The perceived unmet need for home care and impact on frailty related health outcomes among community-dwelling middle-aged and older adults in Canada

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

With the aging population, there is an increased need for the development of interventions and prevention programs to mitigate the impact of frailty on the health and well-being of older Canadians. The association between frailty and adverse health outcomes has been well established, however little is known about the impact of contextual factors that may mitigate or moderate this relationship. Home care services play an important part in providing necessary assistance to seniors within their homes and potentially preventing functional decline. Improved availability and/or accessibility to health care within the community are important target areas for potential prevention and policy reforms. To better understand the significance of unmet home care needs, and potential contributing factors, among Canadians with varying levels of frailty, this thesis sought to explore the role of unmet home care need as a moderating factor of the association between frailty and key health outcomes (i.e., inpatient acute care hospitalization and mortality) among community-dwelling adults aged 45 years and older.

This research utilized data from the 2008/09 Canadian Community Health Survey-Healthy Aging (CCHS-HA) cycle 4.2, linked to administrative health databases, specifically the Discharge Abstract Database (DAD) 2007 through 2011 and Canadian Mortality Database (CMDB) December 2008 through 2011. The study population consisted of all participants aged 45+ years residing in all provinces (excluding Quebec). A previously validated frailty index (FI) was derived from survey items and utilized to determine those who were robust (≤0.1), pre-frail (>0.1 to ≤0.21) and frail (>0.21), within the sample. Descriptive analyses were conducted to determine the prevalence of frailty (robust 52.5%, pre-frail 33.5%, frail 14%) and unmet home care need (2.4%) overall, and by key respondent characteristics. Multivariable logistic regression models adjusted for relevant covariates were utilized to examine the associations between frailty

and first-event inpatient hospitalization and mortality over a 2-year follow-up period, as well as possible effect modification of these associations by the presence/absence of unmet home care need.

This study builds on previous frailty research, which largely focused on more impaired populations, by utilizing population-based data to derive a FI to assess prevalence and outcome associations. The exploration of unmet home care need as a modifier of frailty-outcome associations also builds on research evaluating the role of contextual factors in frailty trajectories. Bivariate results were largely consistent with past frailty research. Respondents who were frail (FI >0.21) were significantly more likely to be older, female, widowed, and to report low household income, low education and low social support availability (SSA). The same characteristics were associated with higher prevalence of unmet home care need.

Previous research has suggested greater unmet health care need among younger (<65 years) cohorts. Studies investigating unmet home care need have found higher prevalence in older age groups, while the absolute number of those reporting unmet home care need is highest among 35-49 year olds. The prevalence of unmet home care need was higher in frail (10.5%) compared to robust (<0.7%) respondents, Those reporting unmet home care need were also more likely to report receiving either formal (21.3%) or informal (65.9%) home care support compared to respondents without such a need (4.9% and 10.7%, respectively). Multivariable analysis showed significant associations between frailty and both hospitalization (OR=3.18, 95% CI 2.35-4.29) and death (OR=4.06, 95% CI 2.39-6.88) after adjusting for key covariates, with the odds of hospitalization for frail respondents much higher in this population than has been found in more impaired populations. Although unmet need was a significant independent predictor of hospitalization in select models, it was not found to significantly modify the association between

frailty and hospitalization. Unmet home care need was significantly associated with death in age and sex adjusted models only, with no statistically significant effect modification found for this outcome. Secondary analyses exploring SSA as an effect modifier were also conducted due to high correlations with both frailty and unmet home care need. SSA was also not found to modify observed frailty-outcome associations in this population.

These results provide evidence of the predictive ability of frailty indices for community-dwelling populations, including middle-aged Canadians (aged 45-64 years). The findings also suggest that, although unmet home care need was not an effect modifier in the current study (possibly reflecting low power given its low prevalence in this relatively healthy survey sample), it was an independent predictor of hospitalization in select multivariable models, and therefore, may represent an important contextual factor requiring further exploration. Given the preliminary nature of the investigation of SSA as an effect modifier of frailty-related outcomes in the present study, further research of its relevance in other middle-aged and older populations is also warranted. The identification of differences in outcomes of those with met versus unmet home, health and psychosocial needs among more vulnerable or frail community-dwelling Canadians will lead to a broader understanding of where services, policy and prevention measures should be targeted.

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List of Abbreviations

ADL	Activities of Daily Living
AL	Assisted living
ALC	Alternate Level of Care
BMI	Body Mass Index
CAPI	Computer-assisted Personal Interviewing
CCHS	Canadian Community Health Survey
CCHS-HA	Canadian Community Health Survey- Healthy Aging
CHS	Cardiovascular Health Study
CIHI	Canadian Institute for Health Information
CMA	Canadian Medical Association
CMDB	Canadian Mortality Database
DAD	Discharge Abstract Database
EFS	Edmonton Frail Scale
FI	Frailty Index
FI-CGA	Frailty Index derived from Comprehensive Geriatric Assessment
FRAIL	Fatigue, Resistance, Ambulation, and Loss
FTS	Frailty Trait Scale
GRLS	Generalized Record Linkage Software
HUI	Health Utilities Index
IADL	Instrumental Activities of Daily Living
ICD-10	International Statistical Classification of Disease and Related Health Problems 10th Revision

LTC	Long-term care
MI	Myocardial Infarction
MOS	Medical Outcome Study
SOF	Osteoporotic Fractures Frailty Index
SSA	Social Support Availability
SSHRC	Social Sciences and Humanities Research Council
SWORDC	South Western Ontario Research Data Centre

Chapter 1

Introduction

Canada is among many countries facing a rapidly aging population. In 2017, the population of adults aged 65 years and older was 6.2 million or 17% in Canada. Over the next 15 years, this number is expected to increase to 10.4 million or 25% of the population (1,2). Along with this population aging, the proportion of seniors aged 75 years and older is expected to double. In 2017 there were 2.6 million people aged 75+ years with a projected increase to 5.7 million in 2037 (1). This age group makes up a large portion of persons in need of continuing care due to their increased likelihood for multiple chronic conditions and disabilities and further increases in their numbers will place increased strain on continuing care services over the next 20 years (1).

Along with this aging population will be an increase in the number of frail older adults (3–6). Although multiple definitions exist, frailty most often refers to a decreased ability to respond to stressors due to multi-system dysfunction, leading to decreased resiliency and increased risk of adverse health outcomes, such as hospitalization and death (5). Approximately one million community-dwelling Canadians are considered frail with a further 1.4 million in a pre-frail state (7,8). These individuals tend to require greater health services and pose a unique challenge within the health care system. Assessment and identification of frailty among community-dwelling older adults is important to the provision of effective and appropriate care (8). This care often involves formal care delivered in the home by health professionals and informal care provided by caregivers, such as family, friends or neighbours. The use of home-

based integrated care strategies for the management of this complex condition has placed a greater emphasis on both formal and informal home care support (9).

Several previous studies of frailty and related outcomes have been conducted among home care clients and residents of both assisted living (AL) and long-term care (LTC) facilities (3,10–15). There is limited research, however, identifying contextual factors that may modify adverse health outcomes in frail older adults receiving formal care in the community or other care settings. Potentially relevant factors that warrant further investigation include informal caregiver burden (9,16), low psychosocial resources (17,18) and unmet need (19). Also scarce are studies specifically focused on the relevance of contextual factors to frailty-related outcomes among community-dwelling older adults *not* receiving these formal care services. One contextual factor that may be particularly important to the health outcomes of community-dwelling older adults with frailty is the presence of perceived unmet health care need (20). Previous research in the area of unmet need has provided important information on how the availability and accessibility of health care (including formal home care) can impact outcomes in those with chronic conditions or disabilities (21–28).

In Canada, approximately 14% of adults living with a chronic condition report having an unmet health care need (23). Unmet health care needs may be an indicator of access issues within the health care system, as they may be the outcome of inadequate availability of necessary health services at the time and in the place they are needed (29). There is a paucity of research exploring frailty and unmet need: what has been found however, is consistent with studies of adults with disabilities and chronic conditions (20). Although frailty is distinct from disability, there appears to be overlap in the types of needs required and barriers to accessing these services (21,25,29–32).

Meeting the needs of older individuals within the community is important for maintaining their independence and autonomy. Functional decline causing impairment in instrumental (IADL) and/or basic activities of daily living (ADL) increases the risk for falls, institutionalization, hospitalization and mortality (33). The provision of both formal and informal home care can assist in mitigating these risks (25). When the needs for home care services go unmet, the risk of these adverse health outcomes increase (23,25,34), as well as the health care costs associated with them (29,35). As previous work has shown, the availability and accessibility of health care can impact outcomes in those with chronic conditions or disabilities (21–25,27,29,30,32).

This thesis used data from the 2008/09 Canadian Community Health Survey - Healthy Aging (CCHS-HA) cycle 4.2 to further explore the potential modifying role of unmet home care need as a salient contextual factor. The CCHS-HA is a population-based cross-sectional survey of a representative sample of Canadians aged 45+ years that has been linked with longitudinal data from the Discharge Abstract Database (DAD) and the Canadian Mortality Database (CMDB) through to 2011. The primary aim of this research was to explore the degree to which perceived unmet home care need modified the associations between frailty level and first-event inpatient hospitalization and mortality assessed over 2-years in community-dwelling adults aged 45 years and older.

A better understanding of unmet home care need in this vulnerable population and its potential impact in modifying adverse health outcomes, especially first-event inpatient hospitalization, may provide important insights into areas for community care interventions. Policies and prevention programs to mitigate deterioration to more severe frailty levels and reduction in risk of adverse outcomes associated with frailty, should be important public health

priorities. The lack of frailty research exploring unmet health care need (or unmet home care need more specifically) means that this study may be a precursor to future work examining this contextual factor. Previous research indicates that younger cohorts report greater unmet health care need than older cohorts (29,36–38). The inclusion of individuals 45 to 64 years of age will allow further comparisons with relevant age- and sex-subgroups to be made and, to our knowledge, has not been done previously. The findings from this research may also help to support enhanced programing and community care services for those of working age and who are not yet considered frail. It has been shown that transitions between frailty levels are bidirectional, with movement between robust and pre-frailty levels more likely than from frail to pre-frail or robust (39). Policy and prevention programing should therefore, also include a focus on improving community care delivery among adults in the earlier phases of frailty progression (e.g., pre-frail) to reduce the likelihood of further functional decline and adverse health outcomes.

Chapter 2

Literature Review

2.1 Frailty

Ensuring high quality and cost-effective care for persons with frailty is emerging as a particularly important priority facing the Canadian health care system. It is estimated that there are over one million frail Canadians, with many more unrecognized (7). The prevalence of frailty among community-dwelling older adults (i.e., those aged 65 years and older) is estimated to be between 10 and 20 percent, with generally higher prevalence estimates reported for women than men (8,40). Although frailty can be experienced at any age, the prevalence of frailty increases with advanced age (7,8,40,41). It is estimated that frailty affects between 25 and 50 percent of adults greater than 85 years of age (13).The rapidly aging Canadian population, and expected increase in numbers of pre-frail and frail older adults, present unique challenges to the health care system, which is organized around the care and treatment of single-system illness (3). The multi-dimensional nature of frailty requires new approaches to the management of care for vulnerable older adults, including early identification of emerging health issues and care plans that consider non-curative management strategies within the community that may mitigate adverse outcomes.

The following sections provide an overview of the defining characteristics of frailty, how frailty is measured and operationalized, and the adverse outcomes associated with frailty.

2.1.1 Defining Frailty

Frailty is most often defined as the decreased ability to respond to stressors due to multi-system dysfunction, leading to decreased resiliency and increased risk of adverse health

outcomes (5). Although there is agreement in the literature on these core features of frailty, there is still debate over how to best operationalize and measure it. There are two broad methods of conceptualizing frailty; as a *syndrome,* caused by underlying pathophysiological processes, which manifest as a collection of identifiable symptoms (41), or a *state* of accumulated deficits (42). Although conceptually different, these models are not mutually exclusive. The phenotypic approach proposed by Fried in 2001, conceptualizes frailty as a *syndrome,* wherein an individual presenting with at least three of five conditions (i.e., weight loss, weakness, exhaustion, slow gait speed and low physical activity), can be considered frail (41). With this definition, individuals with impairments in one or two of the above items meet the criteria of pre-frailty, a latent, pre-clinical phase (41) which may be more amenable to intervention and reversal (39,43,44). Robust individuals are those who may have morbidities, but have no impairment in the above listed items and are therefore not considered pre-frail or frail (13).

The second approach, which views frailty as a *state* of accumulated deficits, is the *cumulative deficit model*, wherein the specific dysfunctions are not as important as the number of deficits identified (42). This approach uses a large number of deficits occurring in several domains and calculates an individual ratio corresponding to a level of frailty (42,45). This approach is widely used in population level research with validated frailty indices (7,10,11,14). This model posits that the accumulation of deficits over time impacts an individual's ability to withstand stressors and that movement between frailty levels may be fluid or malleable (39). The use and validation of both of these approaches has been well established (7,9–11,14,17,19,39,46,47), with both illustrating statistically significant predictive validity for adverse health outcomes in the literature (13). Direct comparison of these two approaches by Kulminski et al., however, revealed that the use of frailty indices more precisely categorizes

individuals within the frailty levels and is, therefore able to more accurately predict adverse outcomes than the phenotypic approach across all levels of frailty (48). As described further in the Methods chapter, this thesis employed the *cumulative deficits model* using a frailty index (FI) derived from survey items assessed as part of the CCHS-HA.

Regardless of the conceptual model being employed, the biological theories as to the origins of frailty are generally similar. Frailty is a clinical condition that is the result of physiological changes, which result in the diminished ability of the body to maintain homeostasis in the face of stressors, such as minor illnesses (13). These changes, although seen as a process of normal aging, are accelerated in frail older adults (13).

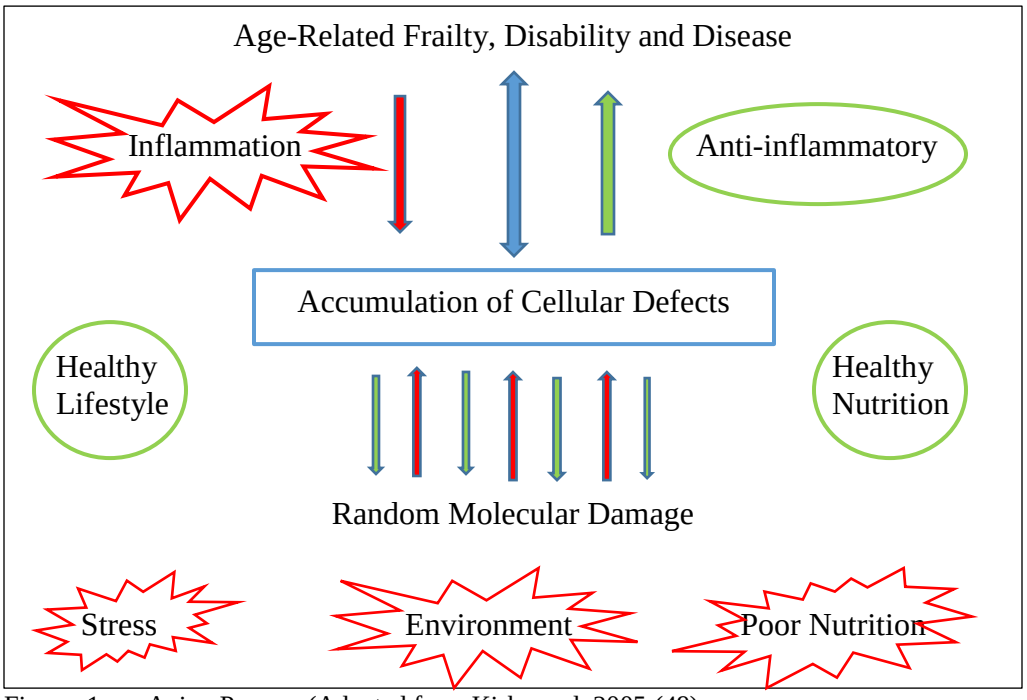


Figure. 1 Aging Process (Adapted from Kirkwood, 2005 (49)

There are a number of converging theories, which aim to describe and explain these changes. Aging in general is thought to be the result of the accumulation of cellular damage

throughout the life course, as a result of minor errors in cellular maintenance and repair mechanisms (see Fig. 1) (49,50). The heterogeneity of human aging can be explained by individual differences in sources of exposure through the life course. Epigenetic mechanisms, physical activity, diet and other lifestyle exposures also contribute to the aging process (49,50). This accumulation of molecular damage leads to dysfunction and vulnerability to disease, however compensatory mechanisms for these age-related changes and diseases exist for most. The amount of accumulated dysfunction needed to overcome these regulatory mechanisms leading to frailty is unknown and may differ across individuals (13,50).

Regardless of how frailty is conceptualized, the underlying mechanisms are generally believed to be the same. The methods for measuring frailty will be discussed in the next section and will provide insight into the operationalization of frailty used in both research and the clinical setting.

2.1.2 Frailty Measures

Although there is general agreement on the key features of frailty, there is still debate over how to best operationalize it. This is reflected in the large number of approaches to the assessment of frailty that have been proposed (51,52). Physical frailty items, multidimensional frailty measures and the frailty index (FI) form three broad categories of approaches to the measure of levels of frailty (4).

Physical frailty measures, following the *phenotypic* approach introduced by Fried et al. (41), include: Fried and colleagues' original measure derived from items assessed in the Cardiovascular Health Study (CHS)(41), the Osteoporotic Fractures Frailty Index (SOF) (53), the Short Physical Performance Battery (54), and the SHARE-FIT (Survey of Health, Aging and

Retirement in Europe Frailty Index) (55). The focus of these measures strictly on the physical domain has been criticized as inconsistent with the accepted definition of frailty as multidimensional (4).

Other frailty measures with a broader multidimensional focus, i.e., beyond physical function, include: the Edmonton Frail Scale (EFS) (56), Fatigue, Resistance, Ambulation, and Loss (FRAIL) (57), Frailty Trait Scale (FTS) (58), and the Tilburg Frailty indicator (59). These measures include domains such as cognition, mood, self-perceived health and psychosocial support, as well as physical functioning.

The FI approach is consistent with the *cumulative deficits model* (46), and utilizes a broad range of health-related items (at least 30 items) to calculate a ratio of deficits present to the number of deficits included in the measure. Unlike the *phenotypic* approach, which dichotomizes frailty levels as present or absent, the FI forms a continuous variable of frailty severity, from not frail or robust through pre-frail and frail (13). There are a number of reliable and validated FI measures developed by researchers including, Searle et al.(47), Armstrong et al.(12), and Hogan et al.(11). These FI measures generally include items such as IADL limitations, mood, cognition, psychosocial support, self-perceived health, chronic conditions and physical functioning.

One of the original FI measures, derived from 92 variables assessed as part of the Canadian Study of Health and Aging (CSHA), included a range of symptoms, disease states, biological measures and dysfunction (60). Each item was evaluated as either present or absent and the total number of present variables was calculated as a proportion of the total considered (60). Each deficit within the model is equally weighted and contributes to the overall level of frailty in the proportional calculation. Searle and Colleagues (47) introduced a method for the creation of a FI, which has since been widely employed (7,11,14). They stipulate that the

included items must be health related, increase (but not reach saturation too early) with age, include deficits that span a range of domains, and exhibit sample deficit consistency (i.e., FI results are similar between random samples, regardless of the number and type of items included) (47). A two-thirds rule has been established when calculating a FI, showing that, regardless of the number of included variables, that no more than two thirds (approximately 0.67) of the deficits can be present in one individual. This number seems to be a threshold for system collapse and death (13).

The number of deficits included must be sufficient to produce accurate estimates, with too few deficits resulting in unstable or unreliable estimations. A minimum of 30 items are believed to be required to effectively and accurately estimate frailty levels (47). Comparative studies using both a full and modified, shorter version of the FI have shown similar predictive validity (40). However, earlier studies that examined both a full and modified FI among a AL and home care cohorts, showed the full FI to have better predictive validity for key outcomes of interest, including institutionalization (11,14), suggesting that for vulnerable older adults, a more comprehensive screening tool should be utilized (14). Although there have been studies that have utilized the FI for community-dwelling older adults not receiving home care (7,61–63), the application of the FI has largely involved LTC, AL and home care cohorts in Canada (10,16,64).

These various assessment approaches introduced above provide measures for the identification of levels of frailty. Despite their differences, both phenotype and cumulative deficits frailty measures have been shown to have predictive validity by illustrating statistically significant associations with selected health outcomes, such as institutionalization, hospitalization and mortality (13). The use of continuous variable models, such as the FI,

however, has been found to provide a more accurate measure of those who are considered pre-frail and robust, when compared to the dichotomous Fried *phenotype* model (13).

2.1.3 Frailty and Adverse Health Outcomes

Older adults with higher (vs. lower) frailty levels face an elevated risk of adverse health outcomes, such as falls, hospitalization, LTC admission and mortality (14). These observed associations are independent of age, sex and comorbidity (14,33,40,60). The prevalence of frailty is typically higher among women than men, though frail men have been found to have higher levels of physical and cognitive impairments than frail women, requiring greater home care support (65,66).

The risk of adverse health outcomes increases with greater levels of frailty, such that the frailest older adults face the greatest risk (66). Although frailty is a strong predictor of disability, institutionalization and mortality, previous research suggests it is only marginally predictive of hospitalization (14). This may reflect the fact that acute care use can be unpredictable and other factors, such as the availability and use of primary and community care, advance directives, previous health care use (14), psychosocial resources and other individual factors (17), can influence the hospitalization of frail older adults. Hospitalization as an outcome measure in frailty research, however, has been widely used (7,11,14,39,67,68) and provides an often available and easily captured population-level measure. Additionally, hospitalization as an outcome of interest is relevant given that care transitions and acute care hospital stays may lead to heightened risks for functional decline among vulnerable older patients (39,69,70). For example, studies have shown that hospitalization events may increase the risk of transition between frailty states (39,44,71,72). This transition is usually from a robust or pre-frail state to a

frail state, which increases the risk of subsequent adverse health outcomes, such as falls, physical decline, re-hospitalization and death (39).

