explore dwelling type, whether living in the community or in institutions.[1-5] Statistics Canada national figures from the 2006 census indicate that most senior Canadians, 91% of women and 95% of men, were community-dwelling.[6] Very few adults under 65 were institutionalised. After age 65, the proportion of seniors living in institutions approximately doubled for each five year increment of additional age. These proportions remained quite low for both men and women through their sixties and seventies (2.4% or fewer living in institutions), but increased to 13% for women and 8.4% for men in their early eighties. By age 85 and older, one third (32%) of senior women and one-fifth of senior men (21%) were living in institutions.[6]

2.1 DETERMINANTS OF LIVING ARRANGEMENTS

A large number of factors appear to have an effect on living arrangements for older adults. Demographic characteristics such as sex, age, and marital status seem to be particularly important—being male, younger or married appear to best support aging in place.[6-18] Socioeconomic factors measured by income, education, and employment status

determine means and capacity for modifying the home environment to cope with changing functions and needs.[2, 9, 10, 19, 20] Cohabitants appear to be indicators of built-in support capacity,[6, 7, 9, 15-17, 21, 22] while social networks can be indicators of the potential for a wider support system,[2, 9, 11, 17, 22-25] both of which facilitate aging in place.

Although health is recognised as a critical factor in maintaining personal autonomy and independence, one key gap in the determinants of aging in place literature is an understanding of the direct association between overall health status and ability to age in place.[10, 11, 13, 15, 21, 26] Living arrangements play a dual role as both a precursor and consequence of health. However, to date, research has primarily focused on the role of living arrangements in influencing health, rather than the reverse.[14, 22, 27-30] The literature that examines the physical health outcomes associated with living arrangements indicates that remaining in housing beyond a person's capability to function independently in that dwelling may pose a wide spectrum of increased risks for serious health outcomes such as falls.[22, 30, 31] Research has also shown the effects of living arrangements on mental health (depression, in particular) in various aging populations.[14, 32-36] For example, living alone or with non-partner cohabitants is a significant predictor of depression, loneliness, and pain.[14, 31, 32, 35]

In contrast, a small but increasing number of studies are beginning to examine precursor effects of health on living arrangements. Declining health has effects on future living arrangements in both direct and indirect ways, as we see in situations where adult children or others must provide general or specialised in-home support in the face of declining health in order for their parent(s) to continue aging in place. Or declining health may trigger changing households to aging-specific living arrangement solutions

such as moving in with children who can provide care, hospitalisation, a stay in a nursing home, or permanent institutionalisation.[10, 11, 15] Given the apparently reciprocal relationship between health and living arrangements, and the increased personal and Canadian social policy emphasis on aging in place, it is vital to learn more about how health directly impacts future living arrangements.[11, 26, 37]

2.2 Conceptual framework of determinants

It is useful to utilise a conceptual framework in attempting to understand this rich literature. While the literature offers a number of frameworks that examine the determinants of living arrangements for older adults,[11, 15, 26, 37, 38] it is noteworthy that most ignore temporality and are therefore unable to examine change. Others focus on some determinants but do not include health at all, or else focus on single aspects of health without capturing the multi-dimensional nature of health. One literature that perhaps comes closest to investigating this complex relationship is late life migration. Late life migration may mean changes in cohabitation, dwelling type, and/or geographical location. In this literature, changing health, both improvements and declines, is seen as one of many factors that may influence decisions to change living arrangements.[11, 39, 40]

Two major theoretical frameworks of late life migration touch upon the relationship of health and future living arrangements. The later-life migration framework published in 1987 by Litwak and Longino[41] provides a useful and widely-supported developmental or later lifecourse typology for classifying three different types of potential moves during later life. Firstly, "amenity moves" are made around retirement

age based on a desire for improved recreation and lifestyle amenities suitable for retirement. These moves are generally restricted to those with sufficient financial means and good health. The second "moderate disability moves" occur when older adults begin to experience some form of chronic health conditions and proactively relocate to be closer to family members who can provide support. The third "institutionalisation moves" occur when health declines to the point that informal and home-based caregivers are no longer able to provide appropriate care and the individuals move into a nursing home.[42-44] While the Litwak and Longino lifecourse framework is useful for understanding the potential development of ongoing and changing motivations for moving in later life on a wider scale, these three typologies are very broad. Not all people will move, and not all who move will experience all three types of moves.[42, 43, 45] In addition, this framework does not include the precursor group of later middle-aged people, for whom employment opportunities are generally the dominant reason for relocation, often with an eye to also moving to a desirable future retirement location in the process.[45] Nor does this literature investigate the effects of health on living arrangements in any detail.

The second late life migration framework involves investigating reason-for-moving typologies in more detail within the context of "goodness of fit" between personal needs and what is available in one's environment.[11, 23] The framework posits that the main motivating factors for later life migration include: health, affiliation, economic security, comfort, functional independence, and family crisis.[42, 46] Examples of motivations include wishing to live in a smaller home after children have left, wanting to purchase or build a new home, wanting to be closer to children or grandchildren, moving

to a better neighbourhood or climate, declining health raising concerns about ability to maintain a home, increasing disability requiring infrastructure supports not currently available in the home, a move closer to supportive social networks, or wanting more convenient access to leisure and recreation opportunities.[17, 23, 42, 45] The complexity and interactivity of possible factors means that outcomes are not always intuitive. For example, in two Canadian studies widowhood was associated with a lower chance of moving, and the vast majority of later-life migration moves were found to be multi-person households changing private dwellings rather than individuals becoming institutionalised.[17, 45] Others utilising the goodness of fit framework attempt to understand the effects of these decision factors on late life migration by categorising them as a either "push" or "pull" factors.[11] "Push" factors are those that cause consideration of a move. For example, loss of mobility from a series of falls may mean consideration of a move to a single-floor home or a transition from living in one's own home to an institution. "Pull" factors are those that make a potential destination attractive. For example, the opportunity to move to a warmer climate may be attractive to someone developing arthritis that is aggravated by cold temperatures. However, as with the Litwak and Longino lifecourse typology above, these migration motivation typologies address health only in general terms. Although it is logical that health is likely an important factor in later-life migration, the way in which health has been captured is not specific or comprehensive, and the nature of the relationship between health and future living arrangements remains unclear.[4, 42]

Drawing on useful elements from the typologies discussed above, the following framework (Figure 1) augments previous research as a way to understand the relationship

between health and future living arrangements. I conceptualise that future living arrangements are a function of the interactions between a large number of factors or determinants over time. I focus on the role of overall health as captured in measuring health-related quality of life (both physical and mental health domains) while including measures of specific aspects of health including long-term health conditions, acute health events, and such health-affecting behaviours as physical activity and smoking. To inform the relationship between health and future living arrangements, the framework incorporates other factors identified in the literature as determinants of living arrangements including: demographic and socioeconomic characteristics, cohabitants, and social networks.

2.3 HEALTH AND LIVING ARRANGEMENTS

To date, studies investigating the effects of health on living arrangements in pre-seniors, seniors, and the very elderly have generally focused on functional status.[11, 15, 20, 26] Other ways in which health has been assessed as a determinant of living arrangements include burden of chronic health conditions, acute health events, health behaviours, depression, and cognitive function.[4, 10, 11, 14, 15, 19, 26, 31, 42, 47, 48]

2.3.1 Long term health conditions

There is growing evidence of a trend to increased burden of disability in young seniors and older middle-aged adults, particularly from musculoskeletal conditions, diabetes, depression and anxiety, nervous system conditions, and obesity, which may begin to impact future aging in place starting at a much younger age.[13, 49-51] In Canada,

the rates of long-term disabilities in the population begin to increase markedly once adults enter the 45 to 54 year age range, virtually doubling rates over the age 35-44 range from 7.4% in women and 6.6% in men to 14.3% in women and 12.6% in men.[8] Current evidence shows some inconsistencies about what effect chronic diseases may have on future ability to age in place.[4, 7, 11, 13, 52] Some studies suggest a simple unidirectional relationship where increased number of chronic disease comorbidities is associated with moving to households of relatives or to institutionalisation,[4, 7] but other evidence posits a more nuanced association that also assesses type and burden of disease resulting from differing chronic conditions. For example, although both involve two chronic diseases, having mild diabetes and high blood pressure would unlikely be as debilitating as having severe Alzheimer's and heart disease. As well, when assessment of burden of disease includes both diagnoses of diseases as well as mitigation by disease management strategies that are available, the relationship between chronic disease and future living arrangements is not necessarily straightforward.[4, 7, 11, 13, 52, 53] There is also evidence to suggest that while chronic conditions generally increase in severity over time, they can also improve, which would likely stabilise living arrangements.[4, 7, 13, 52]

2.3.2 Acute health events

Acute health events including falls, fractures, and immobilisations and hospitalisations appear to have an impact on ability to remain aging in place, particularly if one lives alone, but the overall evidence is limited and inconclusive.[4, 11, 13, 19, 54] Although it is difficult to accurately quantify falls (and resulting fractures) in the community-dwelling population, it is estimated that each year approximately 30% of all seniors (65 years and older) and 50% of seniors over 85 years experience a fall. Of those

who fall, 12 to 42% receive a fall-related injury which could in turn have an effect on ability to continue living at home.[11, 54, 55] Extended or serious illness or injury resulting in long-term immobilisation is thought to have a negative effect on maintaining dwelling stability and independence but there is very little research on this topic.[11] Recent hospitalisations have been shown by some to predict subsequent transition to long-term care,[11, 13] although others find the evidence less conclusive.[4]

2.3.3 Health behaviours

Health behaviours including smoking[56] and physical activity[57, 58] have close associations with physical and mental health over the longer term.[47, 59] Sustained healthy behaviours generally promote functional independence, and unhealthy behaviours do not, which in turn likely has implications for ability to age in place.[11, 47] Smoking appears to reduce ability to recover independence once lost.[47] Physical activity seems to support successful aging and conversely, low levels of activity may be a risk factor for institutionalization.[4, 47, 48] However, the body of literature is currently too small to constitute strong evidence.[4, 11, 47]