Hospitalizations with longer lengths of stay can exacerbate existing conditions and contribute to functional decline, limiting independence and at times leading to increased community care needs or risk for discharge to LTC (73). Other adverse outcomes associated with the hospitalization of older adults include psychological distress, delirium, falls, medication issues and iatrogenic conditions (74–76). It has been found that being frail, living alone, experiencing functional decline and requiring assistance with IADL or ADL are all predictors of hospitalization (5,39,73).

Appropriate screening, assessment and care planning to limit the risk of hospitalization in a vulnerable population of frail adults should form the focus of prevention strategies (4,77). There is work being done to develop non-hospital based management for frail older adults, which hopes to limit subsequent adverse events (77). The focus is appropriate transitional planning, understanding and planning that is reflective of patient goals and multidisciplinary, coordinated geriatric care (77).

Mortality has also been widely used as an outcome measure in frailty research (11,12,40,42,47,48,60,78,79), with a higher risk of death noted for frail compared with pre-frail and non-frail individuals (80). Hogan and colleagues suggest that the modest associations between frailty and hospitalization that have been reported in previous work may be due, in part, to the competing risk of death (4). For this reason, mortality was included in this study as a secondary outcome measure through CMDB linkage.

2.2 Community Care

Community care, including both formal publically-provided home care, as well as informal care provided by family, friends and neighbours, is of increasing public health importance as a means of reducing the risk of acute care hospitalization, functional decline, and LTC placement (14). Over 2 million Canadians with chronic health conditions, disabilities and age-related problems, such as frailty, received formal home care in 2012 (81). Home care is a growing sector of the health care system in Canada, allowing older adults living with IADL or ADL limitations to preserve independence in their homes, while decreasing health care costs (64). Frail older adults are more likely to require and use home care services (82), the provision of which can reduce or delay movement to AL or LTC (83). Efforts are being made to expand publically-funded in-home care services in an attempt to mitigate acute care utilization and LTC placement of vulnerable older adults (81). The identification of individuals most at risk for hospitalization and institutionalization, and those who will benefit the most from community care, is of increasing importance to the health care system (14,83).

Home care also aligns with the wishes of many older adults to age and die in place (84). A movement over the past number of years towards the provision of care within the community is not only to facilitate care that aligns with the values and expectations of the public, but also to promote care options that result in cost savings to the health care system (84). Although there is a vision of increasing access and use of home care for older adults, the amount of care required to meet the growing needs of an aging population is fast outpacing the available resources (1,85). For the most vulnerable Canadians, this puts an increasing amount of pressure on informal (family/friend) caregivers.

Informal caregivers are often spouses or children of older adults, many of whom are women, with the majority being between the ages of 45 and 64 years (85). The informal care they provide ranges from assistance with IADL limitations, such as help with shopping and/or housework, and transportation to appointments, to more intensive care for ADL limitations, such as assisting with bathing, dressing and feeding. In Canada, the provision of home care by informal caregivers is believed to save the health care system approximately $25 billion annually (86). It is estimated that 2 of the 8 million informal caregivers in Canada provide greater than 20 hours of care per week (86). An estimated 2.2 million Canadians, many aged 65 and older, required community care from formal home care services in 2012 (87). This number is expected to increase as the population ages and the proportion of older adults living with disability and frailty rises, adding to the reliance on informal caregivers (86).

This informal care can have profound consequences on the caregiver in the form of stress and burden, including loss of paid work, monetary costs involved in providing care and lost time with other family (16,88). The level of caregiver burden is relative to the functional capacity of the care recipient, the number of hours per week spent on providing care, the amount of social support, and the amount of time outside of care responsibilities caregivers feel they have (88–90). Increasing the availability and accessibility of home care services for vulnerable older adults may act to reduce not only the demands placed on informal care support, but also the need for higher levels of care requirements (16,81–83) .

2.3 Unmet Home Care Need

There is an assumption of equitable access and utilization of health care services in the Canadian health care system. Although Canada has universal health care, there exists inequities

in heath service availability and accessibility (37). Unmet need, which is the difference between required health care services for a particular medical or health-related issue and the actual health care services received, was initially described by Carr and Wolfe (24). This definition has been widely adopted when exploring the prevalence of unmet heath care need, as well as in program and health system evaluations of effective service delivery (19,22,30,32,37,38). Unmet need can be the result of system level factors, such as availability or wait times, and/or may reflect the consequences of sociodemographic or personal factors (19,22,37,38). It has been suggested that income, time constraints, family obligations, education and personal beliefs with regards to the proposed or needed care form person-related factors that contribute to whether a person accesses care when needed (22).

Previous findings indicate that key predictors of unmet health care needs in Canada include being female, under the age of 65, having low income and/or education, multiple chronic conditions, chronic pain, or poor self-perceived health (26,36,38,66,91). Other predictors relate to social support, with a higher prevalence of unmet heath care need noted among those reporting no close relationships, not belonging to a social organization, or having no one to call on for assistance or advice (26,92). A "clustering of disadvantage" (93) in particular sociodemographic and health characteristics, such as low income, education and negative health behaviours (i.e., smoking, poor nutrition and lack of exercise), contribute significantly to health inequalities. This sociodemographic disadvantage substantially increases the risk of unmet health care needs (26). A higher incidence of multiple chronic conditions and health related issues leading to higher health care needs are seen in those from a low versus high socioeconomic background. (26). It has been found that, although this section of the population has higher health care needs, they are

less likely than the wealthiest Canadians to be referred to and to see a specialist physician (37,94).

Women have consistently been found to have greater unmet health care needs than men (26,32,37,38,92,95,96), especially among those under the age of 65 (32,37,38,95). This has been hypothesized to be the result of differences in the opportunity to seek care, as a result of women's social and occupational status (26). Women are more likely than men to be precariously employed, be primary caregivers and to have low income, impeding their ability to seek health care when they need it (26,66).

There is a strong association between unmet health care need and socioeconomic status (21,23,29,37,95). Previous research indicates that higher service users and sicker individuals report higher unmet need (37). This greater service need is also highly correlated with low income status, with lower income individuals disproportionally receiving poorer care (97). The exploration of these determinants indicate that unmet health care needs are a critical indicator of issues with access to necessary services (21,29). Research in the area of unmet need and health care utilization have mostly utilized a dichotomous approach to the operationalization of unmet need (19,36,95,98). The separation of unmet need into domains, such as *availability, accessibility* and *acceptability* however, has broader implications for the study of service utilization and health inequity (29,37). Understanding the reasons for perceived unmet need, and whether the delivery of health care in universal health care systems is equitable, may provide insight for policy change to diminish socioeconomic barriers to accessing necessary care (37).

Studies investigating unmet need for home care in Canada have found that individuals reporting unmet need disproportionately represent those from lower socioeconomic groups, are more often aged 55 to 64 and are often caregivers themselves (25). Those reporting unmet or

partially met home care needs also often reported feelings of loneliness, stress and insomnia (25). Results of a study using the CCHS-HA found that, among those who reported receiving home care services, 53% reported receiving informal care exclusively (99). This highlights the importance and continued reliance on informal sources of care in Canada. Hoover and Rotermann also found that 4% of participants aged 65+ years reported an unmet professional home care need, with the majority of these individuals citing accessibility due to cost as a barrier to care (99). There is a need for improvements in the availability and accessibility of home care, which is likely to increase as the population continues to age and the number of older adults requiring care increases.

There are a number of studies exploring unmet health care need (22,23,32,35–38,92,98,100–103) and a few that have specifically addressed unmet home care need (99,104–108) in the Canadian context. Two studies have looked at unmet home care need utilizing the CCHS-HA. The first, by Hoover and Rotermann, provided a profile of older adults (aged 65+ years) receiving home care services and their self-perceived unmet home care needs (99). The second, by Jin and colleagues, examined the use of and unmet need for home care services among a middle-aged and older adult population with self-reported visual impairment (108). None of the articles utilizing CCHS data examined unmet health or home care need according to frailty status among a population of middle-aged or older (i.e., 45+ years) adults. Consequently, the application of the FI to the CCHS-HA data to examine the impact of unmet home care need on frailty-associated adverse outcomes represents novel research.

2.3.1 Frailty and Unmet Home Care Need

As discussed above, older adults with higher frailty levels face an increased risk of functional decline, falls, hospitalization and mortality. Having the community-based services required to meet the complex needs of this population is imperative to mitigating this risk. Limited availability and accessibility form barriers to health care utilization and may lead to a higher prevalence of unmet home care need. How these barriers impact outcomes for middle-aged and older adults with varying degrees of frailty represents a gap in the literature. Further research in this area may provide important insights regarding relevant policy and prevention interventions for this complex population.

A few studies have explored the impact of unmet health care need in individuals with chronic conditions (23,29,32,38,101,109,110). Common to these studies is the increased risk of adverse health outcomes, such as hospitalization and worsening disability, in the presence of unmet health care need. Older adults with new or worse disabilities following hospitalization are particularly vulnerable to further functional decline and hospital readmission when ADL care needs are not met upon discharge (31). Mitra et al., who examined unmet health care need in a cohort aged 18 to 59 with disabilities, determined that two thirds of participants reported at least one unmet health need (111). This is consistent with other studies examining unmet health care need in comorbid older adults (35,101,109,110), where greater health care needs appear to be positively correlated with greater risk of unmet need.

The presence of chronic conditions may adversely impact physical health, overall well-being and self-perceived health (32,110). Persons with poor self-rated health more frequently report greater *availability* related unmet need than those with good or excellent self-perceived health (29). Unmet health care need attributable to *accessibility* (e.g., cost and transportation) has

been associated with low socioeconomic status; this association, however, has not been found for *availability* related unmet need (29). Interestingly, differences in the type of unmet need reported have been identified between working and retirement age individuals, with a greater association between chronic conditions and *accessibility*-related unmet need found in a younger versus an older population in Canada (29).

There is a lack of research on unmet home care need as an important contextual factor when examining frailty and health outcomes in older adults (112). The findings of the study by Sands et al. (112), suggests that frail older adults with unmet ADL needs have higher rates of acute care admission compared to frail older adults whose ADL needs are met or those who previously had unmet ADL needs, but now have their needs met. This is consistent with findings in the chronic disease literature, suggesting worse health outcomes for those with chronic conditions or disability who also report unmet health or home care need (32,38,95,113). A number of studies, however, have identified unmet health and community care needs as important areas for policy and service delivery improvements (15,16,19,44,114,115). A study by Cameron and colleagues (44) explored the impact of a comprehensive, interdisciplinary intervention program for the management of frail older adults. They found that, when compared to the normally fragmented approach to the care of this complex population, there was a reduction in phenotypic frailty, improved mobility and a decrease in reported unmet home care need (44). These studies illustrate the importance of meeting the health needs of frail adults, with further study required to understand how unmet home care need may modify frailty outcomes.

Research focused on the met and unmet home care needs of older adults with varying degrees of frailty is needed to understand areas for improving access and availability of health and home care services. This study aimed to add to this understanding by exploring how frailty-

related outcomes (with a focus on acute care hospitalization) are modified by unmet home care needs in middle-aged and older adults. The following section presents the framework that guided this research, one that draws on the various contributing domains of health services use.

2.4 Andersen Newman Behavioral Model of Health Services Utilization

The Behavioral Model of Health Services Utilization was originally developed in the late 1960s to better understand health services use by families (116). The family and its sociodemographic background was the focus in this initial model as a result of an assumption of homogeneity among family members (117). It used predisposing, enabling and need factors to determine why services were used and to measure equitable access to health care. *Predisposing factors* are characteristics, including demographics, social structure and health beliefs, that would contribute to health care decisions. *Enabling factors* represent the availability of services within the community and the personal means and knowledge to be able to access them when needed. These are conditions that may facilitate or impede the ability to access health services and include income, employment, transportation, location (rural/urban) and service availability. And *need factors,* which can be either assessed or perceived, and are the main determinant of health care use (117). In this early model these factors all interact to predict health services use in a unidirectional manner (117).

The next phase of the model came in the 1970's and included the health care system and national health policies as contributors to an individual's use and changes in use of health services over time (118). This phase included a shift to the individual as the focus of analysis rather than the family unit in the original model. A consumer satisfaction outcome was also

added in this second phase, demonstrating an understanding that previous health care use, and the outcomes of that use, may contribute to subsequent utilization (118,119).

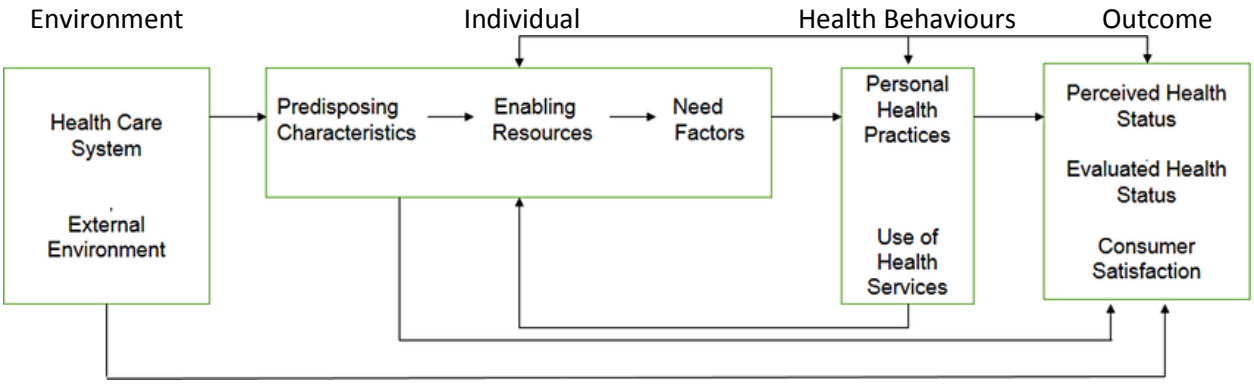
Phase three developed in the 1990s, recognizes the external environment, including the political and economic climate, as well as health behaviours, such as exercise and diet, as contributing components to use and outcomes (120). The next phase built on this with the addition of feedback loops, indicating that the interaction of environmental, individual and health outcomes are not unidirectional, but rather can feedback to each other, influencing subsequent health care decisions (121,122). This fourth model presents a dynamic interaction between individual factors and health behaviors, where health care use can influence and change enabling and need factors, within the individual domain, to affect use and their outcomes (121,122).

This fourth phase was utilized to frame this study as it provides a model of reciprocal relationships. This framework suggests that there is an interaction between individual factors, the assessed and perceived needs of the individual and the availability of care in health services usage (123,124). The revised model (see figure 2) also includes feedback loops between the health behaviours, outcomes and individual factors. These loops suggest that the use of health services, and the outcomes of this use, feedback to influence predisposing and enabling characteristics, as well as the assessed and perceived needs of the individual (123,124). This model provides a psychosocial lens to better understand how individual and environmental factors influence the care that is accessed and received. This revised phase seeks to suggest pathways to policy change or areas for intervention (123–126). This is explained through the concept of mutability, or how easy a particular factor is to change. Enabling factors, such as the availability of home care services, are more mutable than that of predisposing factors, such as the demographic characteristics of an individual (123). The model suggests that if increased

resources in the area of community care were to be employed this would change the availability of health services and may impact health service utilization (123–126).

Outcome in this model refers to the perceived and measured health status of an individual, which is influenced by their health behaviours. These outcomes feedback and influence enabling factors, need factors and subsequent health behaviours. This element of the model is much like the *need* factors of the individual domain, but are the outcome of previous interactions with the health care system (123). Outcome not only includes measures of health status, but also a consumer satisfaction component, which considers how the health care received was perceived by the individual (123,124). The multidimensional nature of both frailty and unmet home care need make this model ideally suited to frame this research, as it illustrates the complexity and interconnectivity of individual and system level factors in the access and utilization of health services.

Figure 2. Behavioral Model of Health Services Utilization - Phase 4



Andersen's Behavioural Model of Health Services Utilization, phase 4 (123)

2.4.1 The Behavioural Model of Health Services Utilization, Frailty and Unmet Need

The *behavioural model of health services utilization* has been widely employed as a study framework in health research, including unmet need (23,29–31,35,38,95,96,98). This framework can act as a guide to understanding the context and interconnectedness of contributing factors to health service use. The use of this model in frailty research is fairly limited (84,127,128) and only one article was identified that utilized the *behavioural model of health services utilization* to explore frailty and unmet need (20). This framework, however provides a method for understanding both the individual and system level factors that influence why people access health care (123). The model eliminates the silo approach to investigating health services use by utilizing feedback loops, illustrating the interaction of individual, environmental and system level factors that contribute to health care decisions (125). The types of unmet need, as discussed above, fit within the elements of the model providing an understanding of where interventions to improve access to care may be most effective. Although limited research exists exploring unmet need in a frail population, this model may assist in illustrating how unmet need may interact to differentially influence health behaviours at various levels of frailty.

Frailty is a multidimensional concept, which includes variables such as mood, cognition, social support, chronic conditions, self-perceived health and physical function, as well as consideration of the instability of the condition leading to an increased risk of adverse health outcomes (3). The use of the *behavioural model of health services utilization* is therefore, ideally suited as a framework for this study as it provides a conceptual model inclusive of environmental and individual factors within the psychosocial, physical and health system domains (123). This model, along with findings from past literature, were used to guide the selection of variables for

both the descriptive and multivariable analyses, as well as framing the discussion following the results.

2.5 Summary

Frailty is a multidimensional condition diminishing one's ability to respond to acute stressors and increasing the risk of adverse health outcomes (3). There have been numerous methods proposed for both the clinical assessment of frailty, as well as the identification of levels of frailty at the population level (12,41,45,47,59,129). The most commonly employed approaches follow either the *phenotype* model (41) or the *cumulative deficits* model (42), with both able to effectively identify levels of frailty that are predictive of adverse outcomes. It has been consistently shown that the identification of frailty provides predictive value for adverse outcomes across assessment tools and in varying populations and settings (11,12,14,40,41,60,61,63,78). Although frailty is associated with LTC placement, functional decline, hospitalization and mortality (3), there is evidence of transition between frailty levels (i.e., that frailty may be dynamic), with some individuals able to move from a more frail state to a pre-frail or robust state (39,70,72).

Although studies exploring unmet health or home care need in a frail population are relatively scarce (15,19,20,31,44), research in the area of chronic conditions and disability have shown that, even within a universal health care system, equity in access to health care services remains an issue (22,23,25,29,32,36). When unmet care is divided into domains, elucidating system versus individual barriers, the accessibility of care remains impacted by socioeconomic status (22,29). This finding provides an opportunity for the investigation of areas for intervention. Understanding how individuals access the health care system and the barriers to this

access may provide an opportunity for policy and prevention strategies targeting this vulnerable population. The exploration of how unmet home care need may modify the association between frailty and adverse outcomes (e.g., inpatient hospitalization, mortality) may provide insights into where programs and policy intervention may be the most successful.

The derivation of a FI using population-based data from a Canadian community-dwelling middle-aged and older adult population is limited (7,40,61,63,130–132), and to our knowledge, has yet to be done using the CCHS-HA cycle. Most studies of older continuing care populations suggest only a modest association between frailty and increased hospitalization suggesting that contextual factors may be modifying this relationship (4). Few contextual variables have been previously identified (16–18,133,134). Although the association between frailty and adverse outcomes is independent of disability and comorbidity, studies exploring contextual factors in the chronic disease and disability literature (31,64,95,113) suggests that these factors may also be relevant to frailty research.

Both formal and informal home care are often necessary to meet the goals of client-centered care, allowing older adults to maintain their independence at home and to delay transitions to higher levels of care (64). Meeting the home and health care needs of middle-aged and older adults at risk for frailty progression is important in mitigating their likelihood for functional decline and adverse health outcomes (12,114,135–137). There is evidence that equitable access to these services is questionable even within Canada's universal health care system (23,25,35). Lower socioeconomic status is the main reason for accessibility issues identified in those who report unmet need in Canada (25). Unmet need is also reported most frequently in the 55 to 64 age group (25) indicating that the investigation of middle-aged, as well

as older adults' unmet home care needs may provide insight into how to improve availability and accessibility of care.

The hospitalization of older adults, particularly those with higher frailty, may be associated with deleterious effects leading to functional decline, worsening frailty, LTC admission and mortality (14). The identification of frailty in older adults may be a key assessment leading to the implementation of necessary care within the home, and through this, decreasing the likelihood of adverse health outcomes. The exploration of the extent to which unmet home care need modifies this relationship may provide further insights into areas for health care policy and delivery reform, and targeting of support for frail older adults (and their family or friend caregivers).

Chapter 3

Study Rationale and Research Questions

3.1 Study Rationale

Older adults with higher frailty levels are at increased risk of physical decline, disability, falls and hospitalization (11,33,39,40,62,63,114,138), and often require assistance and supportive care within the home (14,85,137,139,140). For some, barriers to getting this assistance can lead to worsening health or functional status and the requirement for hospitalization or LTC placement (3,11,35,141). Unmet need for home care has been found to increase the risk of adverse outcomes in older populations (28,30,31,34,98,113); however, the relevance of unmet home care need to middle-aged and older persons with varying degrees of frailty is an important area of research that has yet to be fully explored.