2.3.4 Mental health

Mental health also plays an important role in maintaining independence and likely in remaining community-dwelling as well.[4, 26, 33, 60, 61] Depression and loneliness, particularly for those living alone, can negatively affect health behaviours like good nutrition and exercise, and in turn contribute to decline in physical health.[34]

Neurodegenerative illnesses and cognitive impairment (e.g., dementia, Alzheimer's disease) in older adults is often much harder than physical limitations for informal caregivers to understand, support, and cope with, and this difficulty has implications for early institutionalisation.[4, 26, 62] A recent review concluded that cognitive impairment may be *the* greatest risk factor for and predictor of institutionalisation.[4]

While measures of physical and mental health status are not mutually exclusive, each measurement strategy captures a different aspect of the underlying relationship between health and future living arrangements.[4, 11, 14, 15, 26] However, exploring individual aspects of health is insufficient because overall health is a multi-dimensional construct. If we wish to investigate the impact of health on ability to age in place in the population, from the sick to the healthy, overall health status is the construct of greatest relevance to capture the multi-dimensionality of health.[11, 14, 15, 26]

2.3.5 Health-related quality of life (HRQOL)

Relatively few aging in place studies have used multi-dimensional health measures, and in particular measures that capture both physical and mental health domains.[11, 15, 26, 60, 61] As the two major domains of health, physical and mental health are widely recognised as interrelated in complex ways.[15, 26, 31, 60, 63] For example, although physical health and cognition may typically decline with age, mental health does not necessarily follow the same pattern. Mental health in older age is often self-rated as better than it was in middle age.[60] Because a change in living arrangements could be influenced by physical or mental health (or both), when investigating the overall impact

of health on living arrangements, it is necessary to incorporate a comprehensive measure that supports investigations of both physical and mental health.[4, 11, 15, 26, 60, 63]

One promising summary health measurement approach is assessing health-related quality of life (HRQOL).[57, 58, 64-74] There are two distinct classifications of HRQOL measures: disease-specific (e.g., used to evaluate health outcomes in cardiac surgery patients) and generic (i.e., captures a broad array of health measures and suitable for use in the general population). Generic HRQOL measures are, in turn, divided into two groups: utility/preference measures and health status profiles. The advantage of utilities is that they generate a single preference-based index of health that can be used to calculate quality-adjusted life years (QALYs) for cost-utility analyses. The advantage of profiles is that they incorporate standardised scoring and provide multiple measures of health in separate domains, and can therefore provide holistic as well as specific measures of health.[57, 58, 65-73] In addition, measurement range is sufficiently wide to capture the spectrum of health from excellent to very poor, and the continuous nature of the scale ensures that changes in health status can be detected. Utilising a standardised and widely-used HRQOL instrument also facilitates comparisons with other study findings.[14, 65, 66] In spite of being a self-reported measure of health, HRQOL is considered a valid health outcomes assessment and a more accurate predictor of morbidity, care needs, and mortality than many objective health measures.[66, 75-77] Similarly, in the aging literature subjective health has been shown to be more important to an individual's perception of how well they are aging than objectively-measured morbidity status.[20, 78]

To date, a limited number of studies have investigated associations between measures of HRQOL and living arrangements in older adults.[14, 15, 26, 31] To our knowledge, only Sun et al. have used a standard HRQOL instrument, the EQ-5D, which captures five dimensions of health: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. However, this cross-sectional study investigated the impact of living arrangements on HRQOL as an outcome, and the findings are thus of limited utility to an investigation of HRQOL as a predictor.[14] Only two studies (to our knowledge) have examined how HRQOL influences living arrangements longitudinally.[15, 26] For older participants ≥60 years in Japan over a 3-year period, Brown et al. found that poor health in conjunction with demographic and socioeconomic factors both directly and indirectly triggered changes in living arrangements.[26] In adults ≥70 years in the United States over a 5-year period, Liang et al. found that health conditions did not predict subsequent changes in living arrangements due to overwhelming stability in living arrangements.[15] Given that the study by Brown et al. in particular was conducted with older participants in Japan, and living arrangements in both Brown et al. and Liang et al. referred to cohabitants, these studies have limited applicability to determining impact of HRQOL on ability to remain aging in place in Canada. In addition, neither Brown et al. nor Liang et al. used a standard validated HRQOL measurement tool, but rather captured HRQOL with a collection of individual health measures including: serious and chronic diseases, pain, functional status, single measure self-rated health, cognitive function, and depression.

2.4 SUMMARY OF CURRENT STATE OF THE LITERATURE

Although substantial research has been conducted on determinants of living arrangements for older persons,[4, 11, 26] the body of literature on health as a determinant of aging in place is small. This is a missed opportunity given the importance of aging in place to both to individuals and to society as a whole.[11, 23, 26, 37] We do not know the magnitude of health's effects or whether overall health is more or less destabilising than other determinants of aging in place such as socioeconomic, demographic factors, or single measures of health like disability.[4, 11, 37, 57] Without an understanding of the effects of overall health on living arrangements, our current understanding of the effects (and their magnitudes) of other better-studied determinants may be biased.[15] For example, while a number of studies have shown that having a spouse or partner is protective to aging in place,[15] it may be that the strength of that association changes when overall health is incorporated into the framework. Because we know so little about the impact of overall health on aging in place, it is useful to incorporate a wide range of other determinants into an investigation of health status and living arrangements.

In addition to the lack of research on the association between health and aging in place specifically, there are two major overarching limitations to the literature on determinants of living arrangements for an aging population that are relevant to this investigation.[4, 11, 26] Most studies have been cross-sectional and thus cannot investigate causal pathways, resolve temporality, or examine change over time, a key aspect for understanding the changing profile of an aging population.[9-12, 15, 22, 26, 37, 42] Longitudinal data, because they permit observation of change over time, are better suited to investigating the "complex web of factors"[11] that may have an impact on living

arrangements.[9-11] Longitudinal analyses are becoming more frequent, but the time span investigated is often limited. Short time spans are not well suited to studying changes in living arrangements, which are relatively uncommon events and require longer follow-ups to capture.[15, 26] In addition, while longitudinal investigations of transitions in living arrangements have begun to identify factors associated with future living arrangements, including single measures of health, these associations tend to be inconsistent or difficult to compare because of variations in factors such as the populations studied, measures used, the direction of effect, and study duration. More longitudinal study using standardised measurements is warranted.[4, 7, 9-11, 15, 22, 26, 42, 79]

Secondly, much of the determinants of living arrangements research has been conducted using data collected from subpopulations, which restricts the generalisability of study findings to the general population. Overall there is a need for research using larger population-based samples that incorporate both females and males and a wider age range from middle-aged to the very elderly.[7, 9-12, 15, 26] Such studies provide more reliable and generalisable population-based evidence upon which to develop screening tools to identify those at risk and interventions to address the risks identified.[4, 11, 62] In addition, while findings from studies in countries with distinct health and social policies such as the United States and culturally distinct contexts such as China, Europe and Japan are useful, they do not necessarily mirror the Canadian context.[4, 10, 15, 26] It is, therefore, important to conduct a Canada-specific study.

An investigation of how changing health affects future living arrangements within the Canadian context provides relevant evidence for development of Canada-specific health and social policies and programmes to support aging in place.[4, 11, 62] Canadian

investigations of determinants of living arrangements to date have generally focused on senior migration, predicting future housing needs, identifying factors that predict institutionalisation specifically, and exploring the effects of availability of publicly-funded homecare and social support programs on seniors' living arrangement decisions.[5, 9, 13, 17, 19] Longitudinal research on determinants of living arrangements in Canada is considered lacking.[5, 7] To our knowledge no population-based longitudinal Canadian research has focused on overall health as a determinant of living arrangements. Conducting this research in a longitudinal population-based sample of pre-seniors, seniors, and the elderly in Canada will begin to address the limitations identified in the current literature.

2.5 Objectives

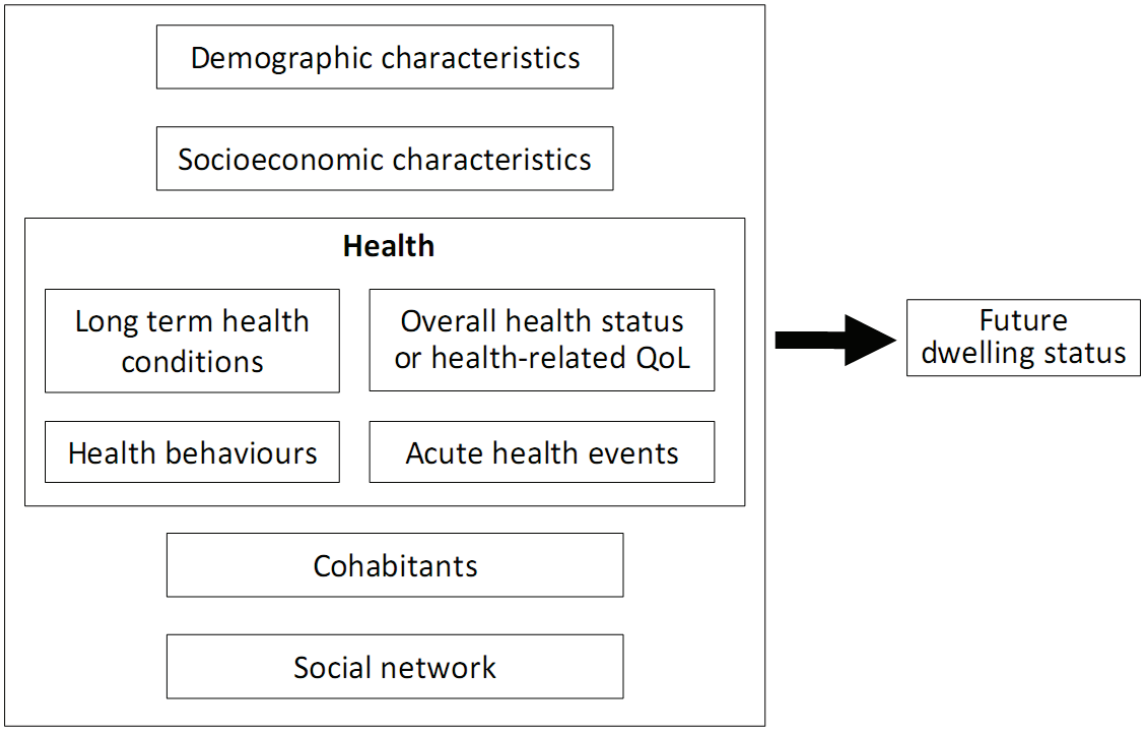
This study examined the relationship between physical and mental health status and future living arrangements longitudinally over a ten-year period, incorporating a broad spectrum of other determinants, in a randomly-selected, population-based sample of pre-senior and senior Canadians who were living in standard community dwellings at baseline. The objectives of this study were to:

(1) Describe and compare the stability of physical and mental health status and living arrangements over ten years.