Although a number of studies have explored frailty-related outcomes in those receiving home care services (14,16,66,142,143) and those residing in AL or LTC facilities (3,4,10,11), there is a paucity of research addressing the impact of frailty (or possible variation by unmet home care need) on health outcomes in population-based cohorts of community-dwelling middle-aged and older adults (20). Frailty research has focused mainly on populations aged 65 years and older, with few studies inclusive of middle-aged adults (132,144). There is evidence, however, for the inclusion of middle-aged individuals (aged 45-64 years) in the multimorbidity literature (145–147). Although the prevalence of multimorbidity (often defined as 2+ chronic conditions) is higher in older adults, the absolute number of individuals suffering from co-occurring multiple conditions is higher in those under 65 years of age (145,146). Socioeconomically disadvantaged individuals have significantly higher rates of multimorbidity than their more affluent counterparts (145,146). With lifestyle choices, such as smoking, heavy

drinking, lack of exercise and poor nutritional choices suggested as contributors to these findings in younger aged cohorts (145–147).

Socioeconomic aspects also drive unmet health care need (26) and the exploration of this contextual factor inclusive of a middle-aged population may provide insight into how both frailty and unmet home care need operate within this younger cohort. Perceived unmet home care need lays at the intersection of system and individual level barriers to accessing needed health care. The *behavioral model of health services utilization* provided a framework for conceptualizing how the various *predisposing*, *enabling* and *need* factors interact to impact health outcomes (first-event hospitalization and mortality) and guided the selection of variables for the analysis.

Along with socioeconomic factors, sex/gender is also a *predisposing* factor relevant to the exploration of unmet home care need and frailty. Previous literature has revealed sex differences in the prevalence of frailty and unmet health or home care need, with women typically experiencing a higher prevalence of frailty (41,79,148,149) and greater reported unmet health or home care need (26,32,38,92,95,98) than men. Due to these known differences, stratification by sex has often been included in frailty studies (8,16,58,79,109,150–152). Stratification analysis for this study was hypothesized to yield differences in risk of hospitalization by frailty level on its own and in the presence or absence of unmet home care need.

The modifiability of the multimorbidity-hospitalization association by demographic characteristics, such as age, sex and physician continuity of care has been previously explored (64,65). Much like multimorbid individuals, frail middle-aged and older adults are medically complex with higher rates of adverse health outcomes (5,11,14,16). Yet to date, there is limited research exploring modifying factors of the frailty-health outcome association (16,17,153). The

identification of modifying factors, such as unmet home care need, can provide insight into where improvements in care management and policy initiatives may be most effective.

There has been limited use of CCHS data to explore frailty (6,7,154–156), and only one known study that has utilized the CCHS-HA. Griffith et al. examined the association between use of an assistive device and fall-related injuries adjusting for frailty (156). The frailty measure employed was a modified version of the clinical frailty scale developed by Rockwood et al. which included chronic conditions, physical activity and activity limitations (156). The CCHS-HA has previously been used in the exploration of unmet need (99), but no studies were found that included frailty and unmet need utilizing this cycle. CCHS-HA data linked to administrative health data through the DAD and CMDB provided an opportunity to examine health, function, sociodemographic information, as well as hospitalization and mortality records. A FI derived and validated using the 2003, 2005 and 2009 CCHS cycles (7), also facilitated the exploration of frailty with CCHS-HA data and its relevance to unmet home care need and health outcomes in the Canadian context. The aim of this study was to provide insight into the characteristics of adults aged 45 years and older with varying levels of frailty; the risk of first-event hospitalization (and mortality) over two-years associated with participants' frailty status; and, the impact of self-perceived unmet home care need on the observed frailty-hospitalization (and mortality) association using a representative Canadian community-dwelling population. Gaps in previous research, including; the investigation of unmet home care need as an effect modifier of the frailty-hospitalization (and death) association, the inclusion of middle-aged and older adults in this type of research, as well as the use of population-data in the Canadian context were addressed through this study.

3.2 Research Questions

This study used the 2008/09 CCHS-HA cycle 4.2 data linked with the Discharge Abstract Database (DAD) from fiscal years 2007/2008 through 2011 and the Canadian Mortality Database (CMDB) from 2008 through 2011. Included were middle-aged and older (aged 45+ years) survey respondents, excluding those residing in Quebec due to lack of DAD administrative data linkage. The following research questions were addressed:

1) What is the association between levels of frailty and all variables, descriptive and contextual, including; sociodemographic characteristics, community care, chronic conditions, previous hospitalization, social support availability and unmet home care need?
2) What is the association between the presence/absence of unmet home care need and all variables, both descriptive and contextual, including; sociodemographic characteristics, community care, chronic conditions, previous hospitalization, social support availability, and frailty level?
3) What is the independent association between respondents' frailty level and inpatient hospitalization (and mortality) over a 2-year follow-up period, overall and stratified by sex?
4) How is the association between frailty level and inpatient hospitalization (and mortality) among respondents modified by perceived unmet home care need?

Chapter 4

Methods

4.1 Data Source: Canadian Community Health Survey - Healthy Aging (CCHS-HA)

4.1.1 Study Population

The CCHS-HA is a population-based, cross-sectional survey conducted by Statistics Canada from December 2008 to November 2009. Its focus was on the health, social and economic determinants of healthy aging and health care use among Canadians. Included were persons aged 45+ years living in private dwellings in all 10 provinces. Excluded were persons living on Native reserves, those residing in institutions, full-time members of the Canadian armed forces, residents of the three territories, and residents of some remote regions (representing about 4% of the target population). The sample was divided proportionately by province with proportional allocation of rural and urban residents based on 2006 Canadian census data. Dwellings with at least one resident 45 years and older were considered for inclusion in the survey (157).

A total of 41,496 households were initially selected, of these, 33,517 households agreed to participate in the survey. This represents an 80.8% household response rate. Of these, one individual from each household was invited to participate (n=33,517), of which 30,865 agreed and participated (representing a 90.2% individual response rate). The result was a combined household and individual response rate of 74.4%.

In addition to completing the CCHS-HA questionnaire, participants were asked to provide consent to allow linkage to health and other administrative data. Deterministic and probabilistic linkage to the DAD from 1999/2000 through to 2012/13 (excluding Quebec) and

probabilistic linkage to Canadian Mortality Database (CMDB) from 2008 through 2011 in all provinces was conducted. For this study CCHS-DAD linkage for fiscal years 2007 through 2011 and CMDB linkage from December 2008 through 2011was used. Consent for data linkage was obtained for 82.6% of CCHS-HA respondents (n=25,486) (157). This study included DAD linkage from 2007 to 2011, representing previous hospitalizations in the year prior to baseline (between Dec 2008 and Nov 2009) through the 2-year first-event hospitalization follow-up period and CMDB linkage from baseline through 2011 also covering the 2-year follow-up period for each participant.

4.1.2 Data Collection

Data collection was conducted using computer assisted personal interviewing (CAPI). Interviews were conducted face-to-face by trained CAPI interviewers for 94% of participants, with the remaining conducted over the phone to accommodate language barriers. This was done only when a bilingual CAPI interviewer was unavailable in the participant's area, or if the participant spoke neither official language and another CAPI interviewer was able to conduct the interview in the requested language. Proxy interviews were allowed for persons unable to complete the interviews themselves due to physical or mental limitations. Proxy interviews represented 2.2% (n=689) of 30,865 respondents (among the weighted analytic sample 2.01% [n=390] were proxy respondents). Proxy respondents were not asked the *Social Support Availability* (SSA) portion of the survey, however the missing values for this variable were found to be less than 5%. The CCHS-HA collected data on health care utilization, health and well-being, social and demographic characteristics, as well as work, retirement, social support and social participation (captured with 37 modules). The survey was developed to examine aging patterns, social and lifestyle determinants of health, and to gain insight on successful aging of the Canadian population aged 45 and older (157).

4.3 Discharge Abstract Database (DAD)

The DAD is a national database with information on all hospital discharges from acute care facilities, as well as information regarding day procedures, rehabilitation and long-term care. Each DAD record contains basic demographic information (i.e., date of birth, postal code), administrative information, such as admission and discharge dates and clinical information regarding diagnoses and procedures during the hospitalization (158). Diagnostic information

provided in the DAD, as well as the CMDB, utilizes the International Statistical Classification of Diseases and Related Health Problems, 10th version (ICD-10). The ICD-10 is a medical classification system developed by the World Health Organization (WHO), which provides an international standard for coding diseases, disorders, injuries and health related conditions by hierarchical body system (159). The DAD does not contain records for the province of Quebec. Quebec does not submit provincial hospitalization records to the DAD, but instead submits annual data files to CIHI, which are then linked to the DAD separately, and are therefore not available for linkage with national surveys, such as the CCHS-HA.

Generalized Record Linkage software (GRLS) developed and employed by Statistics Canada deterministically and probabilistically linked the DAD to the CCHS-HA for all consenting participants. No sex differences have been determined (99).

4.3 Canadian Mortality Database (CMDB)

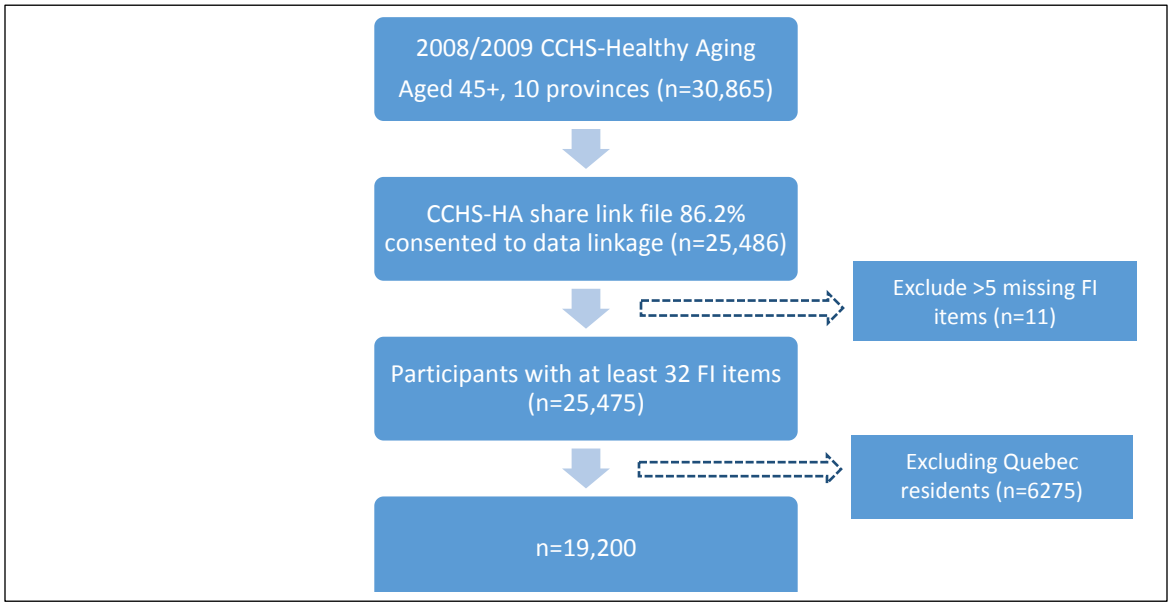
The CMDB is an annual census that collects information on all deaths occurring in Canada. The administrative database contains both demographic and medical (cause of death) information reported by the provincial and territorial Vital Statistics Registries to Statistics Canada. Since 2000, cause of death is coded in CMDB ICD-10 coding (159). Participation by the provinces and territories is compulsory under the Vital Statistics Act mandating all deaths, as well as births, still-births and marriages, be reported to Statistics Canada (160).

The CMDB is linked to the CCHS annual files from 2000 through 2011, as well as the focus content files in 2002, 2004 and 2008 (this includes the healthy aging file), for all respondents outside of Quebec who consented to share and link their survey responses to administrative data (160).

4.4 Analytic Sample

The analytic sample (see Figure 3 below) for this study consisted of all CCHS-HA respondents aged 45 years and older, who consented to having their data linked and who resided outside of Quebec. The CCHS-HA was completed by 30,865 participants from the 10 provinces and 25,486 (86.2%) participants consented to data linkage. Participants residing in Quebec were excluded due to linked data sharing restrictions (n=6,275). Participants with greater than five missing FI items (n=11) were also excluded to be consistent with previous research (7,47). The resultant sample was 19,200 (scale weighted 20,920) participants, which equated to a full weighted sample of 10,272,000.

Figure 3. Flow diagram of analytic sample (unweighted)



4.5 Measures

4.5.1 Exposure of Interest - Frailty Index (FI)

Frailty was assessed using the accumulated deficits approach. A frailty index (FI) was derived utilizing the Health Utility Index (HUI), as well as other survey items (see Appendix A). As previously validated by Hoover and colleagues (7), and similar to other research findings, cut-points were established between 0 (no frailty) and 1 (highest possible level of frailty). Consistent with Rockwood and Mitnitski (45), a frailty score reflects the number of deficits an individual has in relation to the number of deficits considered. For accurate evaluation, an index must consist of a least 30 items and include a range of deficits that are health-related and increase with age, without saturation too early with increasing age.

For this study a 37 deficit index was derived, utilizing the Hoover et al. methodology (7). This index used 19 chronic conditions, as well as 18 items including body mass index (BMI), self-perceived health, IADL and ADL limitations, physical activity, and items from the HUI. Most deficits were dichotomized as present or absent, with some scored as three to six level deficits reflecting severity. Robust (0 to 0.1), pre-frail (>0.1 to ≤0.21) and frail (>0.21) were the cut-points utilized, as validated by Hoover et al. (7). For some of the analysis, including evaluation of effect modification and stratification analysis, a binary frailty variable was utilized (categorized as 0=robust/pre-frail vs. 1=frail) given relatively small cell sizes for some measures.

4.5.2 Effect Modifier of Interest - Unmet Home Care Need

Unmet home care need was evaluated as an independent variable, first through descriptive analysis and as an effect modifier of the association between frailty and 2-year health outcomes (inpatient hospitalization and mortality). Unmet need may act as an effect modifier as

the associations between frailty level and health outcomes may vary according to the presence or absence and type of perceived unmet need. Frailty in the presence of unmet home care need was expected to lead to a higher risk of hospitalization and mortality than frailty in the presence of no unmet home care need

Unmet home care need can be attributable to both individual and system level factors and has previously been operationalized into three groups based on whether the issue related to *availability;* whether necessary health care services were available when and where they were needed, *accessibility;* individual barriers, such as cost or transportation, or *acceptability*, individuals knowledge, understanding and attitudes towards care required (29,37,92). The CCHS-HA *Care Receiving* (CR1) module asks *all* participants questions regarding the receipt of professional home care services, as well as their need for such care in the past 12 months: "During the past 12 months was there ever a time you felt you needed professional home care services, but didn't receive them?" To obtain information on the nature of the unmet home care need, a follow-up question within the module asks those who responded yes to the above question; "thinking of the most recent time, why didn't you receive these services?" There are 15 possible responses, which correspond to availability, accessibility and acceptability barriers. These three groups can also be thought of as either system barriers (availability) or personal barriers (accessibility, acceptability) (29). For the purposes of this study, and as previously operationalized (29), type of unmet home care need was operationalized as a three level variable consisting of *system barrier*, *personal barrier* and both. Due to small cell sizes, however, only preliminary descriptive analyses using this variable were feasible. Therefore, a dichotomous (yes/no) unmet home care need variable was utilized throughout the main analyses.

4.5.3 Outcomes

The primary outcome of interest was first-event inpatient acute care hospitalization within 2-years of baseline (baseline data collection period from Dec 2008 through Nov 2009). Mortality during this same 2-year follow-up was evaluated as a secondary outcome. Hospitalization events were determined through the linkage of CCHS-HA and the DAD. First-event hospitalization was calculated using the admission date minus the baseline date, as well as total length-of-stay (LOS) to determine episode of care resulting in admissions of at least 1 day. First-event inpatient hospitalizations during follow-up was used (defined as a binary [yes/no] measure), in contrast to any or total hospitalizations. This permitted the examination of the initial adverse event after baseline in relation to frailty status. Both urgent and elective admissions were retained in the analysis. It is known that frailty related disability requires greater use of health care services (4,14,16,39,63,161). Declines in health necessitating the management of complications of frailty, not available or well managed within the community, may result in either urgent or elective admissions to acute care facilities. These admissions may result from frailty, but may also impact transition between frailty levels, most typically from less or not frail to a more frail state following hospitalization (4,39,162). For the purposes of this study, any acute care hospitalization event was viewed as potentially due to frailty status and was therefore included. Most responsible diagnostic ICD-10 codes were obtained from the DAD and used to determine the most frequent causes of hospitalization. Deaths were determined through CMDB linkage, with death date and cause of death variables used in the analysis. ICD-10 codes from both the DAD and CMDB were collapsed using the hierarchical physiological system and subsystem structure of the ICD-10 coding guide (159). Diseases and disorders that appeared to be similar in their physiological system of action were collapsed together. For example, ICD-10

coding of myocardial infarction (MI) contains numerous subgroups identifying the specific area of the heart effected (e.g., inferior, posterior). All MI codes were collapsed and identified as MI. This type of collapsing was necessary due to cell size considerations and for presenting the most meaningful results of this sub-analysis.

4.5.4 Covariates

Key covariates of interest were selected from health and sociodemographic domains included in the CCHS-HA. The variables selected for analysis were informed by the Andersen-Newman model, detailed above, and previous frailty and hospitalization literature (4,11,14,16,142,163) and included: age, sex, household income, education, comorbidity and social support availability. DAD-linked previous hospitalization (in the year prior to baseline) was also included in the analysis. The covariates considered for inclusion in the multivariable models were also informed by the results of the descriptive analysis, with core (base) models adjusted for age, sex and comorbidity

Age was categorized as a five level variable: 45-54, 55-64, 65-74, 75-84, and 85+ years. The 45-54 and 55-64 age categories were included as most frailty research and studies of older adults with unmet need have largely focused on adults aged 65 years and older (7,10,68,114,148,164,165). Frailty, however, has been assessed in all age groups, including youth with chronic congenital and acquired conditions (72).

Sex was coded as male or female as determined by the CAPI interviewer, participants were not asked how they identified unless the interviewer deemed this necessary (not known or refusals were not allowed for this question). Stratification by sex allowed for the analysis of differences in frailty outcomes and the impact of unmet home care need by sex. Sex differences

in frailty (148), as well as unmet home care need (26) have previously been demonstrated, and further exploration of these differences in this study was expected to provide additional insights in the area of frailty outcomes.

Estimated household income was a self-reported CCHS-HA continuous variable. Nearly 30% of participants did not provide household income information. For this study, reported household income was divided into tertiles (low=0, middle=1, and high= 2 household income) and further categorized as a four level variable, which included the tertiles (low, middle, high), as well as a missing (9) category as to not exclude participants during the multivariable analyses. This type of household income grouping and the inclusion of a category for missing has previously been done using CCHS data (92).

The 4 level derived CCHS-HA respondent education variable was used in the analyses. This variable was categorized as: less than high school (1), completed high school (2), some post-secondary (3) and completed post-secondary (4).

Comorbidity was derived as a summary count measure of the number of select chronic conditions. Comorbidity has been widely used as a measure of health status in aging research, as it increases the risk of disability, hospitalization and death, and is associated with increased health care costs (33). This measure is normally included in frailty studies in order to demonstrate the relevance of frailty over and above comorbidity and disability (11,14,17). Several indices for calculating comorbidity have been established (166–169), however for the purposes of this study categorization based on a count of self-reported chronic conditions was utilized, consistent with previous work (13,14,135,164). Chronic conditions were defined in the CCHS-HA as long-term conditions diagnosed by a health professional that have lasted or are expected to last greater than six months (157). The CCHS-HA includes a list of 26 common

chronic conditions covering a wide range of physiological systems. The count measure included 19 conditions including; asthma, arthritis, osteoporosis, hypertension, cancer, heart disease, MI, angina, bronchitis, emphysema, COPD, stomach ulcers, thyroid, bowel disorders, including Crohn's, dementia, Parkinson's, diabetes, effect of a stroke, and other not listed conditions. Comorbidity was categorized as a four level variable coded as 0, 1, 2-3 and ≥4 chronic conditions.

Previous hospitalization (i.e., one or more hospitalization(s) in the year prior to baseline) for each respondent was included in the analysis. Two such variables were examined: one obtained through the DAD record linkage and a second self-reported measure from the CCHS-HA. The first was calculated using the CCHS-HA interview date and DAD admission dates, as well as total LOS, to obtain any inpatient hospitalization (0 vs 1+) in the year prior to baseline. The CCHS-HA also asks respondents the following question, "In the past 12 months, have you been a patient overnight in a hospital, nursing home or convalescent home?" This variable, coded yes/no, was included in the descriptive analysis in addition to the calculated DAD previous hospitalization measure for comparison purposes. Since hospitalization data were not available for Quebec residents, necessitating its exclusion from the analytic sample, the inclusion of the self-reported previous hospitalization variable provided an opportunity to assess any differences in prevalence between Quebec and the other regions. The DAD measure of previous hospitalization was employed in key analytical models as it was assumed to be more accurate than the self-reported survey measure.

Prior hospitalization has been found to predict future hospitalization in frail older adults (14,39,170). This would be expected as the hospitalization of older adults can exacerbate existing conditions, such as frailty, leading to subsequent readmissions (13,59,170). Similar findings for

the relevance of prior hospitalization as a predictor of future hospitalization have been reported in the multimorbidity (171) and disability literature (64,172). Because hospitalization can both predict and result from frailty, it is an important covariate to consider when looking at frailty-hospitalization associations.

Similar to previous studies exploring unmet health care need, SSA was included as a covariate (96,98). As well, low social support and participation, among other markers of psychosocial well-being, have previously been found to be correlated with higher levels of frailty (80,133,173). The CCHS-HA includes a series of questions related to self-perceived SSA. This section of the questionnaire is based on the Medical Outcomes Study (MOS) social support survey (174) and includes four categories: *tangible support*; availability of assistance with physical tasks, *emotional/informational support*; assesses positive affect, expression of feelings, and the reception of advice or guidance, *positive interaction*; assesses the availability of someone for social interaction or to have an enjoyable time with, and *affection;* involving the expression of love and affection (92). All of the social support items on the questionnaire begin with the preamble; "How often is each of the following kinds of support available to you if you need it?" Each item is scored based on the frequency with which the support is received: none of the time (0), a little of the time (1), some of the time (2), most of the time (3), and all of the time (4) (157). *Tangible support* and *positive interaction* are assessed with 4 questions each and are scored out of 16. *Emotional/informational support* is assessed with 8 questions and is scored out of 32, and *affection* is scored out of 12 based on 3 questions for a maximum overall SSA score of 76 (109).