(2) Investigate whether clinically-significant change in physical or mental health status predicts future living arrangements.

2.6 Figures

Figure 1 Conceptual framework of health and other determinants of living arrangements.



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CHAPTER 3 MANUSCRIPT

<< NOTE: MANUSCRIPT HAS BEEN PREPARED FOR PUBLICATION BUT NOT YET SUBMITTED. >>

3.1 ABSTRACT

BACKGROUND: As in many other countries, Canada's population is aging, and life spans are expanding. Supporting quality of life during these extended years is a policy concern. The living arrangements of middle-aged and older people are widely recognized as important to their overall quality of life and significant determinants of the need for and use of informal and formal care. Thus it is important and timely to understand the factors that affect living arrangements. To date, the literature generally focuses on the oldest old, is mostly limited to cross-sectional assessment, and rarely addresses the impacts of overall health on living arrangements.

OBJECTIVES: This research investigated the effects of clinically-significant change in physical and mental health status on future living arrangements among middle-aged and older community-dwelling Canadian adults.

METHODS: This study used data from three waves (Baseline, Year 5 and Year 10) of the Canadian Multicentre Osteoporosis Study (CaMos), a population-based prospective cohort study conducted at 9 sites across Canada beginning in 1995. The CaMos sample used in this study includes individuals aged 45+ at baseline who completed at least two consecutive waves of data collection. We examined the longitudinal effects of clinically-significant change in physical and mental health (≥ 5-pt change in SF-36 summary PCS and MCS) on future living arrangements (living in standard versus aging-specific

dwellings, or ‘aging in place’), after adjustment for sociodemographics, cohabitants, social networks, chronic disease, acute health events, and health behaviours, using generalized estimating equations (GEE) logistic regression models.

RESULTS: A total of 6,896 participants (4,999 women and 1,897 men) comprised the longitudinal cohort. A clinically-significant decline of ≥5 points in SF-36 PCS increased the likelihood of not aging in place over stable or improved scores by 41%. Similar decline in SF-36 MCS did not show a statistically significant effect on aging in place. Older age and employment status of retired or unemployed increased the likelihood of not aging in place, whereas living with a partner, engaging in medium or high levels of weekly physical activity, and having children increased the likelihood of aging in place.

CONCLUSIONS: The findings of this population-based longitudinal study help inform social and health policy development to support aging in place in Canada and elsewhere.

3.2 Introduction

Similar to many industrialised nations, Canada is facing an aging population as the 'baby boomer' generation enters its senior years.[1-4] In 2011, 14.8% of Canadians were aged 65 years or older.[5] By 2025 more than 20% of Canadians are projected to be over the age of 65,[6] and seniors over 80 years of age are the fastest-growing segment of the Canadian population.[4] How to support quality of life into these extended years is a growing health and social policy concern.[7-15]

The United Nations has identified living arrangements of older people as a critical worldwide issue,[16] and Canada, as a signatory to the 2002 International Plan of Action on Ageing, has committed to supporting independent living arrangements for its older citizens.[17] The term "living arrangements" is used broadly in the literature to refer to dwelling type, cohabitants, and/or geographical location, but in the context of aging-related policy, generally refers to dwelling type.[18, 19] In western nations such as Canada, adults generally prefer to remain living in their own homes in the community as they age, which is often referred to as "aging in place."[11, 15, 20-23] Aging in place is considered a key aspect of aging well.[18, 23-25]

Successful aging in place occurs when an individual is able to remain in their own home by adapting to increased needs for support or safety that may arise. The benefits accrued include: personal sense of well-being, self-determination, control, identity and independence; privacy; a personally-tailored environment; comfort and familiarity; and social connectedness and social network stability.[11, 21-37] In addition, living arrangements

of older adults are important determinants of the need for and use of informal and formal community-based and institutional care as people age.[8, 11, 22-24, 33, 38-40]

Ability to age in place is influenced by a large number of factors, including demographics, socioeconomics and social networks.[4, 8, 12, 15, 19, 23-25, 33, 35, 38, 40-49] Health is another important determinant of aging in place.[24, 25, 33, 35, 47, 50] Health likely plays a dual role as both a precursor and consequence of living arrangements, but to date research has primarily focused on the role of living arrangements in influencing health, rather than the reverse.[12, 15, 28, 36, 51, 52] Now that public policy is shifting away from institutionalisation and towards supporting aging in place, investigating health as a determinant of ability to age in place is essential.[24, 25, 33, 35, 47, 50] Studies of predictors of institutionalisation or ability to age in place have generally incorporated one or two specific measures of health such as functional status, chronic disease burden, acute health events, health-related behaviours, depression, and cognitive function.[12, 22, 24, 33, 35, 45, 46, 50, 53-56] However, each measure of health is only able to capture a single aspect of the underlying relationship between health and future living arrangements.[12, 22, 24, 35, 50] What is lacking is investigation of health as a holistic, multi-dimensional construct that encompasses all aspects of health.[12, 24, 35, 46, 50, 53] In particular, roles played in aging in place by the two overarching physical and mental domains of health remain unanswered,[17, 24, 35, 50, 56-58] in spite of wide recognition that they are interrelated and interact in unpredictable ways.[35, 50, 56-58] Our paper investigates, in a population-based sample of middle-aged and older Canadians, the effects of overall physical and mental health on ability to age in place.

3.3 BACKGROUND AND RATIONALE

Ability to age in place is influenced by a large number of factors.[4, 8, 12, 15, 19, 23-25, 33, 35, 38, 40-49] Demographic characteristics such as sex, age, and marital status are particularly important—being male, younger or married appear to best support aging in place.[4, 8, 12, 24, 25, 33, 35, 38, 40-44] Socioeconomic factors measured by income, education, and employment status determine means and capacity for modifying the home environment to cope with changing functions and needs.[8, 19, 33, 45, 46] Cohabitants represent built-in support capacity,[4, 8, 15, 35, 38, 40, 43, 47] while social networks can be indicators of the potential for a wider support system,[8, 15, 19, 23, 24, 43, 48, 49] both of which facilitate aging in place.

Health is another important determinant of aging in place.[24, 25, 33, 35, 47, 50] Living arrangements are thought to play a dual role as both a precursor and a consequence of health, but to date research has primarily focused on the role of living arrangements in influencing health, rather than the reverse.[12, 15, 28, 36, 51, 52] This is likely due to earlier policy emphasis on institutionalisation that led to evaluating its outcomes (including changes in health outcomes), whereas policy emphasis is now shifting toward supporting aging in place. Evidence regarding determinants of aging in place, including health, is therefore needed to guide this policy development.[11]

Health and living arrangements

Studies that examine precursor effects of health on living arrangements have generally focussed on functional status.[24, 35, 46, 50, 53] Health as a determinant of aging in

place has also been investigated as burden of chronic disease, acute health events, health behaviours, depression, and cognitive function.[12, 22, 24, 33, 35, 45, 50, 53-56] Some studies suggest a unidirectional relationship between chronic conditions and living arrangements where increased disease burden is associated with moving to households of relatives or to institutionalisation, but other evidence posits a more nuanced association, depending on the condition(s).[22, 24, 25, 40, 59, 60] Acute health events such as falls appear to have a negative impact on ability to remain aging in place, particularly if one lives alone.[22, 24, 25, 45, 61] Health behaviours such as smoking[62] and physical activity[63, 64] have close associations with physical and mental health over the longer term,[54, 65] which in turn likely has implications for ability to age in place.[22, 24, 54, 55] Depression and loneliness, particularly for those living alone, can both negatively affect health behaviours that in turn contribute to decline in health.[66] A recent review concluded that cognitive impairment may be *the* greatest predictor of institutionalisation.[22]

These findings are useful in that each measure of health captures an aspect of the underlying relationship between health and future living arrangements.[12, 22, 24, 35, 50] They are, however, insufficient for policy development because they do not capture a complete picture of health as a multi-dimensional construct.[7] If we wish to investigate the impact of health on ability to age in place in the population (from the sick to the healthy), overall health is the construct of greatest relevance.[12, 24, 35, 50]

Relatively few aging in place studies have used multi-dimensional health measures, and, in particular, measures that capture the two major physical and mental health domains.[17, 22, 24, 35, 50, 57, 58] Physical and mental health are widely recognised as interrelated but not necessarily in predictable ways.[35, 50, 56-58] For example, although

physical health and cognition may typically decline with age, mental health does not necessarily follow the same pattern. Mental health in older age is often self-rated as better than it was in middle age.[57]

Health-related quality of life (HRQOL) and living arrangements

One promising summary health measurement approach is assessing health-related quality of life (HRQOL).[13, 14, 63, 64, 67-75] Some HRQOL instruments are designed to generate health profiles that incorporate standardised scoring and measure health holistically as well as in separate domains.[63, 64, 67-75] Measurement range is designed to capture the spectrum of health from excellent to very poor, and the continuous nature of the scale ensures that changes in health can be detected. In spite of being a subjective measure of health, HRQOL is considered by many researchers to be a more accurate predictor of morbidity, care needs, and mortality than many objective health measures.[46, 68, 76-79]

A limited number of studies have investigated associations between measures of health-related quality of life (HRQOL) and living arrangements in older adults.[12, 35, 50, 56] To our knowledge, only Sun et al. have used a standard HRQOL instrument, the EQ-5D, which captures five dimensions of health: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. However, this cross-sectional study investigated the impact of living arrangements on HRQOL as an outcome, and the findings are thus of limited utility to an investigation of HRQOL as a predictor.[12] Only two studies have examined how HRQOL influences living arrangements longitudinally.[35, 50] For older participants ≥60 years in Japan over a 3 year period, Brown

et al. found that poor health both directly and indirectly triggered changes in living arrangements.[50] In adults ≥70 years in the United States over a 5 year period, Liang et al. found that health conditions did not predict subsequent changes in living arrangements due to overwhelming stability in living arrangements.[35] Given that Brown et al. focused on older participants in culturally-distinct Japan, and living arrangements in both studies referred to cohabitants, these studies have limited applicability to determining HRQOL's impact on ability to remain aging in place outside those contexts. In addition, neither Brown et al. nor Liang et al. used a standard validated HRQOL measurement tool, but rather captured HRQOL with a collection of individual health measures including: serious and chronic diseases, pain, functional status, single measure self-rated health, cognitive function, and depression.