For this study, and as done elsewhere (175), a frequency distribution for each domain of social support was derived using the scores of each dimension of SSA, as well as for the overall

SSA score. Respondents with the lowest tertile scores for overall SSA and each domain of SSA were considered to have 'low' social support (low=0), while the other two thirds were considered to have 'high' SSA (high=1). Thus social support was operationalized as five dichotomous variables; overall SSA low/high (0/1), *tangible support* low/high (0/1), *emotional/informational support* low/high (0/1), *positive interaction* low/high (0/1) and *affection* low/high (0/1).

Other variables included in the descriptive analysis included marital status, rural/urban location, provincial region, aboriginal identity and community health care use, including both formal and informal home care and regular family physician. These descriptive variables have been included as baseline characteristics in other frailty (14,39,85,112,132,155) and unmet health or home care need (20,24,29,38,95,98,176,177) research. It has been found that individuals who live alone (i.e. widowed, divorced) (38,95), have lower educational attainment (24,95), rural location (98,176), or are from a minority groups (25,29,38,177) have higher levels of reported unmet health or home care need in Canada. Characteristics, such as rurality and living alone may impact access to, and availability of health care services and were included to explore there influence on reported unmet home care need (14). Marital status is a CCHS-HA demographic question categorized as married, common-law, widowed, divorced, separated, or single, never married. For the purposes of this study marital status was categorized as a three level variable, including; married/common-law (0), divorced/separated/single/never married (1) and widowed (2).

Rural/urban location is a Statistics Canada derived variable based on the 2006 census data, with urban versus rural designation determined by proximity to a *Census Metropolitan Area* (CMA) and population density. Urban includes CMA, urban core, urban fringe and urban outside a CMA. Urban areas are those with populations greater than 1,000 and a population

density of greater than 400 people per square kilometer. Rural includes all areas not considered urban with populations and densities below the above threshold. Urban (1) vs. rural (2) was utilized for this study.

Province of residence, as self-reported on the CCHS-HA, was collapsed from the 10 provinces included in the survey data to 5 provincial regions, including: Atlantic (Newfoundland, Prince Edward Island, New Brunswick and Nova Scotia), Quebec, Ontario, Prairies (Manitoba, Saskatchewan and Alberta) and British Columbia. Regionalization of some or all of the provinces has previously been done (130,178,179). Analysis excluded Quebec due to lack of administrative data linkage.

Self-reported Aboriginal identity was obtained via the CCHS-HA question; "Are you an Aboriginal person, that is, North American Indian, Métis or Inuit?" Responses included yes (1) or no (2), as well as "do not know" or refused. Less than 1% did not provide a yes/no response to this question and were coded as missing values. This variable was categorized as a binary measure (yes/no).

The CCHS-HA contains two sections of questions that ask about the care respondents may have received in the past 12 months. The first of these sections relates to formal or professional home care support received. The second section then asks about the receipt of informal (family/friend) home care in the past 12 months. The *health care utilization* block has a series of questions related to professional medical care accessed or used in the previous year. This section includes whether respondents have a regular medical doctor. All three of these variables are binary (yes/no).

4.6 Ethics

Application and approval for this research was obtained through the Social Sciences and Humanities Research Council (SSHRC) and Statistics Canada for access to restricted microdata files within the South Western Ontario Research Data Centre (SWORDC) located at the University of Waterloo. Ethics approval was not required for access to secondary data accessed in this way, as no personal identifiers are available to researchers.

4.7 Analytic Strategy

All analyses were conducted using the CCHS-HA master files within the secure environment of the SWORDC, University of Waterloo, and using SAS version 9.4 (SAS Institute Inc., Cary, North Carolina).

All analyses used SAS survey procedures to account for complex survey design and required weighting and bootstrapping. Scale sample weights were applied to all descriptive analyses, as well as bootstrap replicates produced and provided by Statistics Canada (157), in order to produce meaningful nationally representative estimations and analytic results. Full weight and bootstrapping using 500 replicates was also applied to all modelling, as recommended by Statistics Canada data use guide (157).

4.7.1 Descriptive and Bivariate Analyses

Univariate analyses were performed to determine the weighted estimates (percentage and frequency distribution) for all categorical variables examined. Means analysis, including standard error, median and interquartile range (IQR) were conducted for continuous variables;

FI, age, number of chronic conditions, household income and SSA total score. A histogram was produced to evaluate the frailty distribution for this sample.

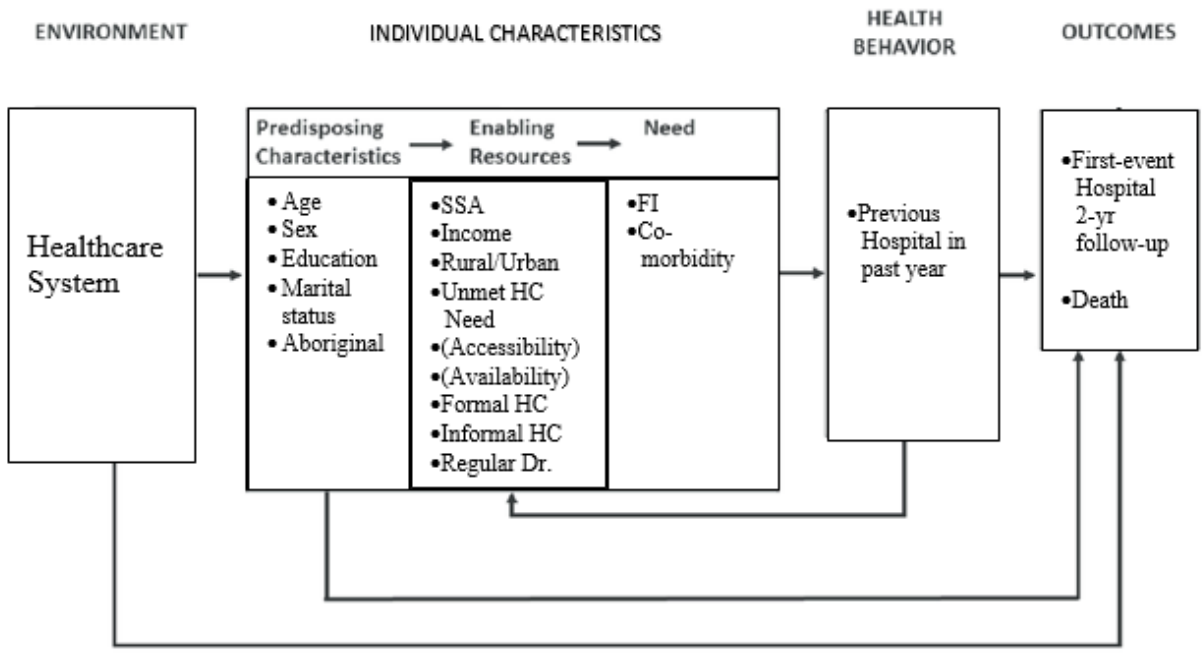
Analysis of most responsible cause of hospitalization and death were determined through the collapsing of conditions into meaningful hierarchical groups. For example, all myocardial infarctions (MI) regardless of area of the heart effected were collapsed together. The use of the ICD-10 coding system guided the selection of conditions for collapse.

This descriptive analysis was informed by the *Behavioral Model of Health Services Utilization,* as health outcomes are a function of *predisposing*, *enabling* and *need* factors, as described in detail above (126). The variables selected for this study reflect aspects of each of these domains and their influence on health care decisions, access and outcomes. Figure 4 illustrates the domain of each of the selected variables and adds feedback loops to illustrate how these domains are interrelated. The presence or absence of unmet home care need and the reason for this unmet need have been added to the *enabling* factors, along with receipt of both formal and informal home care and the presence of a regular medical doctor. The inclusion of these variables as *enabling* factors illustrates both access and barriers to accessing needed care, as well as to highlight the potential mutability (how easily a factor is to change or be influenced) through modifications to policy or care management strategies within the health care system.

Although *outcome* in Andersen-Newman's model was initially conceptualized to include both *perceived* and *evaluated health*, as well as *customer satisfaction* (120), for the purposes of this study outcome includes first-event inpatient hospitalization and death. This is to better illustrate how respondent characteristics and health behaviours may influence these adverse health outcomes. While previous hospitalization has been included in the *health behaviours* domain, a number of other *personal health practices*, such as smoking, diet and exercise, could

have been included here. *Health behaviours* has a feedback loop to *individual characteristics* indicating the interconnectedness of health decision-making and utilization. For the purposes of this study, the feedback loop from *outcome* to the *health behaviours* and *individual characteristics* domains has been removed.

Figure 4. The conceptual framework based on Andersen's *Behavioural Model of Health Services Use* and the corresponding variables and outcome of interest



Note: HC=home care; adapted *Behavioural Model of Health Services Use* (126)

Bivariate analyses were conducted to examine unadjusted associations between select respondent characteristics and frailty level (robust, pre-frail, frail), unmet home care need (yes vs no and type), and 2-year health outcomes (separately for inpatient hospitalization and death). Although not defined a priori, supplementary analyses of select respondent characteristics by the overall SSA measure were conducted given potential interest in this measure as a relevant modifying variable for future research. Associations between categorical variables were examined with cross-tabulations and chi-square tests of statistical significance. Associations between select categorical measures and continuous variables were examined with t-tests and

analysis of variance for comparisons of means. For all statistical tests, the significance level was set to $\alpha = 0.05$. Comparisons of 95% confidence intervals (and degree of overlap) also informed interpretations of statistical differences across estimates. The findings from these bivariate analyses were used (along with previous literature) to inform subsequent modeling approaches.

4.7.2 Multivariable Analyses

Multivariable logistic regression models were used to estimate adjusted odds ratios (and 95% confidence intervals) for associations between frailty, unmet home care need and other select covariates and the 2-year health outcomes (with separate models for inpatient hospitalization and mortality). Potential confounders were selected based on previous literature (e.g., examining frailty and/or unmet home care need) (3,14,16,29,36,104) and findings from the bivariate analyses. As with the descriptive analyses, survey procedures were employed, along with weighting and bootstrap techniques to account for CCHS-HA design complexity.

Key covariates of interest were first examined in models adjusting for age and sex only. Sequential models were then constructed starting with a base model including age, sex, FI group, and comorbidity (Model A). Model B included age, sex, FI group, comorbidity, previous hospitalization, income, education and unmet home care need. Evaluation without previous hospitalization was then conducted with age, sex, FI group, comorbidity, income, education and unmet home care need (Model C). A final model adjusting for age, sex, FI group, comorbidity and unmet home care need was assessed (Model D). Previous hospitalization was removed from Model C given concerns that it may mask associations between other variables of interest (including frailty and unmet home care need) with the inpatient hospitalization outcome. This is due to the likelihood of bidirectional associations between previous hospitalization and both

frailty and unmet home care need making it challenging to know the direction of associations among these variables. Model D did not adjust for income or education, as these covariates were non-significant in Model C.

To explore whether the associations between frailty and health outcomes varied by the presence of unmet home care need, interactions terms were initially added to the models to test for statistical significance. Subsequently, a categorical variable was derived by cross-classifying respondents according to the 3-level frailty measure and presence/absence of unmet home care need. The categorical measure was coded as follows: robust/no unmet home care need (0), pre-frail/no unmet home care need (1), frail/no unmet home care need (2), robust/unmet home care need (3), pre-frail/unmet home care need (4); frail/unmet home care need (5). This approach allowed for a comparison of odds ratios across and within strata defined by frailty and unmet home care need within the entire sample. The same modelling approach was followed as described above.. Interaction terms and the categorical interaction measures were entered into models separately with and without previous hospitalization (Model B and C) to assess any differences in significance.

For mortality assessed over the 2-year follow-up, a binary frailty measure (i.e., not frail [combing robust and pre-frail] vs frail) was cross-classified with unmet home care need to create this categorical measure given the smaller number of outcome events and smaller cell sizes for the 3-level frailty measure. Both interaction terms and the categorical interaction measure were entered into models separately following the modeling strategy described above. As with all previous modelling described, models with and without previous hospitalization were run.

Chapter 5

Results

5.1 Univariate and Bivariate Descriptive Results

5.1.1 Baseline CCHS-HA characteristics of share-linked sample (Table 5.1.1a) (for full sample see Appendix B, Table 5.1.1b)

Among CCHS-HA respondents in the analytical sample (n=19,200), the average FI was 0.118 (95% CI 0.116-0.121), with 52.5% of the sample found to be robust (FI ≤0.1), 33.5% pre-frail (FI>0.1 to ≤0.21) and 14.0% frail (FI >0.21) (Table 5.1.1a). The distribution of FI (as a continuous measure) is presented in Figure 5.1.1 and shows a distribution consistent with previous research with a maximum FI level of <0.68 (47,79,130).

The average age of the sample was 60.4 (95% CI 60.4-60.5) years, 52% were female, and 74% were married or living with a partner. Approximately 54% had completed a post-secondary degree and the median household income was $63,941 (IQR $35,909-$99,551). Most respondents resided in urban areas (79%) and 51% were residents of Ontario. Very few (2.5%) in the sample reported being North American Indian, Métis or Inuit.

Respondents reported an average of 1.8 (95% CI 1.76-1.85) chronic conditions (out of a possible 19), with 16% reporting greater than four chronic conditions. Most respondents reported having a regular family physician (94%) and just over 8% self-reported having been hospitalized in the past year. This self-reported previous hospitalization question included acute care hospitalizations, as well as convalescent and nursing home admissions. Acute care hospitalizations in the prior year derived from the DAD, resulted in a prevalence of approximately 7%. The use of formal home care services (assistance for either or both IADL or

ADL limitations) in the past year was reported by approximately 5% of respondents, while 12% reported receiving informal home care from family or friends during this same time period. Only 2.4% of respondents reported an unmet home care need, having not received home care in the past year when they needed it. Of this group, most (76%) reported a personal barrier as the cause (i.e., accessibility or acceptability). The average overall SSA score was 64.13 (95% CI 63.85-64.77) out of 76. Due to a priori categorization based on tertiles, each univariate domain of SSA contains approximately 30% low SSA scores.

Table 5.1.1a: Baseline characteristics of participants aged 45+ years, overall and by frailty status, 2008-09 CCHS-HA (Cycle 4.2) analytical sample

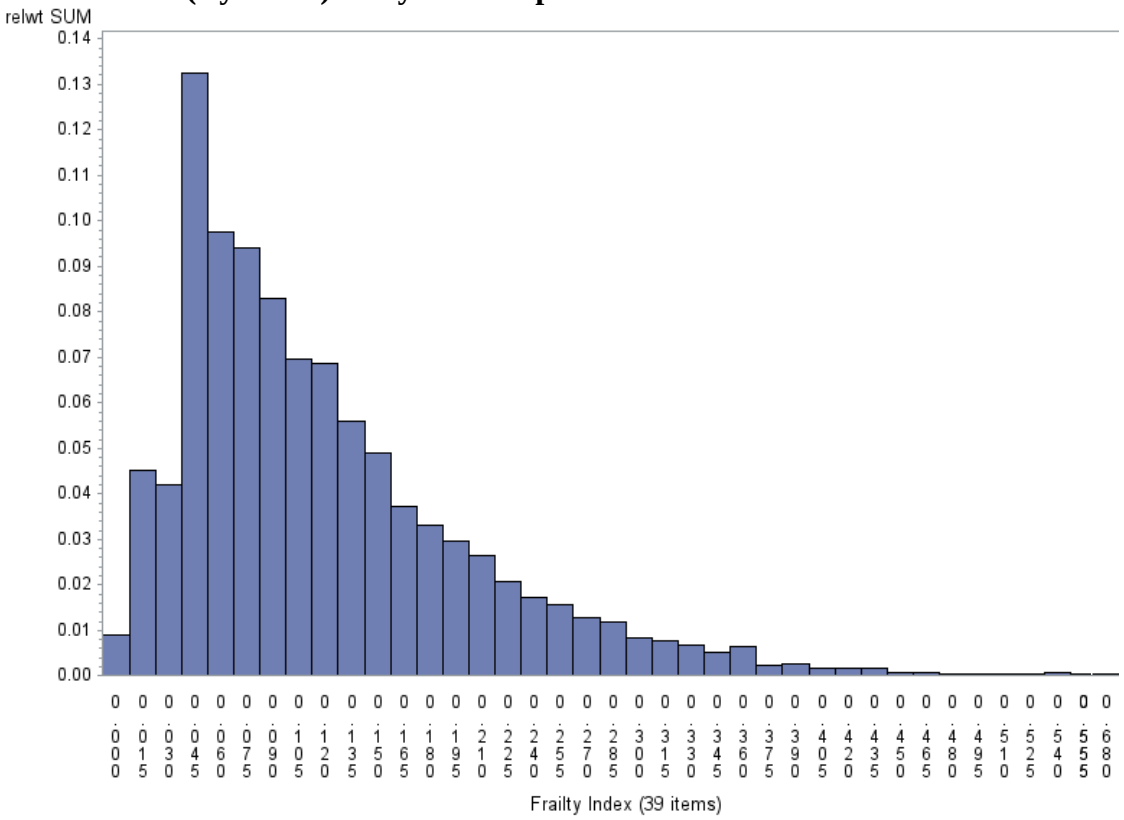
Characteristic	Overall (%, CI)	Frailty (FI) Status (column %, CI)		
		Robust [FI ≤0.1] (52.5%)	Pre-Frail [FI >0.1 to ≤0.21] (33.5%)	Frail [FI >0.21] (14.0%)
Mean age (CI)	60.43 (60.36-60.51)	56.71 (56.47-56.96)	63.02 (62.57-63.47)	68.16 (67.33-68.99)
Median (IQR)	57.70 (50.28-67.39)	53.87 (48.87-61.44)	60.93 (52.78-71.29)	67.43 (57.14-78.43)
Age group				
45-54	38.9 (38.9-38.9)	50.5 (49.2-51.8)	28.9 (26.6-31.2)	19.1 (15.6-22.7)
55-64	29.3 (29.3-29.3)	31.0 (29.9-32.0)	29.4 (27.9-30.2)	22.8 (20.5-25.2)
65-74	17.4 (17.4-17.4)	12.8 (12.1-13.5)	22.4 (21.2-23.7)	22.7 (20.7-24.7)
75-84	10.8 (10.8-10.8)	4.8 (4.3-5.2)	14.7 (13.9-15.5)	23.9 (22.11-25.7)
85+	3.7 (3.6-3.7)	1.0 (0.9-1.2)	4.6 (4.2-5.0)	11.4 (10.3-12.4)
Sex				
Men	48.2 (48.2-48.2)	52.5 (51.2-53.9)	45.6 (43.6-47.6)	38.3 (35.4-41.2)
Women	51.8 (51.8-51.8)	47.5 (46.1-48.8)	54.4 (52.4-56.4)	61.7 (58.8-64.6)
Marital Status				
Married/Partner	73.9 (72.7-75.2)	79.7 (78.1-81.34)	71.8 (69.8-73.7)	57.5 (54.8-60.3)
Separated/Divorced /Never Married	16.0 (14.8-17.1)	15.6 (14.0-17.1)	15.0 (13.3-16.7)	20.1 (17.4-22.8)
Widowed	10.1 (9.6-10.5)	4.7 (4.3-5.2)	13.2 (12.2-14.3)	22.3 (20.7-24.0)
Education level				
< Secondary School	19.7 (18.6-20.8)	12.3 (11.0-13.6)	23.5 (21.6-25.4)	38.5 (35.6-41.4)
Secondary School Grad	20.6 (19.4-21.8)	20.0 (18.2-21.7)	22.5 (20.5-24.6)	18.5 (16.4-20.7)
Some Post-Secondary	5.3 (4.7-6.0)	5.1 (4.3-6.0)	5.5 (4.5-6.5)	5.8 (4.8-6.8)
Post-Secondary Grad	54.3 (52.8-55.9)	62.6 (60.5-64.7)	48.5 (46.1-50.9)	37.2 (34.3-40.0)
Household income				
Mean ($) (CI)	78114 (75225-81004)	91154 (87366-94942)	70411 (66342-74479)	44050 (41623-46476)
Median ($) (IQR)	63941 (35909-99551)	74979 (47818-114591)	59115 (31960-89762)	33835 (19608-59091)
Lowest tertile	12.4 (11.5-13.3)	7.1 (6.2-8.1)	14.0 (12.6-15.3)	28.4 (25.9-30.9)
Middle tertile	22.4 (21.1-23.6)	21.0 (19.3-22.8)	24.4 (22.5-26.3)	22.5 (20.1-24.9)
Highest tertile	35.4 (33.9-37.0)	43.6 (41.3-46.0)	31.5 (29.1-33.9)	14.2 (12.1-16.4)
Missing	29.8 (28.1-31.5)	28.2 (25.7-30.6)	30.2 (27.8-32.5)	34.9 (31.7-38.2)
Aboriginal identity				
Yes	2.5 (2.0-3.0)	1.9 (1.3-2.5)	2.5 (1.9-3.1)	4.9 (3.1-6.7)[E]
No	97.4 (96.9-97.9)	98.0 (97.4-98.6)	97.4 (96.8-98.1)	95.0 (93.2-96.8)