In summary, the existing literature points to a critical new direction of examining overall health as a determinant of future aging in place. To contribute to this emerging inquiry, this study aimed to: (1) describe and compare the stability of physical and mental health status and aging in place over ten years, and (2) investigate whether clinically-significant change in physical or mental health status predicts aging in place. To meet these objectives, we used a population-based longitudinal survey that spanned over 10 years and contained participants of both sexes with a wide age range from middle-aged to the very elderly. The use of this survey thus allowed us to investigate causal pathways and change of relatively uncommon events over a long period of time as experienced by a heterogenous population.[8, 15, 22, 24, 24, 33, 35, 40, 42, 50, 53, 80]

3.4 METHODS

Data and Study Population

This study used data from the Canadian Multicentre Osteoporosis Study (CaMos), a population-based prospective cohort study investigating the incidence, prevalence, risk factors, regional variation, and impact of osteoporosis in Canada. The target population included non-institutionalised individuals over the age of 25 years within a 50-km radius of nine CaMos centres (Vancouver, Calgary, Saskatoon, Toronto, Hamilton, Kingston, Quebec City, Halifax, and St. John's). This population represented approximately 40% of Canadian residents but excluded northern-dwelling First Nations and Inuit Canadians. Since prevalence of osteoporosis is higher in women (25%) than men (10%), CaMos recruited a larger proportion of women than men, based on sample size calculations for 16 age-sex strata. Approximately 1000 individuals were recruited at each site. Assessment for 'full' participation consisted of three components: Interview-Administered Questionnaires (IAQ), self-administered survey instruments, and a clinical assessment. Baseline interviews and clinical assessments were conducted between 1995 and 1997, followed by full reassessments at five year intervals in 2000-2002 (Year 5) and 2005-2007 (Year 10). The baseline response rate for agreement to full longitudinal participation was 42.5% and response rate for the questionnaire and surveys portion was 80%, for a total of 9,423 full-responder participants at baseline.[81, 82]

Although the primary purpose of the CaMos study was to investigate osteoporosis in Canada,[82] the large population-based sample, wide range of participant characterisation, and its longitudinal nature also lend themselves well to this secondary investigation. The data for this study were obtained from questionnaire and survey data

collection at baseline, Year 5 and Year 10. We excluded participants who were younger than age 45 at baseline and who completed fewer than two consecutive questionnaires. This ensured we were able to capture change across a minimum of 5 years, and allowed us to investigate the effects of health on aging in place across a full range of ages from late middle age/pre-retirement into old age. Given these criteria, the CaMos dataset for this study yielded for analysis 6,896 participants (4,999 women and 1,897 men) at baseline and at Year 5. Due to loss to followup between Year 5 and Year 10, the number of participants available for analysis at Year 10 was reduced to 4,904 (3,605 women and 1,299 men). Investigation of the data revealed that, compared to those who completed three waves of data collection, those lost to follow-up after the second wave were older (mean age of 68.3 years compared to 61.6 years) and physically sicker (mean PCS 45.2 compared to 48.7). Proportions of females and males did not differ (constant at 73.5% females, 26.5% males), nor did mental health (mean MCS 53.6 compared to 53.7). Thus for Year 10 we were working with the physically healthier members of the sample.[81, 83]

Measures

Living Arrangements

The outcome variable for this analysis is living arrangements, captured as a binary variable: dwelling in standard community housing or in aging-specific dwellings.[18, 19, 27, 84] All respondents were community-dwelling at baseline by CaMos sampling frame design. For years 5 and 10, we assigned dwelling status to each respondent based on two questions: “Have you moved since your last interview?” and, if yes, “For your most recent move, where have you moved?” The standard dwelling

category includes (1) single family home; (2) apartment; and (3) condominium, while the aging-specific dwelling category includes (4) lodge; (5) nursing home; (6) extended care home; and (7) chronic care hospital. 'Other' (8) responses were reviewed and coded individually according to whether they indicated standard or aging-specific dwellings.

Health-related quality of life

The two exposure variables of interest are Physical Component Score (PCS) and Mental Component Score (MCS) from the Medical Outcomes Study (MOS) Short Form (SF-36) questionnaire, version 1. The SF-36 is a 36-item health-related quality of life (HRQOL) questionnaire that captures how individuals feel in terms of their health, and how they are able to conduct their usual activities. Topic areas covered include: current self-reported health; self-reported health compared to a year prior; degree to which health limits the individual in vigorous or moderate activities, lifting, climbing stairs, bending, walking, bathing and dressing; limitations to work or regular activities due to physical health; limitation to work or regular activities due to emotional problems; degree to which physical health has interfered with normal social activities; degree to which emotional problems have interfered with normal social activities; amount of bodily pain and degree to which it interferes with normal work; how individuals have felt in terms of energy, nervousness, depression, peacefulness, fatigue, and happiness; comparison of the individual's health with others; and the individual's health expectations for the future. Responses to the 36 questions generate eight profiles of health and two summary measures of physical and mental health. The PCS is an aggregate of four profiles: physical functioning, role limitations due to physical health problems, bodily pain, and

general health perceptions, while the MCS combines the remaining four profiles: vitality, social functioning, role limitations due to emotional problems, and mental health.[85, 86] The two SF-36 summary scales were designed to be scored using summated Likert ratings and the item scores relate linearly to the underlying health concept that is being measured.[87-90] The PCS and MCS are standardised to a mean of 50 for average population health; scores above 50 represent better than average health, and below 50, poorer.[91]

We defined clinically significant change in PCS and MCS using 5-point cutoffs, as established in the literature.[81, 92] There is some debate in the literature about the amount of change required in order to be predictive for health outcomes, particularly whether the PCS and MCS and the eight SF-36 subdomains should use the same cutoffs.[81, 85, 92-94] In one study, a 5-point decrease in the PCS from 52 to 47 was shown to be predictive of a 27% increase in health-related inability to work and of a 16% increase in 5-year mortality.[94] In another study conducted in older adults (mean age 63 years) in the primary care setting, with duration limited to one year and using the eight SF-36 subdomains, >5 points from baseline decline in physical and >10 points from baseline decline in mental SF-36 subdomain scores were strongly associated with both hospitalization and mortality.[93] However. more recently 5-point change cutoffs for both the PCS and the MCS have been used.[92, 95]

For Objective 1 a status of 'stable' was assigned if the difference in PCS or MCS over five years was <5 points (whether improvement or decline). Change was considered 'improved' if the score increased ≥5 points, or 'declined' if the score dropped ≤5 points.

Objective 2 used the same definitions as Objective 1, but combined stable and improved and compared them to "declined."

Selected Demographic, Socioeconomic, Health and other Covariates

Other covariates included in the analyses were demographic characteristics (sex, age), cohabitants, social networks (siblings, children), socioeconomic characteristics (education, employment), and single measures of health including aging-related chronic conditions, acute health events (immobilisations, falls, fractures), and health behaviours (smoking, physical activity) (Table 1).[8, 15, 24, 33]

Temporality of variables

We measured the variables over two consecutive waves. We measured living arrangements at wave *t+1* and all other variables at wave *t*. We created the main exposure variable of interest, clinically significant change in SF-36, by subtracting SF-36 at *t* from SF-36 at *t+1*. We treated this variable of clinically significant change in SF-36 as a variable at wave *t* just as all other covariates. In our analyses, two consecutive waves of data constituted one analytical wave, and participants could contribute up to two analytical waves (baseline to Year 5, and Year 5 to Year 10) over the 3 waves of CaMos data used in this study.

Analysis

We described the data in the following three ways. First, we described characteristics of participants at baseline. Second, we reportrd living arrangements and

the mean SF-36 scores (physical and mental components separately) across the three waves. Third, we detailed changes in SF-36 scores and changes in living arrangements across the three waves. We reported all descriptive analyses separately by sex and age group.

We ran generalized estimating equations (GEE) logistic regression models to assess the longitudinal association between clinically-significant change in physical and mental health and future living arrangements, taking into account that measurements from the same individual over time are correlated.[96] We used a logistic link function and an exchangeable correlation structure as appropriate for our marginal (or population-averaged) model.[96, 97] We reported odds ratios[98] and used the standard $p<0.05$ cutoffs to establish statistical significance. We used Stata 11[99] for all analyses.

Data access was approved by the CaMos Research Group Data Analysis and Publications (DAP) Committee, and approval to conduct the study was provided by the Dalhousie University Health Sciences Research Ethics Board (HSREB, see Appendix C).

3.5 Results

The baseline sample was split approximately evenly between those under 65 years of age (2,485 women, 1,040 men) and those over 65 years (2,514 women, 857 men). Participants were predominantly female, married, and Canadian-born (Table 1). Living arrangements tended to be very stable, with the vast majority of both females (97.8%) and males (99.5%) remaining in standard community housing after 10 years of observation (Table 2). The percentage of participants living in aging-specific dwellings increased by age, particularly for females. For those <65 years at baseline, proportions of

females and males living in aging-specific dwellings by Year 10 was fairly similar, although slightly higher for females, but overall numbers were very small (0.2% of women, 0.1% of men). For those ≥65 years at baseline, a substantially higher proportion of females than males were living in aging-specific dwellings by Year 10, although numbers were still small (2% of women, 0.4% of men) (Table 2). All who moved to aging-specific housing by Year 5 remained so at Year 10 (see Appendix B).