Characteristic	Overall (%, CI)	Frailty (FI) Status (column %, CI)		
		Robust [FI ≤0.1] (52.5%)	**Pre-Frail [FI >0.1 to ≤0.21] (33.5%)**	**Frail [FI >0.21] (14.0%)**
Province (grouped)				
Atlantic	10.2 (10.2-10.2)	9.2 (8.8-9.7)	10.5 (9.8-11.2)	12.8 (11.7-13.9)
Ontario	50.9 (50.8-50.9)	51.2 (49.9-52.5)	49.7 (47.8-51.7)	52.2 (49.4-55.0)
Prairies	20.6 (20.6-20.6)	20.4 (19.6-21.2)	21.7 (20.5-22.8)	18.8 (17.1-20.6)
British Columbia	18.4 (18.3-18.4)	19.1 (18.1-20.1)	18.1 (16.7-19.5)	16.1 (14.0-18.2)
Location‡				
Urban	79.4 (77.1-81.6)	80.0 (77.4-82.6)‡	78.4 (75.3-81.5)‡	79.3 (76.4-82.2)‡
Rural	20.6 (18.4-22.9)	20.0 (17.4-22.6)	21.6 (18.5-24.7)	20.7 (17.8-23.6)
No. Chronic Conditions				
Mean (CI)	1.80 (1.76-1.85)	0.71 (0.68-0.74)	2.35 (2.30-2.40)	4.59 (4.45-4.73)
Median (IQR)	0.87 (0-2.24)	0.08 (0-0.73)	1.77 (1.01-2.67)	3.93 (2.75-5.24)
0	26.3 (24.9-27.6)	46.7 (44.5-49.0)	4.7 (3.6-5.8)	<3.3[F]
1	27.1 (25.7-28.6)	38.5 (36.2-40.9)	19.9 (18.1-21.7)	1.8 (1.1-2.5)
2-3	31.0 (29.8-32.2)	14.5 (13.4-15.7)	58.8 (56.7-60.9)	26.2 (23.6-28.8)
4+	15.6 (14.7-16.4)	0.2 (0.1-0.4)	16.6 (15.2-18.1)	70.5 (67.8-73.2)
Regular Family Physician				
Yes	94.4 (93.7-95.1)	93.0 (92.0-94.0)	95.9 (95.1-96.7)	96.0 (94.3-97.7)
No	5.6 (4.9-6.3)	7.0 (6.0-8.0)	4.1 (3.3-4.9)	4.0 (2.3-5.7)[E]
Self-reported Previous Hospitalization				
Yes	8.4 (7.7-9.1)	3.3 (2.6-3.9)	10.7 (9.3-12.0)	22.2 (19.9-24.4)
No	91.6 (90.9-92.3)	96.7 (96.1-97.4)	89.3 (88.0-90.7)	77.8 (75.6-80.1)
DAD-linked Previous Hospitalization				
Yes	6.8 (6.2-7.4)	2.5 (2.0-2.9)	8.9 (7.6-10.1)	18.3 (16.2-20.4)
No	93.2 (92.6-93.8)	97.6 (97.1-98.0)	91.1 (89.9-92.4)	81.7 (79.6-83.8)
Receiving Formal HC				
Yes	5.3 (4.8-5.7)	1.1 (0.8-1.4)	5.3 (4.5-6.0)	20.8 (18.8-22.7)
No	94.7 (94.3-95.2)	98.9 (98.6-99.1)	94.7 (94.0-95.5)	79.3 (77.3-81.2)
Receiving Informal HC				
Yes	12.0 (11.1-12.9)	3.7 (2.9-4.5)	12.8 (11.3-14.3)	41.2 (38.3-44.1)
No	88.0 (87.1-88.9)	96.3 (95.5-97.1)	87.2 (85.7-88.7)	58.8 (55.9-61.7)

Characteristic	Overall (%, CI)	Frailty (FI) Status (column %, CI)		
		Robust [FI ≤0.1] (52.5%)	Pre-Frail [FI >0.1 to ≤0.21] (33.5%)	Frail [FI >0.21] (14.0%)
Unmet HC Need				
Yes	2.4 (2.0-2.7)	<0.7[F]	2.1 (1.6-2.5)	10.5 (8.8-12.1)
No	97.6 (97.3-98.0)	99.6 (99.3-99.9)	98.0 (97.5-98.4)	89.5 (88.0-91.2)
Unmet HC Need Reason				
Personal Barrier	1.8 (1.5-2.1)	<0.4[F]	1.6 (1.2-2.0)	8.4 (6.9-9.9)
System Barrier	0.3 (0.2-0.4)	<0.1[F]	<0.4[F]	1.3 (0.9-1.8)[E]
Both	0.3 (0.1-0.4)[E]	<0.5[F]	<0.3[F]	0.7 (0.4-1.0)[E]
No Unmet Need	97.6 (97.3-98.0)	99.6 (99.3-99.9)	98.0 (97.5-98.4)	89.6 (88.0-91.2)
SSA				
Overall Measure of SSA				
Mean (CI)	64.13 (63.85-64.77)	65.97 (65.39-66.56)	63.72 (63.06-64.38)	59.23 (57.88-60.58)
Median (IQR)	69.93 (56.47-75.20)	71.85 (57.80-75.29)	68.48 (56.17-75.13)	64.87 (48.73-74.64)
Low	29.1 (27.5-30.6)	25.3 (23.2-27.5)	30.6 (28.3-32.9)	39.9 (36.8-43.0)
High	71.0 (69.4-72.5)	74.7 (72.5-76.8)	69.4 (67.1-71.7)	60.1 (57.0-63.2)
SSA Domains				
Affection				
Low	29.8 (28.3-31.4)	26.8 (24.7-29.0)	30.9 (28.6-33.3)	38.9 (35.8-42.1)
High	70.2 (68.6-71.7)	73.2 (71.0-75.3)	69.1 (66.7-71.4)	61.1 (57.9-64.2)
Emotional and				
Informational Support				
Low	30.0 (28.5-31.6)	27.1 (25.0-29.3)	31.2 (28.9-33.6)	38.6 (35.4-41.8)
High	70.0 (68.4-71.5)	72.9 (70.7-75.0)	68.8 (66.4-71.1)	61.4 (58.2-64.6)
Positive Social				
Interaction				
Low	31.5 (30.0-33.1)	27.6 (25.5-29.6)	33.5 (31.1-35.9)	42.4 (39.3-45.6)
High	68.5 (66.9-70.0)	72.4 (70.4-74.5)	66.5 (64.1-68.9)	57.6 (54.4-60.7)
Tangible Support				
Low	33.2 (31.6-34.9)	30.5 (28.3-32.8)	34.4 (32.0-36.7)	41.2 (38.0-44.3)
High	66.8 (65.1-68.4)	69.5 (67.2-71.7)	65.6 (63.3-68.0)	58.8 (55.7-62.0)

Notes: Weighted and bootstrapped prevalence estimates for CCHS-HA analytic sample; FI=frailty index; CI=95% Confidence Interval; HC=home care; [E] use with caution (CV 16.6-33.3%); [F] Coefficient of variation exceeds 33.3%, but cell contains at least 5 records, estimate indicated as being less than upper limit of 95% confidence interval; All comparisons significant across frailty level, $p<0.05$ unless otherwise indicated; ǂ indicates non-significant finding ($p>0.05$); Data source: 2008/2009 Canadian Community Health Survey-Healthy Aging (cycle 4.2) linked to DAD and CMDB

Figure 5.1.1 Weighted distribution of FI (continuous) measure, 2008-09 CCHS-HA (Cycle 4.2) analytical sample.



5.1.2: Research Question #1: Associations between frailty and CCHS-HA respondent characteristics (Table 5.1.1a)

Frail respondents were significantly more likely to be older (mean age 68.2 vs 63.0 for pre-frail and 56.7 for robust) and to be female (61.7% vs 54.4% among pre-frail and 47.5% among robust respondents). Relative to the pre-frail and robust groups, frail respondents were also significantly more likely to be widowed, to have not completed high school and to report lower household incomes. Aboriginal identity was significantly more common among the frail (4.9%) vs pre-frail (2.5%) or robust (1.9%) groups. Respondents in the three FI groups did not vary significantly in terms of urban/rural residence, though frail respondents included a higher proportion of participants from the Atlantic region.

When examining health and social characteristics, frail respondents were significantly more likely than those in the pre-frail or robust groups to have multiple chronic conditions (e.g., 70.5% with 4+ conditions vs 16.6% and 0.2%, respectively) and to have been hospitalized in the past year (18.3% vs 8.9% and 2.5%, respectively). The receipt of both formal and informal (family/friend) home care was significantly more likely among frail (20.8% and 41.2% respectively) compared to pre-frail (5.3% and 12.8%) and robust (1.1% and 3.7%) respondents. They were also significantly more likely to report an unmet home care need relative to pre-frail and robust respondents (10.5% vs 2.1% and <0.7%, respectively). Personal barriers (accessibility and acceptability) were most often cited (8.4%) as the reason for this unmet need. Lower overall (and domain-specific) SSA was found among frail versus pre-frail and robust respondents.

5.1.3 Research Question #2: Associations between unmet home care need and CCHS-HA respondent characteristics (Table 5.1.2)

Respondents with an unmet home care need were significantly more likely than those without such a need to be frail (61.6% vs 12.9%), older (mean age 66.3 vs 60.3 years), female (70.1% vs 51.3%) and less likely to be married or to be living with a partner (46.6% vs 74.6%). Relative to respondents with no unmet home care need, those with unmet home care need were also significantly more likely to have not completed high school (35.8% vs 19.3%) and to report a lower household income (34.5% vs 11.9%) and Aboriginal identity (4.5% vs 2.5%). A slightly higher proportion of participants with unmet home care were respondents from British Columbia and the Atlantic regions, however overlap of confidence intervals suggest caution when interpreting statistically significant differences. There were no significant differences between respondents with and without an unmet home care need according to urban vs rural residence.

Regarding health and social characteristics, respondents who reported unmet home care need had more chronic conditions (mean number of conditions 3.5 vs 1.8 for those with no unmet home care need), with a significantly higher proportion with greater than 4 conditions (46.6% vs 14.8%) compared to those without such a need. They were also more likely to have a regular family physician, to have reported a previous hospitalization (32.4% vs 7.8%), as well as to have a DAD-linked admission in the previous year (26.6% vs 6.3%). Respondents with unmet home care need were also more likely to report receiving both formal (21.3% vs 4.9%) and informal (65.9% vs 10.7%) home care support compared to respondents with no unmet home care need. Respondents with unmet home care need were also found to have low overall SSA (60.9%) compared to those who did not report an unmet home care need (28.3%).

The examination of type of unmet need was not feasible beyond baseline descriptive analysis due to sample size limitations and the relative distribution of unmet need in the analytical sample.

Table 5.1.2: Baseline characteristics of participants aged 45+ years, overall and by unmet home care need, 2008-09 CCHS-HA (Cycle 4.2) analytical sample

Characteristics	Overall (%, CI)	Unmet Home care Need (column %, CI)	
		Yes (2.38%)	No (97.62%)
Mean FI (CI)	0.12 (0.12-0.12)	0.25 (0.23-0.27)	0.12 (0.11-0.12)
Median (IQR)	0.10 (0.06-0.16)	0.24 (0.17-0.32)	0.10 (0.06-0.15)
Frailty Status			
Robust	52.5 (51.0-53.9)	<15.8[F]	53.5 (52.0-55.0)
Pre-Frail	33.5 (32.1-34.9)	28.9 (23.1-34.7)	33.6 (32.2-35.1)
Frail	14.0 (13.2-14.9)	61.6 (55.2-68.1)	12.9 (12.1-13.7)
Mean Age (CI)	60.43 (60.36-60.51)	66.34 (64.66-68.01)	60.29 (60.20-60.37)
Median (IQR)	57.70 (50.28-67.39)	66.30 (55.23-75.78)	57.54 (50.22-67.07)
45-54	38.9 (38.9-38.9)	22.5 (15.6-29.4)	39.3 (39.1-39.4)
55-64	29.3 (29.3-29.3)	24.2 (19.3-29.0)	29.4 (29.3-29.5)
65-74	17.4 (17.4-17.4)	24.3 (18.6-30.0)	17.2 (17.1-17.4)
75-84	10.8 (10.7-10.8)	20.3 (16.1-24.5)	10.5 (10.4-10.6)
85+	3.7 (3.6-3.7)	8.7 (6.3-11.1)	3.5 (3.5-3.6)
Sex			
Men	48.2 (48.2-48.3)	29.9 (23.4-36.3)	48.7 (48.5-48.9)
Women	51.8 (51.7-51.8)	70.1 (63.7-76.6)	51.3 (51.1-51.5)
Marital status			
Married/Partner	74.0 (72.7-75.2)	46.6 (40.2-52.9)	74.6 (73.4-75.9)
Separated/Divorced /Never Married	16.0 (14.8-17.1)	29.5 (23.9-35.2)	15.7 (14.5-16.8)
Widowed	10.0 (9.6-10.5)	23.9 (19.3-28.5)	9.7 (9.2-10.2)
Education level			
< Secondary School	19.7 (18.6-21.8)	35.8 (29.1-42.4)	19.3 (18.2-20.4)
Secondary School Grad	20.6 (19.4-20.8)	14.3 (9.2-19.4)[E]	20.8 (19.6-22.0)
Some Post-Secondary	5.3 (4.7-6.0)	5.2 (2.9-7.6)[E]	5.3 (4.7-6.0)
Post-Secondary Grad	54.3 (52.7-55.9)	44.7 (37.2-52.3)	54.6 (53.0-56.2)
Household income			
Mean (CI)	78114 (75225-81004)	41021 (34992-47049)	78999 (76067-81932)
Median (IQR)	63941 (35909-99551)	28481 (16845-50366)	64276 (37059-99611)
Lowest tertile	12.4 (11.5-13.3)	34.5 (28.3-40.7)	11.9 (11.0-12.8)
Middle tertile	22.4 (21.1-23.6)	21.8 (16.4-27.3)	22.4 (21.1-23.6)
Highest tertile	35.4 (33.9-37.0)	12.4 (7.2-17.5)[E]	36.0 (34.4-37.6)
Missing	29.8 (28.1-31.5)	31.3 (22.6-40.0)	29.7 (28.0-31.5)

Characteristics	Overall (%, CI)	Unmet Home care Need (column %, CI)	
		Yes (2.38%)	No (97.62%)
Aboriginal identity			
Yes	2.5 (2.0-3.0)	4.5 (2.2-6.8)[E]	2.5 (2.0-3.0)
No	97.4 (96.9-97.9)	95.5 (93.2-97.8)	97.4 (97.0-97.7)
Province (grouped)			
Atlantic	10.2 (10.2-10.2)	11.7 (8.8-14.6)	10.1 (10.1-10.2)
Ontario	50.9 (50.8-50.9)	47.7 (40.1-55.4)	50.9 (50.8-51.1)
Prairies	20.6 (20.6-20.6)	15.5 (11.9-19.1)	20.8 (20.7-20.9)
British Columbia	18.3 (18.3-18.4)	25.0 (18.8-31.2)	18.2 (18.0-18.3)
Location[‡]			
Urban	79.4 (77.1-81.6)	79.0 (73.5-84.5)‡	79.4 (77.1-81.6)‡
Rural	20.6 (18.4-22.9)	21.0 (15.5-26.5)	20.6 (18.4-22.9)
No. Chronic Conditions			
Mean (CI)	1.80 (1.76-1.85)	3.54 (3.20-3.89)	1.76 (1.71-1.81)
Median (IQR)	0.87 (0-2.24)	2.81 (1.32-4.51)	0.85 (0-2.17)
0	26.3 (24.9-27.6)	8.7 (4.1-13.3)[E]	26.7 (25.3-28.1)
1	27.1 (25.7-28.6)	11.0 (4.8-17.2)[E]	27.5 (26.1-29.0)
2-3	31.0 (29.8-32.2)	33.7 (27.8-39.6)	30.9 (29.7-32.1)
4+	15.6 (14.7-16.4)	46.6 (39.5-53.7)	14.8 (14.0-15.7)
Regular Family Physician			
Yes	94.4 (93.7-95.1)	97.0 (95.2-98.7)	94.3 (93.6-95.0)
No	5.6 (4.9-6.3)	3.0 (1.3-4.8)[E]	5.7 (5.0-6.4)
Self-reported Previous Hospitalization			
Yes	8.4 (7.7-9.1)	32.4 (26.1-38.7)	7.8 (7.1-8.5)
No	91.6 (90.9-92.3)	67.6 (61.3-73.9)	92.2 (91.5-92.9)
DAD-linked Previous Hospitalization			
Yes	6.8 (6.2-7.4)	26.6 (20.7-32.4)	6.3 (5.8-6.9)
No	93.2 (92.6-93.8)	73.4 (67.6-79.3)	93.7 (93.1-94.2)
Receiving Formal HC			
Yes	5.3 (4.8-5.7)	21.3 (16.9-25.7)	4.9 (4.4-5.3)
No	94.7 (94.3-95.2)	78.7 (74.3-83.1)	95.1 (94.7-95.6)
Receiving Informal HC			
Yes	12.0 (11.1-12.9)	65.9 (59.8-72.1)	10.7 (9.9-11.5)
No	88.0 (87.1-88.9)	34.1 (27.9-40.2)	89.3 (88.5-90.1)

Characteristics	Overall (%, CI)	Unmet Home care Need (column %, CI)	
		Yes (2.38%)	No (97.62%)
Social Support Availability			
Mean (CI)	64.31 (63.85-64.77)	48.88 (46.25-51.52)	64.68 (64.23-65.13)
Median (IQR)	69.93 (69.15-70.71)	54.96 (31.34-66.38)	70.31 (56.65-75.22)
Overall Measure of SSA			
Low	29.1 (27.5-30.6)	60.9 (54.3-67.5)	28.3 (26.8-29.8)
High	70.9 (69.4-72.4)	39.1 (32.5-45.7)	71.7 (70.2-73.2)

Notes: Weighted and bootstrapped prevalence estimates for CCHS-HA analytic sample; FI=frailty index; HC=home care; [E] use with caution (CV 16.6-33.3%); [F] Coefficient of variation exceeds 33.3%, but cell contains at least 5 records, estimate indicated as being less than upper limit of 95% confidence interval; All comparisons between met and unmet home care need significant, $p<0.05$ unless otherwise indicated; ǂ indicates non-significant finding ($p>0.05$). Data source: 2008/2009 Canadian Community Health Survey-Healthy Aging (cycle 4.2) linked to DAD and CMDB

5.1.4 Outcomes (Tables 5.1.3a and 5.1.3b)

Among CCHS-HA sample respondents, 15.3% had an inpatient acute care hospital admission during the 2-year follow-up. Of these admissions, 62% were urgent, while the remaining 38% were classified as elective. The distributions of the most common causes of inpatient hospitalization (defined using the most responsible diagnosis code), overall and by admission type, are presented in Table 5.1.3a. Cancer, age-related arthrosis, genitourinary, heart and digestive system diseases, represented the top five overall reasons for inpatient hospitalization (captured for the first such event during the 2-year follow-up). The top causes of urgent admission were palliative care, heart disease and cancer, while elective admissions were more commonly the result of arthrosis, cancer and genitourinary diseases.

During the 2-year follow-up, 3.3% of CCHS-HA respondents died. Cancer, heart disease, and acute MI were the leading causes of death (see Table 5.1.3b).

Table 5.1.3a: Most frequent causes of hospitalization among respondents aged 45+ years during 2-year follow-up, overall and by admission type, 2008-09 CCHS-HA (Cycle 4.2) analytical sample

Rank	Any Admission 15.3% 95% CI 14.5-16.1)	Elective Admission 37.6% (95% CI 34.8-40.5)	Urgent Admissions 62.4% (95% CI 59.5-65.2)
1	Cancer	Age-related arthrosis	Palliative Care
2	Age-related arthrosis	Cancer	Heart Disease
3	Genitourinary disease (including prostate)	Genitourinary disease (including prostate)	Cancer
4	Heart Disease	Eye Disorders	Infection/Sepsis (Including Pneumonia)
5	Diseases of digestive system, other	Benign Neoplasms	Disease of the Digestive system, other
6	Palliative Care	Diseases of musculoskeletal system, other	COPD
7	Infection/sepsis (including pneumonia)	Hernia	Acute Myocardial Infarct
8	Diseases of musculoskeletal system, other	Disease of the Digestive system, other	Arrhythmias (including atrial fibrillation)
9	COPD	Admission for follow-up or Observation	Heart Failure
10	Hernia	Heart Disease	Extremity injury
11	Eye disorders	Surgical, medical care, implant/graft complications	Stroke
12	Arrhythmias (including Atrial Fibrillation)	Admission for treatment or procedure	Chest Pain, other
13	Acute Myocardial Infarct	Convalescence	Convalescence
14	Benign Neoplasms	Extremity Injury	Other Diseases of the Respiratory system
15	Heart Failure	Palliative Care	Diseases of musculoskeletal system, other
16	Extremity Injury	Diseases of the Gallbladder	Hip Fracture
17	Surgical, medical care or Implant/graft complications	Thyroid/other Gland Disorders	Genitourinary disease (including prostate)
18	Convalescence	Crohn's or Colitis	Substance abuse disorders
19	Other Diseases of the Respiratory system	Heart Failure	Crohn's or Colitis
20	Stroke	Obstetrics	Blood Disorders (including anaemia)
21	Chest Pain, other	Nervous System Disorders	Intestinal Obstruction
22	Admission for follow-up or observation	Blood Disorders (including anaemias)	Urinary Tract Infection
23	Crohn's or Colitis	Stroke	Age-related Arthrosis
24	Hip Fracture	COPD	Head or Neck Injury
25	Diseases of the Gallbladder	Urinary Tract Infection	Disease of the Gallbladder

Note: ranking based on ICD-10 codes collapsed into meaningful groups using ICD-10 chapters and sub-chapters (159)

Table 5.1.3b: Top causes of death among respondents aged 45+ years during 2-year follow-up, 2008-09 CCHS-HA (Cycle 4.2) analytical sample

Rank	Causes of Death 3.3% (95% CI 3.0-3.7)
1	Cancer
2	Heart Disease
3	Acute Myocardial Infarct
4	Stroke
5	COPD
6	Dementia
7	Diabetes
8	Alcohol abuse
9	Diseases of the gastrointestinal system
10	Pneumonia
11	Heart Failure
12	Renal Failure
13	Fall
14	Suicide
15	Blood disorders (including anaemia, coagulation, thrombosis)

Note: ranking based on ICD-10 codes collapsed into meaningful groups using ICD-10 Chapters and sub-chapters (159)

5.1.5 Bivariate Results: CCHS-HA Respondent characteristics (including frailty) and inpatient hospitalization (Tables 5.1.4a and 5.1.4b)

Table 5.1.4a presents the associations between frailty and both outcomes (hospitalization and death) during the 2-year follow-up. Overall, 15.3% of respondents experienced an outcome hospitalization and 3.3% died. Frail respondents were more likely to have experienced a hospitalization (33.9%) compared to their pre-frail (18.6%) and robust (8.2%) counterparts. This pattern was also seen for death with frail (10.2%) respondents more likely to have died compared to those who were pre-frail (3.4%) or robust (1.4%).