Overall health, as measured by the PCS and MCS, demonstrated different trends when viewed as population means rather than change trajectories. At baseline, mean PCS were lower than the established Canadian norm of 50 for adult women (49.7) and men (51.4).[100] PCS mean for women <65 years was 49.0 and for women ≥65 years was 45.0 at baseline. PCS mean for men <65 years was 50.8 for men <65 years and for men ≥65 years was 47.6 at baseline. In contrast, MCS were higher than Canadian norms for adult women (50.9) and men (52.6)[100] MCS mean for women <65 years was 52.5 and for women ≥65 years was 54.2 at baseline. MCS mean for men <65 years was 53.8 for men <65 years and for men ≥65 years was 55.7 at baseline. Mean PCS tended to gradually decrease across time for both females and males, and to a greater degree for females. In contrast, mean MCS showed consistent gradual upward trends for both females and males (Table 2). However, trajectories for both PCS and MCS demonstrated considerable change in either direction (improvement or decline) into Year 5 and 10 (Table 3). While percentages of overall health instability were similar between age groups, health status decline in combination with older age was associated with living in aging-specific housing, although the small numbers render any inferences as potentially unreliable (Table 3).

Our logistic regression analysis showed that a clinically-significant decline in the SF-36 PCS was associated with a statistically significant, increased likelihood (OR 1.41, CI 1.08 - 1.85) of living in aging-specific dwellings within 5 years, compared to stable or clinically-significant improvement in PCS and adjusting for all other variables in the model. However, no relationship was evident between clinically-significant changes in SF-36 MCS and future living arrangements (OR 1.00, CI 0.72 - 1.39) (Table 4).

A number of covariates demonstrated a statistically significant increased likelihood of living in aging-specific dwellings within 5 years. Compared to those aged less than 60 years, older age groups substantially increased the likelihood of living in an aging-specific dwelling (OR 4.09, CI 1.55 - 10.81 for those aged 70-79 years, and OR 12.7, CI 4.61 - 34.95 for those aged ≥80). Retirement also increased the likelihood substantially (OR 9.61, CI 1.28 - 72.30) over being employed full time, as did unemployment (OR 11.53, CI 1.50 - 88.83). The number of aging-related chronic conditions showed dose-response risk relationships with living in aging-specific dwellings—although having one condition was not significant, having two chronic conditions increased likelihood over no conditions (OR 1.89, CI 1.16 - 3.09) and having three or more conditions showed an even stronger negative effect (OR 2.57, CI 1.56 - 4.25). While having 1 or 2 siblings was not significant compared to having none, having 3 or more siblings increased likelihood of living in aging-specific dwellings within 5 years (OR 2.31, CI 1.03 - 5.21). Falls were the only statistically significant acute health covariate to increase likelihood of living in aging-specific dwellings (OR 1.42, CI 1.03 - 1.95) over no falls (Table 4).

Covariates that decreased the likelihood of living in aging-specific housing within five years included living with a spouse or partner as a cohabitant (OR 0.36, CI 0.25 - 0.53), compared to living alone; having a medium or high level of physical activity (ORs 0.61, CI 0.46 - 0.83 and 0.42, CI 0.28 - 0.62, respectively), compared with low activity; and having a social network that includes one or two children (ORs 0.52, CI 0.27 - 1.00 and 0.57, CI 0.35 - 0.92, respectively), over having no children (Table 4).

3.6 Discussion

This study examined the association between change in health status and future living arrangements. Specifically, our study showed that a clinically-significant decline in physical health, as measured by a ≥5-point change in the SF-36 PCS, increased the likelihood of living in aging-specific rather than standard dwellings within five years by 41%, compared to those who did not experience a decline. We did not find a similar association with decline in mental health, as measured by the SF-36 MCS. To our knowledge this is the first study that has examined the effects of HRQOL on aging in place.

The literature, though small, demonstrates the effectiveness of the SF-36 PCS in predicting future health-related outcomes.[71, 93, 94] Health-related outcomes, such as hospitalisations and inability to work, in turn can directly affect living arrangements. Our study findings augment this small literature on the predictability of the SF-36 PCS: a ≥5-point decline is predictive of living in aging-specific dwellings within five years.[92, 95]

The relationship between mental health and future living arrangements was unclear in our findings, likely due to five factors. Firstly, although the SF-36 questions

differentiate between limitations due to "physical" or "emotional" health, it is possible that individuals might attribute difficulties related to cognitive function as physical rather than emotional.[10] Secondly, there may be crossover effects between mental health and physical health or health behaviours that modify the direct association of mental health with aging in place.[46, 79, 95, 101-104] Thirdly, the effects of mental health and aging in place are likely reciprocal, making it difficult to unpack relative effects.[23] Fourthly, there may be interactions between mental health and optimistic outlook[57, 66, 105, 106] that may dilute or mask the impact of the mental health construct measured by the SF-36. Finally, there is likely survivor bias due to loss to follow-up of the generally sicker participants over the course of the ten-year study.[83]

Our study also confirmed two known key 'protective' factors to reducing the likelihood of living in aging-specific living arrangements. Living with a spouse/partner showed a strong 'protective' effect in our model.[35, 38, 40, 46, 47] Having children to provide support was also 'protective' to this association.[8, 19, 23, 24, 43, 48, 49, 107] Although we did not confirm an overall dose-response effect between number of children and reduction in likelihood of ability to age in place—having more than two children did not show a statistically-significant effect on aging place—this is likely a function of small numbers in the modelling rather than a true effect. If it is a true effect, there is some evidence that this may be due to smaller families being more focused on supporting their few members, whereas children in larger families may assume others are 'taking care of it.'[108]

Our study uniquely contributes to a small but growing body of evidence that physical activity is a key factor in supporting and promoting aging in place,[95] and successful aging overall.[22, 54, 55, 107, 109] Specifically, our findings demonstrate the

importance of engaging in moderate to high levels of physical activity in order to maintain aging in place. Our findings also support existing literature that older age and reduced financial resources (measured using employment status), not surprisingly, substantially increase the likelihood of living in aging-specific living arrangements within five years.[4, 8, 33, 41, 46, 110-112] However, our measure of financial resources is non-ideal. We wanted to investigate the impact of income levels on the relationship between health and aging in place because financial resources are important to enabling aging in place. Unfortunately, our dataset did not include a comparable income variable across the three data collection waves and we therefore utilized the most related sociodemographic variables available to us: employment and education. Education did not show significance in the model, while some categories of employment status were significant. However, while an employment status of unemployed may be more readily accepted as a reasonable indication of limited financial means, retirement status cannot be seen as such. For example, a widow relying solely on a federal pension for income and a retired professional with full employment pension as well as federal pension benefits would experience drastically different income levels. Therefore, while our findings align with existing literature about the effect of income on aging in place, we interpret these results with caution, and recommend inclusion of an income variable in future studies.

Two other factors showed statistically significant effects on the likelihood of living in aging-specific living arrangements within five years. Aging-related chronic conditions displayed an expected dose-response relationship with maintaining aging in place, with two or more chronic diseases showing statistical significance in increasing likelihood of not aging in place.[22, 24, 25, 40, 59] Of the acute health events we examined,

falls were the only measure that was a statistically significant risk factor against aging in place. This finding contributes to the small existing literature on long term effects of falls on living arrangements.[24, 61]

Although our study contributes to an understanding of the roles that physical health status, physical activity, and falls play in future aging in place, there are some limitations. The literature indicates that living arrangements are substantially different between the sexes.[4, 8, 24, 33, 40, 41] Unfortunately, in spite of our large sample size, we were unable to run separate analyses by sex due to the rarity of the outcome, living in aging-specific housing. In combination with using a predominantly female sample (73.5% female at baseline) it is therefore likely that our results more closely reflect the female rather than male experience of the effects of health on living arrangements. For future research we recommend use of a population-based dataset sufficiently large to conduct separate analyses by sex.

Due to the rarity of the outcome, it was not possible to explore a more nuanced conceptualization of dwelling status. Restricted to a dichotomization of living in standard community dwellings or in aging-specific dwellings, we would have preferred to differentiate more fully among types of aging-specific dwellings in order to capture gradual dwelling status transitions in our longitudinal data. In particular we anticipate that differentiating between institutionalization and the many independent and assisted living options also available would have been very informative.

As is inevitable in longitudinal studies involving older participants, loss to follow-up is a limitation for our study. After 10 years, loss to follow-up for the full CaMos study was 33% of baseline (approximately 40% deaths, 37% refusals and 23% loss of contact,

data not shown). Overall loss to follow-up for our subset at Year 10 was 29% of baseline. A substantially higher proportion of participants who moved to aging-specific housing in Year 5 were lost to follow-up in Year 10, compared to those who were aging in place. Given that those lost to follow-up were older and physically sicker, the remaining sample contains the healthier survivors.[83] Our findings, therefore, reflect this healthier population, and it is likely that the real relationship between physical and mental health and future living arrangements in the population is underestimated in our results.[81, 83]

Our dataset afforded a number of notable advantages, including: population-based sampling, prospective study design with a lengthy follow-up period (10 years), and extensive participant characterization including use of the SF-36.[100, 113] The SF-36 is one of the most validated and widely-used HRQOL generic health profile instruments in both clinical and population-based research settings in over sixty countries, including Canada, and is thus ideal for comparisons with other studies.[68, 68-74, 81, 86, 92, 100, 114-126] The SF-36 is suitable for use in middle-aged, senior, and elderly populations,[68, 127-131] and is sensitive to change and thus appropriate for longitudinal investigations.[68, 74, 87, 90, 132-136] The main advantage of the SF-36 over single health measures is its ability to assess a broad range of physical, psychological and social aspects of overall health using three different types of self-reported information: symptoms, functions, and sense of well-being.[63, 64, 67-75] Thus, using the SF-36 PCS and MCS provides a new and useful lens through which to investigate the longitudinal relationship between health and aging in place.

To summarise, this study provides a unique perspective on the effect of health on ability to age in place. To our knowledge only one other study[53] has examined the effects

of changes in overall health status on future living arrangements, and ours is the only study to employ the MOS SF-36. By using a comprehensive HRQoL instrument, we were able to examine the association of clinically-significant change in both physical and mental health to future aging in place. We found that change in physical health status plays a role in future ability to age in place, independently of a number of individual physical health measures. Therefore a change in physical health could be a signal for individuals and their families to consider options for making housing and care adjustments to prevent or defer future institutionalisation. In addition, our findings support emerging understanding that staying physically active and maintaining health can help individuals stay out of institutions.

3.7 TABLES

Table 1 Study sample characteristics at baseline (CaMos data, 1995-2007)

	Females		Males	
	N	%	N	%
Total (n=6,896)	4,999	73.5	1,897	26.5
Baseline age (Years)				
Less than 60	1,673	33.5	745	39.3
60—69	1,799	36.0	637	33.6
70—79	1,269	25.4	433	22.8
80+	258	5.1	82	4.3
Cohabitants				
Live alone	1,579	31.6	357	18.8
Live with spouse/partner	2,962	59.3	1,466	77.3
Live with other(s)*2	458	9.2	74	3.9
Social Networks (means)				
Siblings	4	(SD 3.3)	4	(SD 3.3)
Children*1	3	(SD 1.8)	3	(SD 1.5)
Education (highest level)				
Less than High School	1,940	38.8	628	33.1
High School	779	15.6	237	12.5
Some post-secondary	1,664	33.3	560	29.5
University degree or more	616	12.3	472	24.9
Employment status				
Employed--Full time	851	17.0	631	33.3
Employed--Part time*3	538	10.8	154	8.1
Retired	2,229	44.6	1,031	54.4
Not employed*4	1,381	27.6	81	4.3
SF36--Summary Scores (Means)--Range 1-100				
Physical Component Score (PCS; min 5.53, max 72.03)	47.0	(SD 10.1)	49.4	(SD 8.8)
Mental Component Score (MCS; min 5.76, max 74.73)	53.3	(SD 8.7)	54.6	(SD 7.8)
Aging-related chronic conditions*5				
None	1,891	37.8	862	45.4
1	1,740	34.8	665	35.1
2	868	17.4	259	13.7
3 or more	500	10.0	111	5.9
Acute health events				
Immobilisation (confined to bed/chair > 1 month)	630	12.6	246	13.0
Falls (past month/year)	308	6.2	119	6.3
Fractures (past year)	5	0.1	1	0.1
Smoking status				
Never smoker	2,668	53.4	599	31.6
Former smoker	1,682	33.7	998	52.6
Current smoker	649	13.0	300	15.8
Physical activity (past year)*6				
Low weekly physical activity (bottom tertile)	1,365	27.3	648	34.2
Medium weekly physical activity (middle tertile)	1,925	38.5	630	33.3
High weekly physical activity (top tertile)	1,708	34.2	617	32.6

***1 Data comes from Year 5**

***2 Includes:** Other relative (daughter/son-in-law, grandchild, niece/nephew), friend, housekeeper, roommate, boarder/tenant

***3 Includes:** Employed PT, disability, self-employed, sick leave

***4 Includes:** FT homemaker, unemployed, student, volunteer, leave of absence

***5 Includes:** Osteoporosis, osteoarthritis, hypertension, heart attack(s), stroke/TIA(s), neuromuscular disease (incl. Parkinson's, MS), respiratory disease (incl. COPD, asthma, emphysema, chronic bronchitis), diabetes Type(s) 1&2

***6 Values derived as follows.** The original categorical variable that captured average hours per week of moderate, vigorous and strenuous activity was transformed to a numeric variable by assigning the centre value in the category's range. A new weighted numeric variable was then created according to the Kirkland method**137** by calculating each individual's amount of moderate activity + vigorous (*1.5) + strenuous (*2.0) activity minutes per week. The variable was then split into tertile categories as shown.

Table 2 Living arrangements and HRQOL by sex and age group across waves

	Baseline (n=6,896)				Year 5 (n=6,896)				Year 10 (n=4,904)			
	<65yrs at baseline		>=65yrs at baseline		<65yrs at baseline		>=65yrs at baseline		<65yrs at baseline		>=65yrs at baseline	
FEMALE	**n**	%	**n**	%	**n**	%	**n**	%	**n**	%	**n**	%
Living arrangements (standard)*1	2,485	36.0%	2,514	36.5%	2,479	35.9%	2,434	35.3%	2,044	41.7%	1,451	29.6%
Living arrangements (aging-specific)*2	0	0%	0	0%	3	0.04%	79	1.1%	8	0.2%	99	2.0%
SF-36 PCS (means)*3	49.0	(SD 9.7)	45.0	(SD 10.1)	47.7	(SD 10.1)	42.2	(SD 11.1)	47.1	(SD 9.9)	40.9	(SD 10.6)
SF-36 MCS (means)*4	52.5	(SD 9.0)	54.2	(SD 8.3)	53.8	(SD 8.7)	54.8	(SD 8.4)	54.2	(SD 8.4)	55.1	(SD 8.4)
MALE	**n**	%	**n**	%	**n**	%	**n**	%	**n**	%	**n**	%
Living arrangements (standard)*1	1,040	15.1%	857	12.4%	1,038	15.1%	841	12.2%	821	16.7%	453	9.2%
Living arrangements (aging-specific)*2	0	0%	0	0%	2	0.03%	15	0.2%	3	0.1%	21	0.4%
SF-36 PCS (means)*3	50.8	(SD 8.4)	47.6	(SD 8.9)	50.0	(SD 8.5)	44.5	(SD 10.5)	49.0	(SD 8.6)	43.1	(SD 10.0)
SF-36 MCS (means)*4	53.8	(SD 8.2)	55.7	(SD 7.1)	54.9	(SD 7.3)	55.5	(SD 7.7)	55.6	(SD 6.6)	55.7	(SD 7.7)

***1** standard living arrangements (i.e., house, apartment, condo)
***2** aging-specific living arrangements (i.e., lodge, nursing home, extended care home, chronic care hospital, independent seniors housing)
***3** SF-36 Physical Component Score (PCS)
***4** SF-36 Mental Component Score (MCS)

NOTE1: Living Arrangements--5 missing in Year 5; 4 missing in Year 10
NOTE2: Lost to followup--1,992 participants between Years 5 and 10

Table 3 Change in SF-36 and change in living arrangements, by sex and age group across waves

	Living arrangements															
	<65 years at baseline								>=65 years at baseline							
	At Year 5				At Year 10				At Year 5				At Year 10			
	Standard*3		Aging-spec*4		Standard*3		Aging-spec****		Standard*3		Aging-spec****		Standard*3		Aging-spec****	
SF-36 scores	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
FEMALES	(2,462 person waves)				(2,042 person waves)				(2,467 person waves)				(1,535 person waves)			
Change in SF-36 PCS score*1																
Improved -- n (%)	481	19.5%	0	0%	384	18.8%	4	0.2%	379	15.4%	15	0.6%	216	14.1%	18	1.2%
Stable*2 -- n (%)	1,315	53.4%	2	0.1%	1,113	54.5%	1	0.05%	1,148	46.5%	26	1.1%	678	44.2%	31	2.0%
Declined -- n (%)	664	27.0%	0	0%	537	26.3%	3	0.1%	868	35.2%	31	1.3%	543	35.4%	49	3.2%
Change in SF-36 MCS score*1																
Improved -- n (%)	653	26.5%	0	0%	417	20.4%	4	0.2%	577	23.4%	21	0.9%	325	21.2%	27	1.8%
Stable*2 -- n (%)	1,400	56.9%	1	0.04%	1,251	61.3%	3	0.1%	1,343	54.4%	36	1.5%	788	51.3%	54	3.5%
Declined -- n (%)	407	16.5%	1	0.04%	366	17.9%	1	0.05%	475	19.3%	15	0.6%	324	21.1%	17	1.1%
MALES	(1,035 person waves)				(822 person waves)				(845 person waves)				(472 person waves)			
Change in SF-36 PCS score*1																
Improved -- n (%)	173	16.7%	0	0%	109	13.3%	0	0%	135	16.0%	2	0.2%	74	15.7%	1	0.2%
Stable*2 -- n (%)	633	61.2%	2	0.2%	517	62.9%	2	0.2%	397	47.0%	9	1.1%	213	45.1%	8	1.7%
Declined -- n (%)	227	21.9%	0	0%	193	23.5%	1	0.1%	298	35.3%	0	0%	164	34.7%	12	2.5%
Change in SF-36 MCS score*1																
Improved -- n (%)	214	20.7%	1	0.1%	156	19.0%	1	0.1%	180	21.3%	2	0.2%	75	15.9%	8	1.7%
Stable*2 -- n (%)	668	64.5%	1	0.1%	539	65.6%	1	0.1%	466	55.1%	10	1.2%	283	60.0%	7	1.5%
Declined -- n (%)	151	14.6%	0	0%	124	15.1%	1	0.1%	184	21.8%	3	0.4%	93	19.7%	6	1.3%

Abbreviations: Aging-spec, Aging-specific; PCS, SF-36 Physical Component Score; MCS, SF-36 Mental Component Score

***1** Clinically-significant change in SF-36 component scores calculated for between baseline-->Yr5 for living arrangements at Yr 5, and for between Yr5-->Yr10 for for living arrangements at Yr10

***2** Stable SF-36 means change of <5 pts per 5 yr wave, ergo Improved or Declined indicate clinically-significant change (increase or decrease, respectively) of ≥5pts

***3** Standard living arrangements means living in standard housing (house, apartment, condominium)

***4** Aging-specific living arrangements means not aging in place (lodge, nursing home, extended care home, chronic care hospital, aindependent seniors housing)