Table 5.1.4b presents the unadjusted associations between the other covariates and inpatient hospitalization during the 2-year follow-up. Older versus younger respondents were significantly more likely to have been hospitalized (e.g., 39% among 85+ compared to 8.5% among those in the 45-54 age group). Those with less than a high school education were significantly more likely to have been hospitalized than respondents who completed a post-secondary degree (23.0% vs 12.4%, respectively). Lower versus higher household income was also significantly associated with the likelihood of hospitalization (21.6% vs. 10.8%, respectively). Those residing in urban (14.7%) versus rural (17.5%) dwellings were slightly less likely to have experienced inpatient hospitalization. Significant regional differences were also observed with Ontarians (13.5%) less likely than respondents from all other regions to have been hospitalized in the follow-up period. There were no significant differences in the likelihood of hospitalization between men and women or by Aboriginal identity.

When exploring the health and social covariates, respondents with a greater number of chronic condition (4+), were significantly more likely to have been hospitalized (30.7%) compared to respondents with fewer conditions (18.5%, 9.2% and 8.6% for those with 2-3, 1 or 0

conditions, respectively). Those with a regular doctor were significantly more likely to experience an inpatient hospitalization during follow-up (15.6% vs 10.4% for those without). Respondents who experienced a previous hospitalization, whether self-reported (34.7%) or a DAD-linked (39.7%) admission, were significantly more likely to have been hospitalized during follow-up than those without a previous admission (13.5%). Hospitalization was significantly more likely for respondents receiving either formal (39%) or informal (33.1%) home care compared to those who were not receiving such care (~13-14%). Hospitalization was also significantly more likely for those reporting unmet home care need (31.4%) compared to respondents without such need (14.9%). No significant differences in hospitalization were found between respondents with low versus high SSA.

Table 5.1.4a: Proportion of respondents aged 45+ years who experienced each outcome during the 2-year follow-up, by frailty status, 2008-09 CCHS-HA (Cycle 4.2) analytical sample

Outcome	Overall N (%, 95% CI)	Frailty Status (column %, 95% CI)			
		Robust	Pre-Frail	Frail	p-value
		52.47%	33.50%	14.03%	
Death	3.3 (3.0-3.7)	1.4 (0.9-1.9)	3.4 (2.9-4.0)	10.2 (8.9-11.5)	<.0001
Any hospitalization	15.3 (14.5-16.1)	8.2 (7.2-9.3)	18.6 (17.1-20.1)	33.9 (31.2-36.6)	<.0001

Table 5.1.4b: Baseline characteristics of participants aged 45+ years, overall and by inpatient hospitalization during 2-year follow-up (row percent distribution), 2008-09 CCHS-HA (Cycle 4.2) analytical sample

Characteristics	Overall (%, CI)	Hospitalization (row %, CI)	
		Yes (15.30%)	No (84.70%)
Mean (CI)	0.12 (0.12-0.12)	0.17 (0.17-0.18)	0.11 (0.11-0.11)
Median (IQR)	0.10 (0.06-0.16)	0.17 (0.09-0.23)	0.09 (0.05-0.14)
Frailty Status			
Robust	52.5 (51.0-53.9)	8.2 (7.2-9.3)	91.8 (90.7-92.8)
Pre-frail	33.5 (32.1-34.9)	18.6 (17.1-20.1)	81.4 (79.9-82.9)
Frail	14.0 (13.2-14.9)	33.9 (31.2-36.6)	66.1 (63.4-68.8)
Age			
Mean age (CI)	60.43 (60.36-60.51)	66.81 (66.00-67.62)	59.28 (59.14-59.42)
Median (IQR)	57.70 (50.28-67.39)	66.13 (55.64-76.96)	56.50 (49.84-65.22)
Age group			
45-54	38.9 (38.9-38.9)	8.5 (6.8-10.1)	91.5 (89.9-93.2)
55-64	29.3 (29.3-29.3)	12.6 (11.2-14.1)	87.4 (85.9-88.8)
65-74	17.4 (17.4-17.4)	19.5 (17.7-21.2)	80.5 (78.8-82.3)
75-84	10.8 (10.8-10.8)	32.4 (30.0-34.7)	67.6 (65.3-70.0)
85+	3.7 (3.6-3.7)	39.0 (35.6-42.4)	61.0 (57.6-64.4)
Sex‡			
Men	48.2 (48.2-48.2)	15.5 (14.2-16.8)‡	84.5 (83.2-85.8)‡
Women	51.8 (51.8-51.8)	15.1 (14.0-16.3)	84.9 (83.7-86.0)
Education level			
< Secondary School	19.7 (18.6-20.8)	23.0 (20.9-25.1)	77.0 (74.9-79.1)
Secondary School Grad	20.6 (19.4-21.8)	15.1 (13.0-17.2)	84.9 (82.8-87.0)
Some Post-Secondary	5.3 (4.7-6.0)	16.7 (12.8-20.6)	83.3 (79.4-87.2)
Post-Secondary Grad	54.3 (52.8-55.9)	12.4 (11.3-13.5)	87.6 (86.5-88.7)
Household income			
Mean (CI)	78114 (75225-81004)	66857 (60728-72985)	79978 (76931-83025)
Median (IQR)	63941 (35909-99551)	49400 (26969-84502)	64782 (39523-99716)
Lowest tertile	12.4 (11.5-13.3)	21.6 (19.7-23.5)	78.4 (76.5-80.3)
Middle tertile	22.4 (21.1-23.6)	15.5 (13.9-17.1)	84.5 (82.9-86.1)
Highest tertile	35.4 (33.9-37.0)	10.8 (9.3-12.3)	89.2 (87.7-90.7)
Missing	29.8 (28.1-31.5)	17.9 (16.0-19.7)	82.1 (80.3-84.0)
Aboriginal identity‡			
Yes	2.5 (2.0-3.0)	19.5 (12.8-26.3)‡[E]	80.5 (73.7-87.2)‡
No	97.4 (96.9-97.9)	15.2 (14.4-16.0)	84.8 (84.0-85.6)
Province (grouped)			
Atlantic	10.2 (10.2-10.2)	17.2 (16.0-18.4)	82.8 (81.6-84.0)
Ontario	50.9 (50.8-50.9)	13.5 (12.1-14.8)	86.5 (85.2-87.9)
Prairies	20.6 (20.6-20.6)	17.6 (16.1-19.1)	82.4 (80.9-83.9)
British Columbia	18.4 (13.3-18.4)	16.7 (14.8-18.7)	83.3 (81.3-85.2)
Location			
Urban	79.4 (77.1-81.6)	14.7 (13.8-15.7)	85.3 (84.3-86.2)
Rural	20.6 (18.4-22.9)	17.5 (15.3-19.7)	82.5 (80.3-84.7)

Characteristics	Overall (%, CI)	Hospitalization (row %, CI)	
		Yes (15.30%)	No (84.70%)
No. Chronic Conditions			
Mean (CI)	1.80 (1.76-1.85)	2.73 (2.60-2.86)	1.64 (1.59-1.68)
Median (IQR)	0.87 (0-2.24)	1.91 (0.626-3.53)	0.74 (0-1.96)
0	26.3 (24.9-27.6)	8.6 (6.9-10.3)	91.4 (89.7-93.1)
1	27.1 (25.7-28.6)	9.2 (7.8-10.7)	90.8 (89.3-92.2)
2-3	31.0 (29.8-32.2)	18.5 (16.9-20.2)	81.5 (79.8-83.1)
4+	15.6 (14.7-16.4)	30.7 (28.3-33.1)	69.3 (66.9-71.7)
Regular Family Physician			
Yes	94.4 (93.7-95.1)	15.6 (14.7-16.4)	84.4 (83.6-85.3)
No	5.6 (4.9-6.3)	10.4 (8.0-12.8)	89.6 (87.2-92.0)
Self-reported Previous Hospitalization			
Yes	8.4 (7.7-9.1)	34.7 (30.9-38.4)	65.3 (61.6-69.1)
No	91.6 (90.9-92.3)	13.5 (12.7-14.4)	86.5 (85.6-87.3)
DAD-linked Previous Hospitalization			
Yes	6.8 (6.2-7.4)	39.7 (35.5-43.8)	60.3 (56.2-64.5)
No	93.2 (92.6-93.8)	13.5 (12.7-14.3)	86.5 (85.7-87.3)
Receiving Formal HC			
Yes	5.3 (4.8-5.7)	39.0 (35.4-42.7)	61.0 (57.3-64.6)
No	94.7 (94.3-95.2)	14.0 (13.1-14.8)	86.0 (85.2-86.9)
Receiving Informal HC			
Yes	12.0 (11.1-12.9)	33.1 (30.3-35.9)	66.9 (64.1-69.7)
No	88.0 (87.1-88.9)	12.9 (12.0-13.7)	87.1 (86.3-88.0)
Unmet HC Need			
Yes	2.4 (2.0-2.7)	31.4 (25.8-37.0)	65.6 (63.0-74.2)
No	97.6 (97.3-98.0)	14.9 (14.1-15.7)	85.1 (84.3-85.9)
Social Support Availability			
Mean (CI)	64.31 (63.85-64.77)	63.28 (62.37-64.18)	64.49 (64.00-64.99)
Median (IQR)	69.93 (56.47-75.20)	69.41 (55.60-75.16)	70.05 (56.54-75.21)
Overall SSA[ǂ]			
Low	29.1 (27.5-30.6)	15.5 (14.0-17.1)ǂ	84.5 (82.9-86.0)ǂ
High	70.9 (69.4-72.5)	14.6 (13.6-15.6)	85.4 (84.4-86.4)

Notes: Weighted and bootstrapped prevalence estimates for CCHS-HA analytic sample; FI=frailty index; CI=95% Confidence Interval; HC=Home care; [E] use with caution (CV 16.6-33.3%); [F] Coefficient of variation exceeds 33.3%, but cell contains at least 5 records, estimate indicated as being less than upper limit of 95% confidence interval; All comparisons between hospitalized and not hospitalized in 2-year follow-up period significant, $p<0.05$ unless otherwise indicated; ǂ indicates non-significant finding ($p>0.05$). Data source: 2008/2009 Canadian Community Health Survey-Healthy Aging (cycle 4.2) linked to DAD and CMDB

5.1.6 Bivariate Results: CCHS-HA respondent characteristics (including frailty) and mortality (Table 5.1.5)

As noted above (Table 5.1.4a), frailty was significantly associated with mortality during the 2-year follow-up. With regard to other covariates (Table 5.1.5), respondents in the oldest age group versus those in the youngest group were also more likely to die during follow-up (18.6% vs 0.9%, respectively). Other characteristics significantly associated with mortality were, male versus female sex (3.7% vs 2.9%), less than high school education (6.2% vs 2.4% for post-secondary degree), and low household income (6.5% vs 1.9% for highest income tertitle). A greater number of chronic conditions was also significantly associated with mortality (8.1% for those with 4+ conditions vs 1.1% for those with none). Previous hospitalization in the year prior to baseline, whether self-reported (10.5%) or DAD-linked (12.1%) was significantly associated with mortality. The receipt of either formal (15.2%) or informal (10.4%) home care support compared to not receiving such support (2.7% and 2.3%, respectively) was also significantly associated with death during follow-up. Those who reported having experienced an unmet home care need (8.9%) were also more likely to have died compared to those with no unmet home care need (3.2%). Although mortality was significantly more likely among respondents who reported Aboriginal identity (<9.2%) than those who did not, the coefficient of variance was above 33.3% and therefore, caution is warranted with regard to interpretation of this finding. Neither region, nor urban/rural location were significantly associated with death. Not having a family physician, as well as low SSA, also showed non-significant association with death.

Table 5.1.5: Baseline characteristics of participants aged 45+ years, overall and by death during 2-year follow-up (row percent distribution), 2008-09 CCHS-HA (Cycle 4.2) analytical sample

Characteristics	Overall (%)	Death (row %)	
		Yes (3.32%)	No (96.68%)
Mean FI (CI)	0.12 (0.12-0.12)	0.20 (0.19-0.21)	0.12 (0.11-0.12)
Median (IQR)	0.1 (0.06-0.16)	0.19 (0.11-0.27)	0.1 (0.06-0.15)
Frailty Status			
Robust	52.5 (51.0-53.9)	1.4 (0.9-1.9)	98.6 (98.1-99.1)
Pre-frail	33.5 (32.1-34.9)	3.4 (2.9-4.0)	96.6 (96.0-97.1)
Frail	14.0 (13.2-14.9)	10.2 (8.9-11.5)	89.8 (88.5-91.1)
Mean Age ± SE	60.43 (60.36-60.51)	73.45 (71.53-75.37)	59.99 (59.90-60.07)
Median (IQR)	57.70 (50.28-67.39)	75.59 (62.76-82.69)	57.31 (50.11-66.61)
Age group			
45-54	38.9 (38.9-38.9)	0.9 (0.3-1.6)[E]	99.1 (98.4-99.7)
55-64	29.3 (29.3-29.3)	1.9 (1.4-2.3)	98.1 (97.7-98.6)
65-74	17.4 (17.4-17.4)	3.6 (3.0-4.3)	96.4 (95.7-97.0)
75-84	10.8 (10.8-10.8)	10.3 (8.8-11.7)	89.7 (88.3-91.2)
85+	3.7 (3.6-3.7)	18.6 (16.1-21.1)	81.4 (78.9-83.9)
Sex			
Men	48.2 (48.2-48.2)	3.7 (3.2-4.2)	96.3 (95.8-96.8)
Women	51.8 (51.8-51.8)	2.9 (2.4-3.5)	97.1 (96.5-97.6)
Education level			
< Secondary School	19.7 (18.6-20.8)	6.2 (5.4-7.0)	93.8 (93.0-94.6)
Secondary School Grad	20.6 (19.4-21.8)	3.0 (2.2-3.8)	97.0 (96.2-97.8)
Some Post-Secondary	5.3 (4.7-6.0)	3.1 (1.8-4.3)[E]	96.9 (95.7-98.2)
Post-Secondary Grad	54.3 (52.8-55.9)	2.4 (1.9-2.9)	97.6 (97.1-98.1)
Household income			
Mean ± SD	78114 (75225-81004)	56909 (47010-66807)	78799 (75849-81750)
Median (IQR)	63941 (35909-99551)	39016 (22495-69727)	64231 (36992-99591)
Lowest tertile	12.4 (11.5-13.3)	6.5 (5.4-7.6)	93.5 (92.4-94.6)
Middle tertile	22.4 (21.1-23.6)	3.2 (2.7-3.8)	96.8 (96.2-97.3)
Highest tertile	35.4 (33.9-37.0)	1.9 (1.2-2.6)	98.1 (97.4-98.8)
Missing	29.8 (28.1-31.5)	3.8 (3.1-4.4)	96.2 (95.6-96.9)
Aboriginal identity			
Yes	2.5 (2.0-3.0)	<9.2[F]	95.4 (90.8-99.9)
No	97.4 (96.9-97.9)	3.3 (2.9-3.6)	96.7 (96.4-97.1)
Province (grouped)‡			
Atlantic	10.2 (10.2-10.2)	3.5 (3.0-3.9)‡	96.5 (96.1-97.0)
Ontario	50.9 (50.8-50.9)	3.4 (2.8-3.9)	96.6 (96.1-97.2)
Prairies	20.6 (20.6-20.6)	3.4 (2.7-4.1)	96.6 (95.9-97.3)
British Columbia	18.4 (13.3-18.4)	3.0 (2.4-3.7)	97.0 (96.3-97.6)
Location‡			
Urban	79.4 (77.1-81.6)	3.2 (2.8-3.6)‡	96.8 (96.4-97.2)
Rural	20.7 (18.4-22.9)	3.7 (3.0-4.4)	96.3(95.6-97.0)

Characteristics	Overall (%)	Death (row %)	
		Yes (3.32%)	No (96.68%)
No. Chronic Conditions			
Mean (CI)	1.80 (1.76-1.85)	3.14 (2.92-3.36)	1.76 (1.71-1.80)
Median (IQR)	0.87 (0-2.24)	2.32 (0.88-3.97)	0.84 (0-2.16)
0	26.3 (24.9-27.6)	1.1 (0.8-1.4)	98.9 (98.6-99.2)
1	27.1 (25.7-28.6)	2.3 (1.3-3.2)[E]	97.7 (96.8-98.7)
2-3	31.0 (29.8-32.2)	3.7 (3.1-4.3)	96.3 (95.7-96.9)
4+	15.6 (14.7-16.4)	8.1 (7.0-9.2)	91.9 (90.8-93.0)
Regular Family Physician[‡]			
Yes	94.4 (93.7-95.1)	3.4 (3.0-3.7)	96.6 (96.3-97.0)
No	5.6 (4.9-6.3)	2.8 (1.8-3.9)‡[E]	97.2 (96.1-98.2)
Self-reported Previous Hospitalization			
Yes	8.4 (7.7-9.1)	10.5 (8.6-12.5)	89.5 (87.5-91.4)
No	91.6 (90.9-92.3)	2.7 (2.3-3.0)	97.3 (97.0-97.7)
DAD-linked Previous Hospitalization			
Yes	6.8 (6.2-7.4)	12.1 (9.9-14.4)	87.9 (85.6-90.1)
No	93.2 (92.6-93.8)	2.6 (2.3-3.0)	97.3 (97.0-97.7)
Receiving Formal HC			
Yes	5.3 (4.8-5.7)	15.2 (12.6-17.9)	84.8 (82.1-87.4)
No	94.8 (94.3-95.2)	2.7 (2.3-3.0)	97.3 (97.0-97.7)
Receiving Informal HC			
Yes	12.0 (11.1-12.9)	10.4 (9.0-11.8)	89.6 (88.2-91.0)
No	88.0 (87.1-88.9)	2.3 (2.0-2.7)	97.7 (97.3-98.0)
Unmet HC Need			
Yes	2.4 (2.0-2.7)	8.9 (6.1-11.6)	91.1 (88.4-93.9)
No	97.6 (97.3-98.0)	3.2 (2.8-3.5)	96.8 (96.5-97.2)
Social Support Availability			
Mean (CI)	64.31 (63.85-64.77)	61.22 (59.34-63.09)	64.41 (59.90-60.07)
Median (IQR)	69.93 (56.47-75.20)	68.59 (53.42+75.18)	69.96 (56.50-75.21)
Overall SSA[‡]			
Low	29.1 (27.5-30.6)	3.5 (2.9-4.0)‡	96.5 (96.0-97.1)
High	70.6 (69.4-72.5)	3.0 (2.5-3.4)	97.1 (96.6-97.5)

Notes: Weighted and bootstrapped prevalence estimates for CCHS-HA analytic sample; FI=frailty index; CI=95% Confidence Interval; HC=home care; [E] use with caution (CV 16.6-33.3%); [F] Coefficient of variation exceeds 33.3%, but cell contains at least 5 records, estimate indicated as being less than upper limit of 95% confidence interval; All comparisons between respondents who died and those who did not, are significant at $p<0.05$ unless otherwise indicated; ‡ indicates non-significant finding ($p>0.05$)

Data source: 2008/2009 Canadian Community Health Survey-Healthy Aging (cycle 4.2), linked to DAD and CMDB

5.2 Multivariable Results

5.2.1 Research Question #3: Independent association between frailty level and inpatient hospitalization and death over 2-year follow-up period, overall and stratified by sex

5.2.1.1 Multivariable Logistic Regression Model: Frailty and Hospitalization (Table 5.2.1.1)

The association between vulnerability, as measured by frailty, and first-event hospitalization over a 2-year follow-up period was examined using logistic regression models initially adjusted for age and sex only and then in selected models adjusted for other relevant covariates (labeled Models A to D, Table 5.2.1.1). Model A, with adjustment for age, sex and comorbidity, represents a base model typically explored in other frailty-outcome research (10,11,14,16). As illustrated, frailty level showed a statistically significant association with subsequent hospitalization across all models. This association was highest in the age and sex adjusted model when compared to other models with additional covariates (e.g., after adjusting for age and sex only, the odds of hospitalization for pre-frail and frail respondents was 2.04 (95% CI 1.69-2.47) and 3.96 (95% CI 3.24-4.85) times greater, respectively, than for robust participants. The magnitude of the association was somewhat attenuated after adjusting for all relevant covariates (Model B) with the odds of hospitalization 1.76 (95% CI 1.40-2.21) times higher for pre-frail respondents and 2.84 (95% CI 2.10-3.84) times higher for frail respondents when compared to robust respondents.