Table 4 Effects of change in SF-36 and covariates on future living arrangements

	Unadjusted*6			Fully Adjusted*7		
Variables used in modelling*2	**Odds Ratio**	***P* Value**	**95% Confidence Interval**	**Odds Ratio**	***P* Value**	**95% Confidence Interval**
SF36--Clinically relevant change*1						
PCS (?5pts decline since previous wave)	1.92	0.00	1.47 - 2.49	1.41	0.011	1.08 - 1.85
MCS (?5pts decline since previous wave)	1.05	0.77	0.76 - 1.45	1.00	0.986	0.72 - 1.39
Sex	1.74	0.00	1.21 - 2.50	0.94	0.757	0.61 - 1.43
Baseline Age (years)*8						
<60	ref	ref	ref	ref	ref	ref
60—69	2.43	0.035	1.06 - 5.54	1.00	0.998	0.38 - 2.64
70—79	15.79	0.000	7.05 - 35.39	4.09	0.004	1.55 - 10.81
80+	68.32	0.000	30.22 - 154.46	12.70	0.000	4.61 - 34.95
Cohabitants*8						
Live alone (ref)	ref	ref	ref	ref	ref	ref
Live with spouse/partner	0.15	0.000	0.11 - 0.21	0.36	0.000	0.25 - 0.53
Other (sibling, children, parents)	0.54	0.006	0.35 - 0.84	0.68	0.118	0.42 - 1.10
Social Network--Siblings						
0 (ref)	ref	ref	ref	ref	ref	ref
1	1.33	0.518	0.56 - 3.14	1.72	0.246	0.69 - 4.31
2	1.85	0.142	0.81 - 4.20	2.17	0.083	0.90 - 5.22
3+	2.13	0.052	0.99 - 4.57	2.31	0.043	1.03 - 5.21
Social Network--Children						
0 (ref)	ref	ref	ref	ref	ref	ref
1	0.45	0.008	0.25 - 0.81	0.52	0.050	0.27 - 1.00
2	0.36	0.000	0.24 - 0.56	0.57	0.021	0.35 - 0.92
3+	0.58	0.002	0.40 - 0.82	0.69	0.076	0.46 - 1.04
Education						
Less than High School (ref)	ref	ref	ref	ref	ref	ref
High School	0.76	0.206	0.49 - 1.17	1.07	0.762	0.68 - 1.69
Some post-secondary	0.70	0.035	0.50 - 0.98	1.03	0.889	0.71 - 1.49
Univ Degree or more	0.54	0.007	0.34 - 0.84	1.09	0.737	0.67 - 1.76
Employment status*8						
Employed--Full time (ref)	ref	ref	ref	ref	ref	ref
Employed--Part time*3	6.62	0.070	0.86 - 51.01	2.05	0.598	0.14 - 29.19
Retired	52.68	0.000	10.07 - 275.66	9.61	0.028	1.28 - 72.30
Other*4	50.25	0.000	9.47 - 266.71	11.53	0.019	1.50 - 88.83
Aging-related chronic conditions*5 *8						
0 (ref)	ref	ref	ref	ref	ref	ref
1	2.39	0.000	1.50 - 3.83	1.29	0.322	0.78 - 2.13
2	5.04	0.000	3.20 - 7.94	1.89	0.010	1.16 - 3.09
3+	8.07	0.000	5.09 - 12.79	2.57	0.000	1.56 - 4.25
Acute health events						
Immobilised (ever/since last interview)	1.24	0.322	0.81 - 1.89	1.15	0.544	0.73 - 1.81
Falls (past month/year)	1.91	0.000	1.44 - 2.54	1.42	0.032	1.03 - 1.95
Fractures (past year)	2.55	0.012	1.23 - 5.31	1.49	0.314	0.68 - 3.25
Smoking status						
Never smoker (ref)	ref	ref	ref	ref	ref	ref
Former smoker	0.95	0.755	0.71 - 1.28	1.23	0.214	0.89 - 1.71
Current smoker	0.69	0.134	0.43 - 1.12	1.29	0.358	0.75 - 2.20
Physical activity (past year)*8						
Low activity (bottom tertile)	ref	ref	ref	ref	ref	ref
Medium activity (middle tertile)	0.54	0.000	0.41 - 0.72	0.61	0.001	0.46 - 0.83
High activity (top tertile)	0.26	0.000	0.18 - 0.37	0.42	0.000	0.28 - 0.62

Abbreviations: ref, reference category; LA, living arrangements (standard vs. aging-customised dwellings); var, variable; PCS (SF36 Physical Component Score); MCS (SF36 Mental Component Score)

***1** SF-36 PCS & MCS scores change calculated for baseline-Year5 interval and for Year5-Year10 interval

***2** For time-dependent variables (other than PCS & MCS change) used baseline value for baseline-Year5 interval; Year5 value for Year5-Yr10 interval

***3** Employed Part time includes: Employed part time, disability, self-employed, sick leave

***4** Other (employment status) includes: Homemaker full time, unemployed, student, volunteer, leave of absence

***5** Cumulative burden of chronic diseases over waves.
Includes: Osteoporosis, osteoarthritis, hypertension, heart attack(s), stroke/TIA(s), neuromuscular disease, respiratory disease, diabetes (1&2)

***6** Living arrangements *x* <variable>

***7** Living arrangements *x* <all variables>

***8** Variable significant in Wald testing

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CHAPTER 4 CONCLUSION

Academic Summary:

The goal of this thesis was to examine the association between changes in overall physical and mental health and future ability to age in place.

In Chapter 2 (Background) I reviewed the existing empirical evidence on determinants of aging in place as found in a number of discourses, including gerontology, healthy aging, independence in aging, aging in place, determinants of living arrangements, determinants of institutionalisation, late life migration, and others. I identified that there was insufficient investigation of overall health as a determinant of aging in place in general, and almost no use of multi-dimensional measures of overall physical and mental health, specifically.

In Chapter 3 (Manuscript) I conveyed the complete scope of the study, including specific objectives, methods, results, and discussion. We found that a clinically-significant decline (≥5 pts) in overall physical health, as measured by the SF-36 summary PCS (physical health) is associated with living in aging-specific dwellings within five years, after adjustment for a wide range of sociodemographic, social network and health-related measures. We did not find a similar association with decline in overall mental health, as measured by the SF-36 summary MCS (mental health). To our knowledge this is the first study that has examined the effects of health-related quality of life (HRQOL) on aging in place.

Our study also corroborates two known key 'protective' factors to reducing the likelihood of living in aging-specific living arrangements: living with a spouse/partner and having children to provide support. Our study also provides unique evidence about

the ‘protective’ role of moderate to high levels of physical activity in supporting aging in place.

We confirmed older age as a ‘risk’ factor known to substantially increase the likelihood of living in aging-specific living arrangements within five years. We also found that increasing burdens of aging-related chronic diseases increase risk of not being able to age in place, as do falls.

While this study has contributed new empirical findings to the body of knowledge about determinants of aging in place, future work in larger datasets should test these results separately by sex, which will add additional important evidence, given that we know the experience of aging in place, as well as aging overall, differs substantially by sex. Including a measure of income status is also desirable.

In summary, this thesis investigation provides a unique perspective on the effect of HRQOL scores on future ability to age in place. To our knowledge no population-based longitudinal Canadian research has focused on overall health as a determinant of living arrangements.

Personal Reflections:

The journey of developing a research proposal, securing data, conducting analyses, and writing up and pondering the meaning of the results has taught me a number of valuable scholarly lessons and skills:

- Focusing an inquiry when surrounded by an ocean of information
- Research skills like data management, GEE longitudinal analysis, and how to use Stata software

- Increased respect for the skills required for sound scientific inquiry
- Increased compassion toward other researchers about the compromises that inevitably have to be made to the 'perfect' study in order to complete the 'doable' study

I have also learned a great deal about aging in general, and living arrangements for older persons specifically:

- Urgency for research and public policy to respond to the rapid aging of populations worldwide
- Heterogeneity of the aging experience, as opposed to stereotypes
- Substantially different aging and living arrangements experience for women than for men
- Expansion of a simplistic personal view of living arrangements for older persons. My experience with older relatives has been that they have always lived in their own house or apartment or with a family member until they passed away or (rarely) unless they needed 24 hour medical care (generally at the very end of their lives)—my understanding of the multi-faceted reality of the living arrangement environment has been expanded a hundred-fold through my thesis readings

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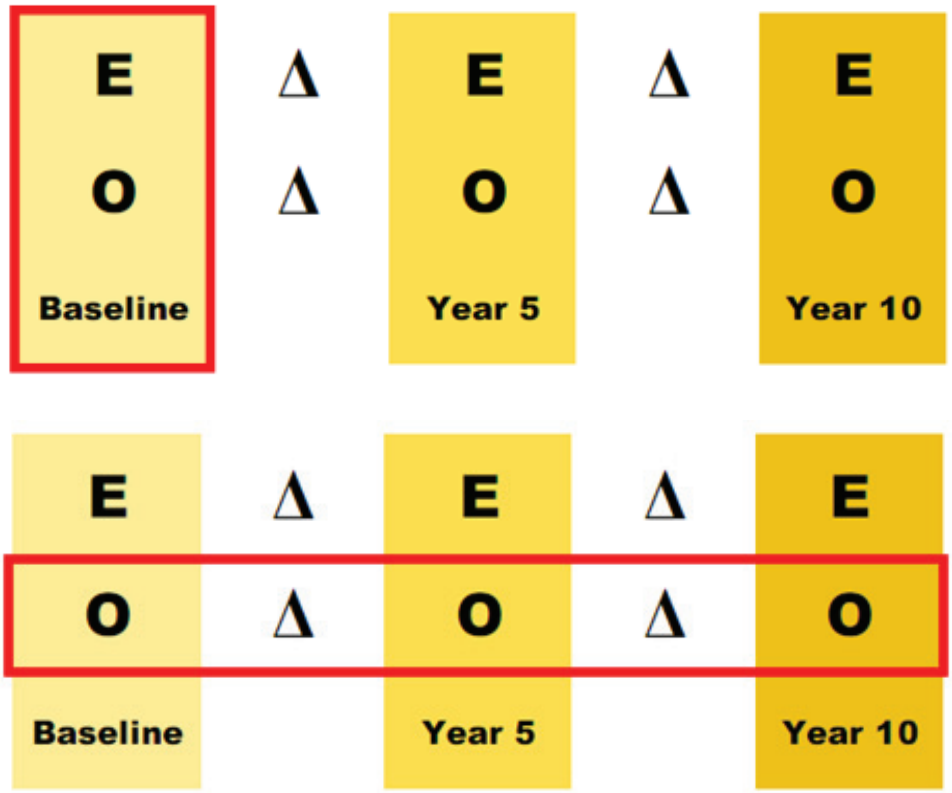
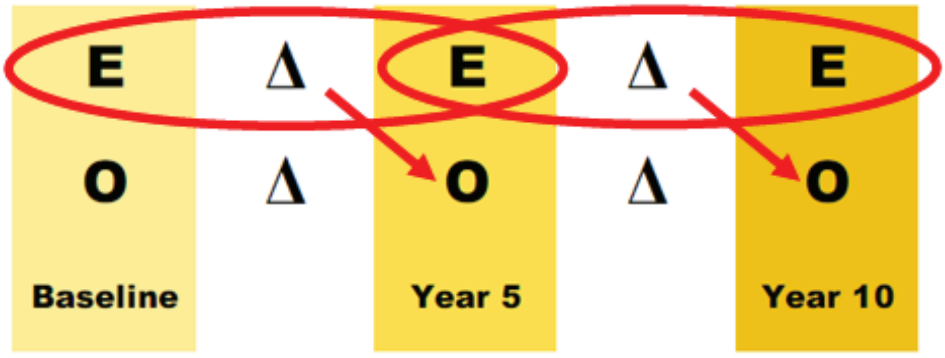
APPENDIX A Study objectives in diagrammatic format