When examining the age and sex adjusted models, other covariates significantly associated with hospitalization included increasing age and number of chronic conditions, previous hospitalization, lower (and missing responses for) household income, lower educational

levels, and the presence of an unmet home care need. These associations were particularly strong for age (e.g. OR=6.99, 95% CI 5.39-9.06 for respondents aged 85+ vs 45-54 years), comorbidity (e.g., OR=2.95, 95% CI 2.25-3.85 for those with 4+ chronic conditions vs 0), previous hospitalization (e.g., OR=3.32, 95% CI 2.77-3.98), and unmet home care need (e.g., OR=2.07, 95% CI 1.58-2.72). Following the inclusion of frailty in the model and adjustment for other relevant covariates (Model B), several variables were no longer statistically significant predictors of hospitalization, including comorbidity, income, education and unmet home care need. This largely reflects the associations between frailty and these other variables (especially comorbidity). Though the magnitude of associations for age and previous hospitalization were reduced with further adjustment for frailty and other covariates, both remained strong predictors of subsequent hospitalization (Model B). Further, with adjustment for frailty and other covariates, sex showed a statistically significant association with hospitalization with a lower odds observed for women vs. men (e.g., OR=0.80, 95% CI 0.68-0.95, Model B).

The removal of previous hospitalization from the model (Model C) resulted in slight increases in odds ratios for age, sex and frailty. Unmet home care need in Model C became statistically significant (OR=1.33 95% CI 1.02-1.77) without previous hospitalization. No changes in significance were observed for either income or education, which remained non-significant at all levels. Thus, a final model (Model D) was analyzed adjusting for age, sex, comorbidity and unmet need (i.e., with income and education removed).When comparing Models C and D, only slight differences in estimates for frailty and other relevant covariates were observed

5.2.1.2 Frailty and Death (Table 5.2.1.2)

The same modeling strategies as used with the hospitalization outcome were employed when modelling the death outcome. The logistic regression models analyzed initially adjusted for age and sex followed by models adjusted by other covariates (labeled Models A to D). As with follow-up hospitalization, a base model adjusting for age sex and comorbidity (Model A) was examined. All model analyses were weighted and bootstrapped to account for complex survey design. The most vulnerable frail group showed statistically significant associations with death across all models. This association was highest in Model A (OR=4.19, 95% CI 2.49-7.05 for frail vs. robust participants) compared with age and sex adjusted, Models B, C and D. The addition of all other relevant covariates in Model B diminished this association slightly with the odds of death for frail respondents 3.57 (95% CI 2.13-5.99) times higher than for robust respondents. Interestingly, pre-frail respondents showed a non-significant association with death relative to those who were robust in Model B with the inclusion of these covariates.

Age and sex adjusted models showed the following covariates to be significantly associated with death: older age, being male, higher number of chronic conditions, previous hospitalization, low household income, less than high school education and unmet home care need. As with the hospitalization outcome, age showed a particularly strong association with death (OR=26.41, 95% CI 11.80-59.08 for the 85+ compared to 45-54 age group). Non-significant associations with death however, were found for the 55-64 year old age group across all models. Comorbidity was significantly associated with death following adjustment for age and sex (OR=3.14, 95% CI 2.12-4.65 for those with 4+ conditions and OR=1.84, 95% CI 1.24-2.71 for those with 2-3 conditions relative to those with 0 conditions). Having only one chronic condition was non-significant in all models. Previous hospitalization (OR=2.92, 95% CI 2.25-

3.77), low education (OR=2.69, 95% CI 2.09-3.46 for less than secondary school) and unmet home care need (OR=2.06, 95% CI 1.47-2.91) also showed strong significant associations with death in age and sex adjusted models.

The addition of frailty and all other relevant covariates in Model B changed the strength and significance of a number of variables, such that several covariates were no longer statistically significant predictors of death. Comorbidity, income, education, unmet home care need and pre-frail status all became non-significant in Model B. These changes likely reflect the association between frailty and these variables. Pre-frail status was significantly associated with death in models that did not adjust for previous hospitalization (Models A, C and D). Comorbidity, low income and education and unmet home care need remained non-significant predictors of death after the exclusion of previous hospitalization (Model C). Older age remained the strongest predictor of death following the inclusion of frailty and additional covariates, although the magnitude of this association was diminished in Models A through D. Unlike the hospitalization outcome, unmet home care need was only significant in the age and sex adjusted models. Again, SSA was non-significant (age and sex adjusted).

Table 5.2.1.1: Multivariable analysis assessing the associations between key covariates and inpatient hospitalization during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)

Characteristics	Odds Ratio (95 % Confident Interval)				
	Age and Sex Adjusted	Model A	Model B	Model C	Model D
Age					
45-54 *	1.00	1.00	1.00	1.00	1.00
55-64	**1.56 (1.21-2.00)**	**1.37 (1.06-1.78)**	**1.37 (1.05-1.78)**	**1.38 (1.06-1.78)**	**1.37 (1.05-1.78)**
65-74	**2.61 (2.04-3.34)**	**1.92 (1.48-2.49)**	**1.83 (1.39-2.40)**	**1.88 (1.44-2.46)**	**1.92 (1.48-2.49)**
75-84	**5.19 (4.08-6.59)**	**3.24 (2.51-4.19)**	**3.04 (2.32-4.00)**	**3.14 (2.41-4.09)**	**3.24 (2.51-4.19)**
85+	**6.99 (5.39-9.06)**	**3.94 (3.00-5.21)**	**3.75 (2.77-5.08)**	**3.85 (2.87-5.16)**	**3.93 (2.97-5.21)**
Sex					
Male *	1.00	1.00	1.00	1.00	1.00
Female	0.90 (0.78-1.05)	**0.81 (0.70-0.95)**	**0.80 (0.68-0.95)**	**0.78 (0.67-0.92)**	**0.81 (0.69-0.94)**
Frailty Status					
Robust *	1.00	1.00	1.00	1.00	1.00
Pre-frail	**2.04 (1.69-2.47)**	**1.85 (1.48-2.32)**	**1.76 (1.40-2.21)**	**1.82 (1.46-2.28)**	**1.84 (1.47-2.30)**
Frail	**3.96 (3.24-4.85)**	**3.27 (2.44-4.40)**	**2.83 (2.10-3.84)**	**3.07 (2.23-4.13)**	**3.18 (2.35-4.29)**
No. of CC					
0 *	1.00	1.00	1.00	1.00	1.00
1	0.97 (0.73-1.28)	0.84 (0.63-1.13)	0.88 (0.65-1.18)	0.88 (0.66-1.19)	0.85 (0.63-1.13)
2-3	**1.78 (1.36-2.33)**	1.09 (0.80-1.50)	1.09 (0.79-1.50)	1.13 (0.82-1.54)	1.09 (0.80-1.50)
4+	**2.95 (2.25-3.85)**	1.21 (0.84-1.73)	1.18 (0.81-1.70)	1.26 (0.88-1.80)	1.21 (0.84-1.74)
Previous Hosp					
No (0) *	1.00	-	1.00	-	-
Yes (1)	**3.32 (2.77-3.98)**	-	**2.49 (2.05-3.02)**	-	-
Income					
Highest Tertile *	1.00	-	1.00	1.00	-
Middle Tertile	1.11 (0.90-1.36)	-	0.98 (0.79-1.20)	0.99 (0.80-1.21)	-
Lowest Tertile	**1.38 (1.11-1.72)**	-	1.02 (0.81-1.30)	1.02 (0.81-1.29)	-
Missing	**1.33 (1.06-1.68)**	-	1.17 (0.92-1.48)	1.18 (0.94-1.49)	-
Education					
Post-sec grad*	1.00	-	1.00	1.00	-
Some post-sec	1.29 (0.95-1.76)	-	1.25 (0.90-1.72)	1.21 (0.87-1.67)	-
Secondary school	1.23 (1.00-1.51)	-	1.14 (0.92-1.41)	1.15 (0.93-1.42)	-
< Secondary school	**1.41 (1.19-1.67)**	-	1.16 (0.97-1.38)	1.16 (0.98-1.38)	-

Characteristics	Odds Ratio (95 % Confident Interval)				
	Age and Sex Adjusted	**Model A**	**Model B**	**Model C**	**Model D**
Unmet HC Need					
No *	1.00	-	1.00	1.00	1.00
Yes	**2.07 (1.58-2.72)**	-	1.17 (0.89-1.53)	**1.33 (1.02-1.77)**	**1.30 (1.00-1.70)**
SSA					
High *	1.00	-	-	-	
Low	1.03 (0.89-1.20)	-	-	-	

Notes: frailty level= Robust (≤ 0.1), Pre-frail (> 0.1 to ≤ 0.21), Frail (> 0.21); Previous hosp= inpatient hospital admission in previous year; HC=home care; sec=secondary; CC=chronic conditions; SSA=social support availability; * indicates reference group; statistically significant findings **bolded (p<0.05);** CCHS-HA=Canadian Community Health Survey-Healthy Aging

Table 5.2.1.2: Multivariable analysis assessing the associations between key covariates and mortality during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)

	Odds Ratio (95 % Confidence Interval)				
Characteristics	**Age and Sex Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**
Age					
45-54 *	1.00	1.00	1.00	1.00	1.00
55-64	2.09 (0.94-4.67)	1.85 (0.82-4.17)	1.79 (0.80-4.03)	1.82 (0.80-4.11)	1.85 (0.82-4.16)
65-74	**4.11 (1.88-8.96)**	**3.12 (1.44-6.78)**	**2.90 (1.37-6.13)**	**3.04 (1.43-6.46)**	**3.12 (1.44-6.77)**
75-84	**12.72 (5.85-27.65)**	**8.24 (3.87-17.58)**	**7.52 (3.63-15.60)**	**7.92 (3.80-16.50)**	**8.24 (3.87-17.56)**
85+	**26.41 (11.80-59.08)**	**15.16 (6.89-33.35)**	**13.96 (6.48-30.07)**	**14.50 (6.73-31.25)**	**15.18 (6.90-33.39)**
Sex					
Male *	1.00	1.00	1.00	1.00	1.00
Female	**0.66 (0.51-0.86)**	**0.59 (0.44-0.78)**	**0.57 (0.42-0.79)**	**0.56 (0.41-0.76)**	**0.58 (0.44-0.77)**
Frailty Status					
Robust *	1.00	1.00	1.00	1.00	1.00
Pre-frail	**1.59 (1.08-2.35)**	**1.64 (1.01-2.67)**	1.54 (0.95-2.49)	**1.63 (1.01-2.62)**	**1.63 (1.00-2.65)**
Frail	**3.84 (2.65-5.58)**	**4.19 (2.49-7.05)**	**3.57 (2.13-5.99)**	**4.03 (2.41-6.73)**	**4.06 (2.39-6.88)**
No. of CC					
0 *	1.00	1.00	1.00	1.00	1.00
1	1.65 (0.93-2.93)	1.46 (0.78-2.74)	1.49 (0.79-2.82)	1.50 (0.79-2.88)	1.47 (0.79-2.75)
2-3	**1.84 (1.24-2.71)**	1.12 (0.66-1.90)	1.11 (0.65-1.88)	1.15 (0.68-1.94)	1.13 (0.66-1.91)
4+	**3.14 (2.12-4.65)**	1.09 (0.61-1.97)	1.04 (0.58-1.85)	1.11 (0.63-1.98)	1.10 (0.61-1.97)
Previous Hosp					
No (0) *	1.00	-	1.00	-	-
Yes (1)	**2.92 (2.25-3.77)**	-	**2.61 (2.03-3.37)**	-	-
Income					
Highest Tertile *	1.00	-	1.00	1.00	-
Middle Tertile	1.00 (0.68-1.49)	-	0.86 (0.58-1.26)	0.87 (0.59-1.27)	-
Lowest Tertile	**1.61 (1.04-2.50)**	-	1.21 (0.79-1.85)	1.21 (0.79-1.84)	-
Missing	1.20 (0.77-1.85)	-	1.04 (0.68-1.59)	1.04 (0.69-1.59)	-
Education					
Post-sec Grad *	1.00	-	1.00	1.00	-
Some post-sec	1.29 (0.81-2.07)	-	1.04 (0.64-1.69)	1.00 (0.62-1.60)	-
Secondary school	1.25 (0.91-1.73)	-	1.14 (0.82-1.58)	1.14 (0.83-1.58)	-
< Secondary	**2.69 (2.09-3.46)**	-	1.12 (0.89-1.40)	1.13 (0.90-1.40)	-

	Odds Ratio (95 % Confidence Interval)				
Characteristics	**Age and Sex Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**
Unmet HC Need					
No *	1.00	-	1.00	1.00	1.00
Yes	**2.06 (1.47-2.91)**	-	1.15 (0.79-1.66)	1.32 (0.92-1.90)	1.36 (0.95-1.95)
SSA					
High *	1.00	-	-	-	-
Low	1.06 (0.86-1.20)	-	-	-	-

Notes: Frailty level=robust (0.10), pre-frail (>0.10-0.21), frail (>0.21); HC=home care; Sec=secondary; previous hosp=inpatient hospital admission in previous year; CC= chronic conditions; SSA=social support availability; * indicates reference group; statistically significant findings **bolded (p<0.05);** CCHS-HA=Canadian Community Health Survey-Healthy Aging

5.2.2 Sex Stratified Analysis

5.2.2.1 Hospitalization Outcome (Table 5.2.2.1)

Sex stratified logistic regression models initially adjusted for age were analyzed, followed by models adjusting for frailty and other covariates (Models A to D, Table 5.2.2.1) following the same modelling approach used for earlier analysis among full sample. Age adjusted models were initially assessed followed by a base model adjusting for age and comorbidity (Model A). Models adjusting for all other relevant covariates (Model B) and excluding previous hospitalization (Model C), income and education (Model D) were then analyzed. As with the full sample, statistically significant frailty-hospitalization associations were found across all models for both sexes, with the magnitude of this association highest in the age-adjusted models compared to models adjusted for other covariates. The magnitude of this association was lower after adjusting for all relevant covariates (Model B) for both males and females. The strength of the association between frailty and hospitalization was greater among males than females (e.g., in Model B, OR=3.39, 95% CI 1.97-5.81 for frail vs robust males and OR=2.47, 95% CI 1.76-3.47 for frail vs robust females).

When examining the age adjusted models, covariates significantly associated with hospitalization for both sexes included increasing age and number of chronic conditions, previous hospitalization, low and missing income, less than high school education and unmet home care need. As with frailty, estimated associations between increasing age and hospitalization were more pronounced among males than females. Age was non-significant for women below 65 years across all models, but significant associations were found at all ages compared to the 45-54 reference group for men. For men aged 85+ years the odds of hospitalization was 8.92 (95% CI 5.98-13.32) times that of the 45-54 group. While women of the same age had 5.71 (95% CI 4.08-7.99) times the odds of hospitalization compared to the 45-54 age group. Other sex differences in age-adjusted models

included relatively stronger associations with hospitalization for income and education (i.e., for secondary school) among males and for comorbidity among females. Both previous hospitalization and unmet home care need were significantly associated with hospitalization for both sexes, with only modest difference in the magnitude of associations. Among both sexes, SSA was not significantly associated with hospitalization in age-adjusted models and was not pursued further.

The inclusion of frailty and adjustment for other relevant covariates in Models A and B produced changes in the strength and significance of associations for several variables among men and women. Comorbidity was no longer a significant predictor of hospitalization with frailty in the model (Model A). After adjusting for all relevant covariates (Model B), income, education and unmet home care need also became non-significant predictors of hospitalization and the magnitude of associations observed for age, frailty and previous hospitalization was reduced somewhat. After removing previous hospitalization (Model C), missing income showed a statistically significant positive association with hospitalization among men (OR=1.38, 95% CI 1.00-1.90), while unmet home care need showed a statistically significant association with hospitalization among women (OR=1.48, 95% CI 1.06-2.06). Following the additional exclusion of income and education (Model D), unmet home care need remained significantly associated with hospitalization among women only (OR=1.46, 95% CI 1.06-2.02).

Table 5.2.2.1: Sex stratified multivariable analysis assessing the associations between key covariates and hospitalization during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)

	Males Odds Ratio (95 % Confidence Interval)					Females Odds Ratio (95 % Confidence Interval)				
Characteristics	**Age Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**	**Age Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**
Age										
45-54 *	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
55-64	**1.94 (1.34-2.79)**	**1.80 (1.23-2.63)**	**1.75 (1.19-2.58)**	**1.76 (1.21-2.57)**	**1.80 (1.23-2.63)**	1.26 (0.91-1.75)	1.05 (0.74-1.47)	1.07 (0.75-1.52)	1.08 (0.77-1.52)	1.04 (0.74-4.47)
65-74	**3.11 (2.19-4.42)**	**2.38 (1.65-3.42)**	**2.24 (1.53-3.27)**	**2.28 (1.57-3.23)**	**2.38 (1.65-3.43)**	**2.21 (1.57-3.11)**	**1.56 (1.08-2.24)**	**1.50 (1.03-2.18)**	**1.57 (1.09-2.26)**	**1.55 (1.08-2.22)**
75-84	**6.90 (4.83-9.84)**	**4.57 (3.14-6.65)**	**4.16 (2.79-6.19)**	**4.28 (2.90-6.33)**	**4.57 (3.14-6.65)**	**4.00 (2.91-5.49)**	**2.36 (1.68-3.33)**	**2.29 (1.58-3.31)**	**2.36 (1.65-3.38)**	**2.36 (1.67-3.32)**
85+	**8.92 (5.98-13.32)**	**5.17 (3.37-7.93)**	**4.72 (3.00-7.44)**	**4.90 (3.15-7.61)**	**5.17 (3.37-7.93)**	**5.71 (4.08-7.99)**	**3.11 (2.17-4.46)**	**3.08 (2.07-4.57)**	**3.14 (2.14-4.59)**	**3.10 (2.16-4.46)**
Frailty Status										
Robust *	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pre-frail	**1.95 (1.50-2.54)**	**1.82 (1.30-2.56)**	**1.72 (1.22-2.43)**	**1.77 (1.27-2.47)**	**1.82 (1.30-2.56)**	**2.12 (1.62-2.77)**	**1.85 (1.35-2.53)**	**1.77 (1.29-2.44)**	**1.85 (1.35-2.54)**	**1.83 (1.33-2.51)**
Frail	**4.44 (3.28-6.00)**	**3.98 (2.37-6.68)**	**3.39 (1.97-5.81)**	**3.70 (2.21-6.19)**	**3.95 (2.33-6.70)**	**3.71 (2.84-4.86)**	**2.80 (2.01-3.89)**	**2.47 (1.76-3.47)**	**2.66 (1.90-3.73)**	**2.66 (1.91-3.70)**
No. of CC										
0 *	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	0.79 (0.55-1.15)	0.71 (0.49-1.04)	0.74 (0.51-1.08)	0.75 (0.52-1.08)	0.71 (0.49-1.04)	1.21 (0.78-1.87)	1.02 (0.64-1.63)	1.08 (0.66-1.75)	1.08 (0.67-1.75)	1.02 (0.64-1.64)
2-3	**1.62 (1.12-2.35)**	1.01 (0.64-1.59)	0.99 (0.64-1.55)	1.05 (0.68-1.63)	1.01 (0.64-1.59)	**2.02 (1.36-3.01)**	1.23 (0.76-1.99)	1.28 (0.78-2.09)	1.29 (0.79-2.09)	1.24 (0.77-2.00)
4+	**2.67 (1.84-3.88)**	0.99 (0.56-1.76)	0.99 (0.57-1.73)	1.04 (0.61-1.80)	1.00 (0.56-1.77)	**3.42 (2.27-5.15)**	1.51 (0.91-2.52)	1.49 (0.88-2.53)	1.59 (0.95-2.68)	1.52 (0.92-2.53)
Previous Hosp										
No (0) *	1.00	-	1.00	-	-	1.00	-	1.00	-	-
Yes (1)	**4.02 (3.06-5.29)**	-	**2.32 (1.78-3.02)**	-	-	**4.40 (3.48-5.56)**	-	**2.68 (2.05-3.50)**	-	-
Income										
Highest Tertile *	1.00	-	1.00	1.00	-	1.00	-	1.00	1.00	-
Middle Tertile	1.69 (1.33-2.15)	-	1.02 (0.79-1.33)	1.03 (0.80-1.33)	-	2.15 (1.57-2.95)	-	0.90 (0.64-1.25)	0.91 (0.65-1.27)	-
Lowest Tertile	**2.41 (1.87-3.11)**	-	1.11 (0.81-1.53)	1.10 (0.80-1.51)	-	**1.34 (0.96-1.86)**	-	0.93 (0.66-1.30)	0.93 (0.67-1.30)	-
Missing	**2.12 (1.59-2.81)**	-	1.37 (0.99-1.90)	**1.38 (1.00-1.90)**	-	**1.58 (1.15-2.17)**	-	0.99 (0.71-1.37)	1.01 (0.73-1.39)	-
Education										
Post-Sec grad*	1.00	-	1.00	1.00	-	1.00	-	1.00	1.00	-
Some Post-Sec	1.61 (0.99-2.63)	-	1.45 (0.84-2.50)	1.38 (0.80-2.38)	-	1.25 (0.87-1.80)	-	1.06 (0.74-1.52)	1.04 (0.72-1.51)	-
Secondary	**1.41 (1.04-1.91)**	-	1.24 (0.88-1.73)	1.26 (0.90-1.76)	-	1.16 (0.89-1.52)	-	1.06 (0.80-1.40)	1.07 (0.81-1.41)	-
< Secondary	**2.11 (1.69-2.65)**	-	1.15 (0.90-1.48)	1.16 (0.90-1.48)	-	**2.11 (1.68-2.66)**	-	1.15 (0.89-1.49)	1.16 (0.90-1.49)	-

	Males Odds Ratio (95 % Confidence Interval)					Females Odds Ratio (95 % Confidence Interval)				
Characteristics	**Age Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**	**Age Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**
Unmet HC Need										
No *	1.00	-	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00
Yes	**2.38 (1.45-3.91)**	-	1.00 (0.62-1.62)	1.13 (0.70-1.80)	1.11 (0.69-1.78)	**2.76 (1.96-3.88)**	-	1.29 (0.91-1.81)	**1.48 (1.06-2.06)**	**1.46 (1.06-2.02)**
SSA										
High *	1.00	-	-	-	-	1.00	-	-	-	-
Low	1.16 (0.91-1.46)	-	-	-	-	1.01 (0.84-1.20)	-	-	-	-

Notes: Frailty levels = Robust (<0.10), Pre-frail (0.10-0.21), frail (>0.21); CC=chronic conditions; HC=home care; previous hosp= inpatient hospital admission in prior year; Sec= secondary; SSA=social support availability; * indicates reference group; **bolded OR indicated significant at p<0.05**; Although unmet home care need was non-significant in Model B, included in Model C and D for consistency and to assess with and without other covariates

5.2.2.2 Death Outcome (Table 5.2.2.2)

Results of the sex-stratified analysis with death as the outcome are displayed in Table 5.2.2.2 below. The same modeling strategy as above was employed for this sex-stratified analysis. Age was significantly associated with death for the 75+ age groups for women in all models. Among men, there were statistically significant associations between all age levels and death in the age-adjusted model and significant at 65+ levels in Models A to D. At all age levels, among men there were significantly higher odds of death then were found among women. In Model B 75-84 year old men had 8.87 (95% CI 3.38-23.24) times greater odds of death than those in the 45-54 year old reference group, compared to women of the same age (OR=7.30, 95% CI 2.38-22.40). Although women also had significantly greater odds of death in these age groups, the magnitude of difference was not as large.