Objective 1: Describe and compare the stability of physical and mental health status and living arrangements over ten years..

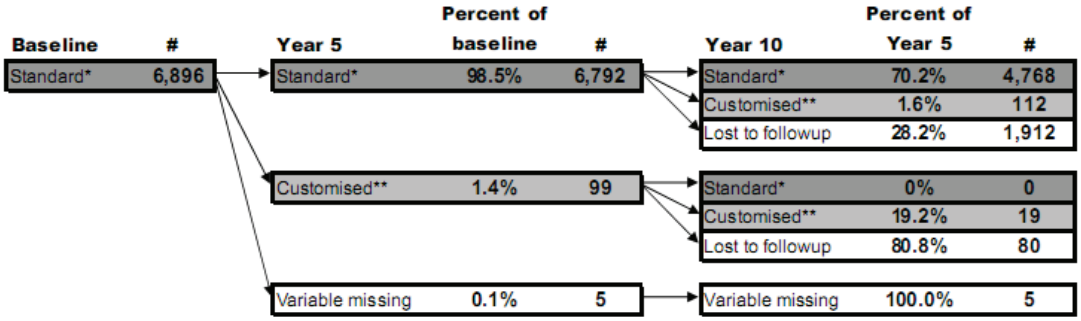


Objective 2: Investigate whether clinically-significant change in physical or mental health status predicts future living arrangements.



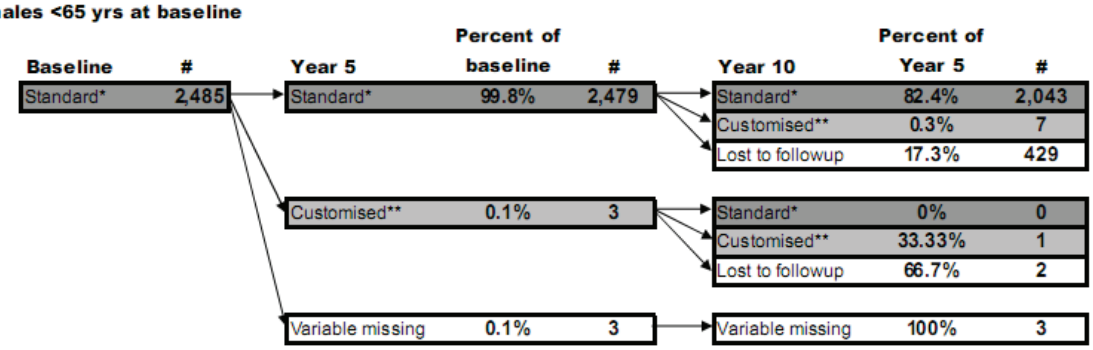
APPENDIX B Individual living arrangements transitions by sex and baseline age group across waves

All participants (n=6,896)

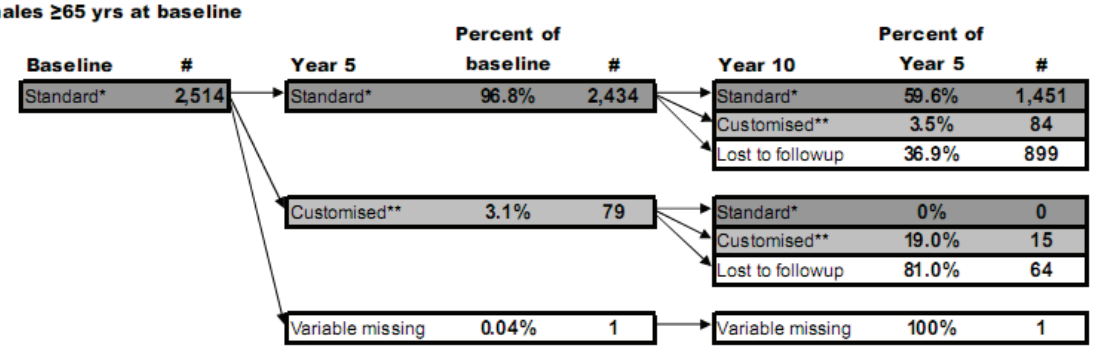


Participant subsets

Females <65 yrs at baseline

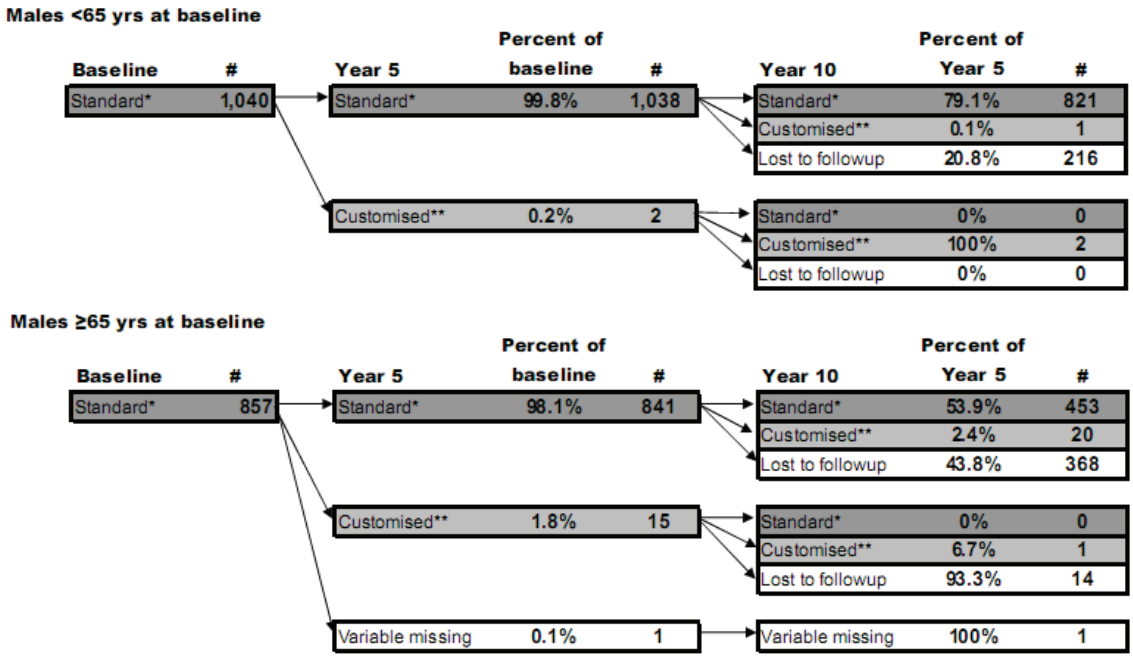


Females ≥65 yrs at baseline



continued …

Appendix B—cont'd: Individual living arrangements transitions by sex and baseline age group across waves



*standard living arrangements (i.e., house, apartment, condo)
**aging-specific living arrangements (i.e., lodge, nursing home, extended care home, chronic care hospital, independent seniors housing)

NOTE: Lost to followup (1,992) includes: death, refusal, unable to contact

APPENDIX C Dalhousie University Health Sciences Human Research Ethics Board Letter of Approval – Project # 2010 2224 (version 2)

DALHOUSIE UNIVERSITY
Inspiring Minds

Health Sciences Human Research Ethics Board
Letter of Approval

Date: June 10,2010

To: Camille L Angus, Community Health and Epidemiology
Susan Kirkland , Community Health and Epidemiology

The Health Sciences Research Ethics Board has examined the following application for research involving human subjects:

Project # 2010-2224 (version 2)

Title: The Effects of Physical and Mental Health Status on Transitions in Living Arrangements of Community-Dwelling Middle-Aged and Older Canadians

and found the proposed research involving human subjects to be in accordance with Dalhousie Guidelines and the Tricouncil Policy Statement on *Ethical Conduct in Research Using Human Subjects*. This approval will be in effect for 12 months from the date indicated below and is subject to the following conditions:

1. Prior to the expiry date of this approval an annual report must be submitted and approved.
2. Any significant changes to either the research methodology, or the consent form used, must be submitted for ethics review and approval *prior to their implementation*
3. You must also notify Research Ethics when the project is completed or terminated, at which time a final report should be completed.
4. Any adverse events involving study participants are reported immediately to the REB

Effective Date: June 10,2010 signed:
Expiry Date: June 10,2011 Jeannette McGlone (Chair HSHREB)

IMPORTANT FUNDING INFORMATION - *Do not ignore*

To ensure that funding for this project is available for use, you must provide the following information and FAX this page to RESEARCH SERVICES at 494-1595

Name of grant /contract holder _____ Dept. _____
Signature of grant / contract holder _____
Funding agency _____
Award Number _____ Dal Account # (if known) _____