When assessing age-adjusted models, frailty, comorbidity, previous hospitalization, income, education and unmet home care need were all significantly associated with death for men. Frailty, comorbidity, previous hospitalization and unmet need had significant associations with death for women. Age was the largest predictor of death for both sexes, with the magnitude of this association greater for men. Both pre-frail (OR=2.45, 95% CI 1.31-4.60, Model D) and frail levels (OR=6.32, 95% CI 3.24-12.33, Model D) were significantly associated with death for men, but only frail female respondents had an increased odds of death for all models. Previous hospitalization was significant for both sexes, with a stronger association with death among men. Number of chronic conditions was significantly associated with death at all levels for men in the age-adjusted models, but only significantly associated with death at the 4+ level for women. Low income was significant in age-adjusted, Model B and Model C for men only and non-significant in all models for women. Less than secondary school education was significant for men only in the age-adjusted models, this association was not found in any other models. As with hospitalization, unmet home care need was significant in

the age-adjusted models for both sexes. The magnitude of this association was greater among men (2.39, 95% CI 1.38-4.16) compared to women (1.96, 95% CI 1.23-3.11). SSA was non-significant in the age-adjusted models and was therefore not pursued further in the core models.

After adjusting for all relevant covariates (Model B) frail men had 5.08 (95% CI 2.53-10.21) times greater odds of dying than those who were robust, compared to 2.37 (95% CI 1.25-4.51) times the odds for frail women vs robust women. Pre-frailty was significantly associated with death for men, but not women in all models. Previous admission was also significant for both men and women, with men (3.07 95% CI 2.10-4.47) having higher odds of death then their female counterparts (2.18 95% CI 1.62-2.94). Unlike the hospitalization outcome, unmet home care need remained non-significant in Model C following the removal of previous hospitalization. Comorbidity, education and unmet home care need were all not significantly associated with death in Model A through D for both sexes.

Table 5.2.2.2: Sex stratified multivariable analysis assessing the associations between key covariates and mortality during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)

	Males Odds Ratio (95 % Confidence Interval)					Females Odds Ratio (95% Confidence Interval)				
Characteristics	**Age Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**	**Age Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**
Age										
45-54 *	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
55-64	**2.73 (1.11-6.71)**	2.36 (0.50-5.84)	2.33 (0.92-5.90)	2.37 (0.93-6.04)	2.36 (0.95-5.86)	1.55 (0.41-5.92)	1.47 (0.38-5.68)	1.43 (0.39-5.22)	1.45 (0.40-5.25)	1.46 (0.38-5.67)
65-74	**5.88 (2.19-14.02)**	**4.06 (1.66-9.95)**	**3.66 (1.47-9.14)**	**3.85 (1.52-9.72)**	**4.07 (1.66-9.98)**	2.66 (0.73-9.76)	2.35 (0.65-8.53)	2.45 (0.78-7.67)	2.53 (0.80-7.95)	2.33 (0.64-8.48)
75-84	**17.21 (4.83-42.25)**	**10.05 (3.96-25.50)**	**8.87 (3.38-23.24)**	**9.41 (3.55-24.92)**	**10.06 (3.97-25.48)**	**9.06 (2.43-33.81)**	**6.95 (1.96-24.61)**	**7.30 (2.38-22.40)**	**7.50 (2.45-22.95)**	**6.94 (1.96-24.60)**
85+	**35.13 (14.45-85.38)**	**17.86 (7.02-45.45)**	**16.36 (6.21-43.14**	**17.14 (6.48-45.33)**	**17.91 (7.04-45.59)**	**19.30 (5.04-73.86)**	**13.36 (3.69-48.39)**	**14.03 (4.44-44.38)**	**14.25 (4.52-44.90)**	**13.36 (3.69-48.44)**
Frailty Status										
Robust *	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pre-frail	**2.38 (1.51-3.77)**	**2.47 (1.32-4.62)**	**2.33 (1.24-4.39)**	**2.47 (1.33-9.57)**	**2.45 (1.31-4.60)**	0.92 (0.56-1.51)	0.97 (0.52-1.81)	0.91 (0.49-1.66)	0.95 (0.52-1.74)	0.96 (0.51-1.79)
Frail	**5.66 (3.65-8.77)**	**6.49 (3.38-12.46)**	**5.08 (2.53-10.21)**	**6.01 (3.05-11.84)**	**6.32 (3.24-12.33)**	**2.40 (1.54-3.74)**	**2.53 (1.29-4.96)**	**2.37 (1.25-4.51)**	**2.55 (1.34-4.84)**	**2.42 (1.22-4.78)**
No. of CC										
0 *	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	**1.84 (1.00-3.36)**	1.52 (0.85-2.72)	1.56 (0.84-2.88)	1.57 (0.84-2.92)	2.72 (0.85-2.73)	1.37 (0.47-4.00)	1.36 (0.40-4.57)	1.36 (0.40-4.59)	1.38 (0.41-4.61)	1.36 (0.41-4.57)
2-3	**2.46 (1.53-3.95)**	1.18 (0.64-2.16)	1.15 (0.63-2.09)	1.25 (0.69-2.28)	2.17 (0.65-2.17)	1.21 (0.64-2.31)	1.00 (0.41-2.48)	1.00 (0.41-2.49)	0.99 (0.40-2.45)	1.01 (0.41-2.48)
4+	**4.07 (2.45-6.75)**	1.04 (0.56-1.93)	1.03 (0.56-1.90)	1.09 (0.59-2.03)	1.94 (0.56-1.94)	**2.19 (1.11-4.32)**	1.10 (0.38-3.18)	0.98 (0.34-2.83)	1.06 (0.37-3.03)	1.10 (0.38-3.20)
Previous Hosp										
No (0) *	1.00	-	1.00	-	-	1.00	-	1.00	-	-
Yes (1)	**3.99 (2.74-5.82)**	-	**3.07 (2.10-4.47)**	-	-	**2.59 (1.93-3.48)**	-	**2.18 (1.62-2.94)**	-	-
Income										
Highest Tertile *	1.00	-	1.00	1.00	-	1.00	-	1.00	1.00	-
Middle Tertile	1.21 (0.78-1.89)	-	0.95 (0.61-1.50)	0.97 (0.62-1.52)	-	0.75 (0.38-1.50)	-	0.70 (0.35-1.36)	0.70 (0.36-1.37)	-
Lowest Tertile	**2.47 (1.53-4.00)**	-	**1.85 (1.12-3.06)**	**1.78 (1.07-2.95)**	-	0.97 (0.50-1.91)	-	0.73 (0.39-1.40)	0.75 (0.40-1.43)	-
Missing	1.39 (0.83-2.32)	-	1.21 (0.73-1.99)	1.19 (0.73-1.96)	-	0.93 (0.47-1.83)	-	0.80 (0.41-1.55)	0.82 (0.42-1.57)	-
Education										
Post-sec grad *	1.00		1.00	1.00		1.00		1.00	1.00	
Some post-sec	1.21 (0.62-2.38)	-	1.18 (0.56-2.48)	1.08 (0.52-2.24)	-	0.96 (0.51-1.80)	-	0.93 (0.48-1.76)	0.92 (0.49-1.72)	-
Secondary grad	1.57 (0.95-2.60)	-	1.42 (0.87-2.31)	1.41 (0.87-2.31)	-	0.90 (0.57-1.40)	-	0.90 (0.59-1.37)	0.90 (0.59-1.38)	-
< Secondary	**1.62 (1.19-2.21)**	-	1.17 (0.84-1.64)	1.18 (0.85-1.63)	-	1.13 (0.80-1.60)	-	1.01 (0.74-1.40)	1.03 (0.75-1.40)	-

Characteristics	Males Odds Ratio (95 % Confidence Interval)					Females Odds Ratio (95% Confidence Interval)				
	Age Adjusted	**Model A**	**Model B**	**Model C**	**Model D**	**Age Adjusted**	**Model A**	**Model B**	**Model C**	**Model D**
Unmet HC Need										
No *	1.00	-	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00
Yes	**2.39 (1.38-4.16)**	-	1.10 (0.58-2.09)	1.30 (0.70-2.40)	1.39 (0.75-2.59)	**1.96 (1.23-3.11)**	-	1.28 (0.81-2.03)	1.43 (0.90-2.27)	1.41 (0.89-2.24)
SSA										
High *	1.00	-	-	-	-	1.00	-	-	-	-
Low	1.20 (0.90-1.60)	-	-	-	-	1.01 (0.72-1.41)	-	-	-	-

Notes: * indicates reference group; **bolded OR indicated significant at p<0.05**; OR=odds ratio; Education, income and unmet home care need entered into model B separately and together. Although unmet home care need was non-significant in Model B, included in Model C for consistency with full sample modelling.

5.2.3 Research Question #4: Association between frailty status and inpatient hospitalization and death over 2-year follow-up period, by unmet home care need

5.2.3.1 Frailty and Hospitalization (Table 5.2.3.1 and Figure 5.2.3.1)

The association between frailty and hospitalization was not found to be modified by unmet home care need. Interactions terms entered into Models A and B separately were non-significant (i.e., frail*unmet home care need p=0.2966 for hospitalization outcome Model A). Further analysis of effect modification by unmet home care need was evaluated using a categorical frailty-unmet home care need measure (see Table 5.2.3.1). Relative to the reference group (robust respondents with no unmet home care need), those who were frail and also reported an unmet home care need showed the strongest association with subsequent hospitalization after adjusting for age, sex, comorbidity and previous hospitalization (OR=3.30, 95% CI 2.29-4.76; Model A). It appears that this association was largely driven by respondents' frailty status (e.g., OR=2.91, 95% CI 2.13-3.97 for frail respondents with no unmet home care need relative to the reference group) suggesting the absence of any meaningful effect modification by unmet home care need. These findings were generally unchanged in Model B (adjusted for age, sex and comorbidity but excluding previous hospitalization). One approach to further exploring for the presence of possible effect modification with this categorical frailty-unmet home care need measure is to compare ratios derived across strata (as shown in Table 5.2.3.1). However, the relative imprecision of the estimate observed for robust respondents with an unmet home care need (reflected by the large CI and resulting from the small cell size) hinders the interpretation of these ratios. That is, though the ratio of observed ORs across strata suggest that the association between frailty and hospitalization is more pronounced among those with vs without an unmet home care need (e.g., 11.79 vs 2.91) – this is not true across all

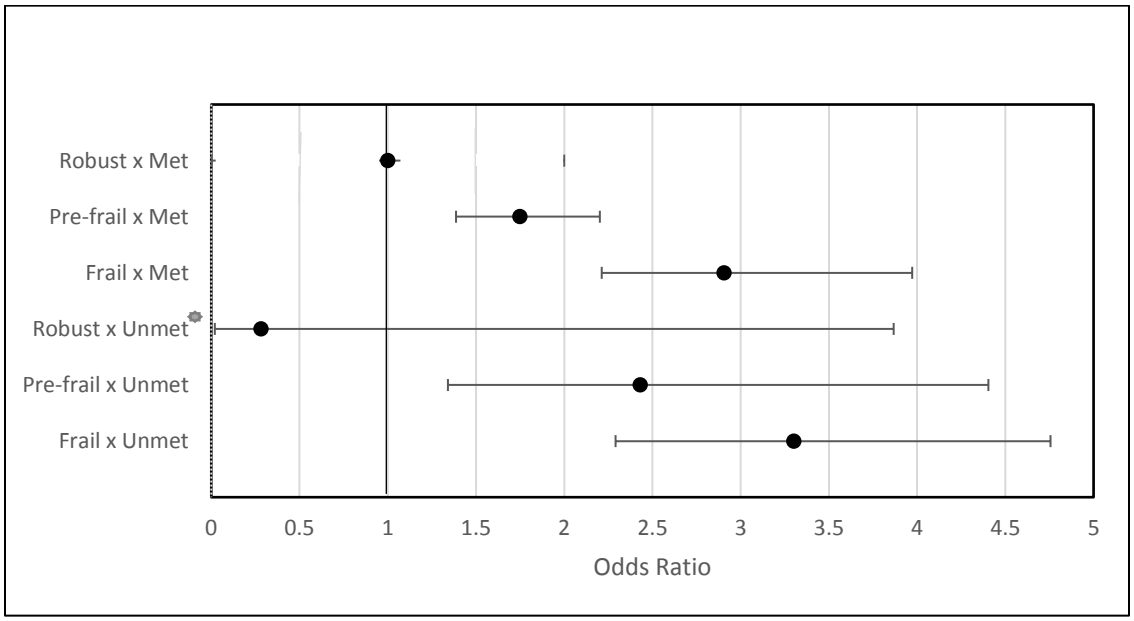
estimates captured by the wide confidence interval observed for robust participants with an unmet home care need. Figure 5.2.3.1 plots the odds ratios (and 95% CI) for the categorical frailty-unmet home care need measure estimated from Model A and illustrates the overlap among confidence intervals for various estimates relative to the reference group.

Table 5.2.3.1: Multivariable analysis of the association between frailty-unmet home care need categorical variable and hospitalization during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)

	Odds Ratio (95% Confidence Interval)
	Hospitalization
Model A[a]	
Frailty (FI) and Unmet Home Care Need	
Robust & No Unmet Home care Need	1.00
Pre-Frail & No Unmet Home Care Need	1.75 (1.39-2.20)
Frail & No Unmet Home Care Need	2.91 (2.13-3.97)
Robust & Unmet Home Care Need	0.28 (0.02-3.87)ǂ
Pre-frail & Unmet Home Care Need	2.43 (1.34-4.40)
Frail & Unmet Home Care Need	3.30 (2.29-4.76)
Ratio [Frail vs Robust] No Unmet Home Care Need	2.91
Ratio [Frail vs Robust] Unmet Home Care Need	11.79*
Model B[b]	
Frailty (FI) and Unmet Home Care Need	
Robust & No Unmet Home care Need	1.00
Pre-Frail & No Unmet Home Care Need	1.82 (1.45-2.28)
Frail & No Unmet Home Care Need	3.18 (2.35-4.30)
Robust & Unmet Home Care Need	0.38 (0.03-5.05)ǂ
Pre-frail & Unmet Home Care Need	3.04 (1.76-5.27)
Frail & Unmet Home Care Need	3.96 (2.76-5.68)
Ratio [Frail vs Robust] No Unmet Home Care Need	3.18
Ratio [Frail vs Robust] Unmet Home Care Need	10.42*

Notes: FI=Frailty Index; [a] Model A adjusted for age, sex, comorbidity and previous hospitalization; [b] Model B adjusted for age, sex and comorbidity; ǂ indicates non-significant (p>0.05); Model A robust/unmet home care need for hospitalization (p = 0.3423); Model B robust/unmet home care need for hospitalization (p=0.4594); all other reported values significant at p<.001; * caution required in the interpretation of findings due to wide confidence intervals and instability of estimate as a result of the small proportion of non-frail respondents with unmet home care need.

Figure 5.2.3.1: Association between frailty-unmet home care need categorical variable and hospitalization during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)



Notes: Plots frailty-unmet home care need categorical interaction (using 3 level categorical frailty variable) for 2-year hospitalization outcome. Ratio (unmet home care need vs no unmet home care need) for hospitalization Among robust=0.28*; pre-frail (2.43/1.75)=1.39; frail (3.30/2.91)=1.13. *indicates non-significant (p-value >0.05)

5.2.3.2 Frailty and Death (Table 5.2.3.2 and Figure 5.2.3.2)

Following the same modelling strategy as used for hospitalization, interaction terms (frailty*unmet home care need) were added to the death outcome models separately, with non-significant results in both Models A (p=0.6344) and B (p=0.4563). Assessment of effect modification using a categorical frailty-unmet home care need variable was conducted and also revealed no strong evidence of effect modification of the frailty-death association by unmet home care need (Table 5.2.3.2). Relative to the reference group (not frail and no unmet home care need), respondents who were both frail and reported an unmet home care need showed the highest odds for death during follow-up (e.g., OR=2.85, 95% CI 1.84-4.40; Model A adjusting for age, sex, comorbidity and previous hospitalization). Again, this association appears to be largely driven by frailty (e.g., OR=2.50, 95% CI 1.89-3.30 for frail respondents with no unmet need relative to the reference group). Comparing the ratio of odds ratios across strata suggest that the frailty-mortality association was slightly more pronounced among respondents without than with an unmet home care need (e.g., 2.50 vs. 2.02) but as with hospitalization, caution in interpreting these ratios is needed given the relatively less precise estimate observed for non-frail respondents with an unmet home care need. Findings from Model B (excluding previous hospitalization) were generally similar although odds ratios associated with levels of this categorical variable were somewhat more pronounced (as was the difference in the ratio of odds ratios across strata).

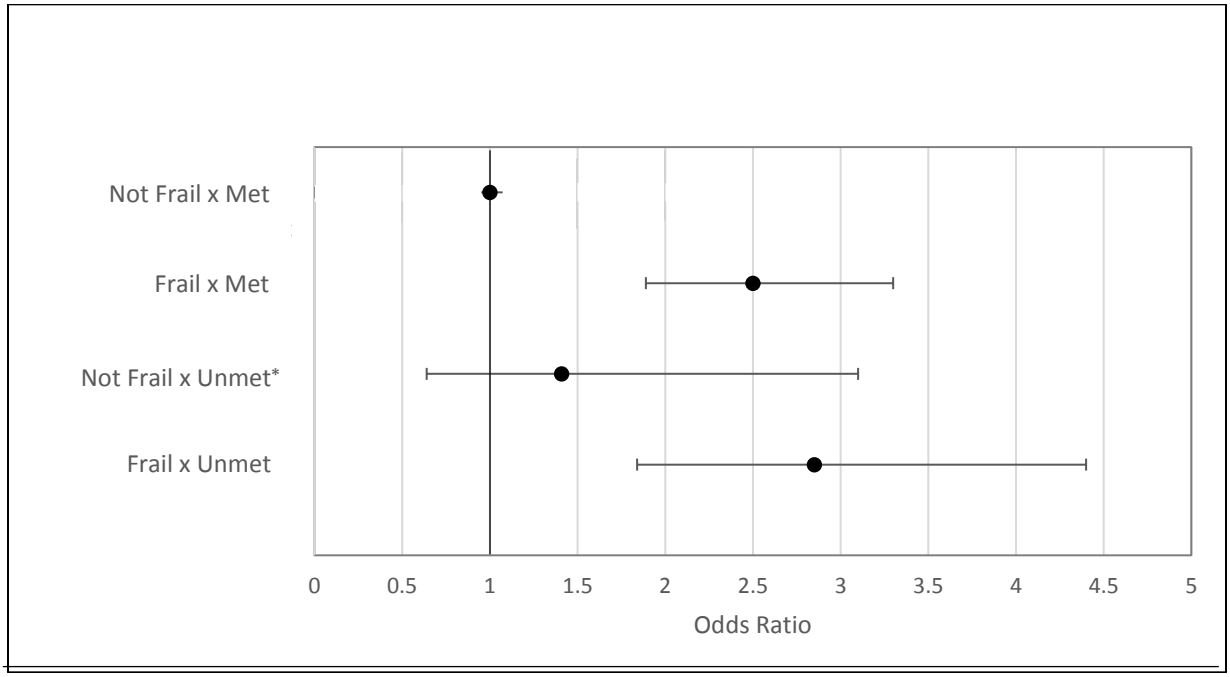
Figure 5.2.3.2 plots the odds ratios (and 95% CI) for the categorical frailty-unmet home care need measure in relation to mortality estimated from Model A and illustrates the overlap among confidence intervals for various estimates relative to the reference group.

Table 5.2.3.2: Multivariable analysis of the association between frailty-unmet home care need categorical variable and mortality during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)

	Odds Ratio (95% Confidence Interval)
	Death
Model A[a]	
Frailty (FI) and Unmet Home Care Need	
Not Frail & No Unmet Home Care Need	1.00
Frail & No Unmet Home Care Need	2.50 (1.89-3.30)
Not Frail & Unmet Home Care Need	1.41 (0.64-3.10)ǂ
Frail & Unmet Home Care Need	2.85 (1.84-4.40)
Ratio [Frail vs Not Frail] No Unmet Home Care Need	2.50
Ratio [Frail vs Not Frail] Unmet Home Care Need	2.02*
Model B[b]	
Frailty (FI) and Unmet Home Care Need	
Not Frail & No Unmet Home Care Need	1.00
Frail & No Unmet Home Care Need	2.72 (2.05-3.60)
Not Frail & Unmet Home Care Need	1.78 (0.84-3.78)ǂ
Frail & Unmet Home Care Need	3.50 (2.26-5.41)
Ratio [Frail vs Not Frail] No Unmet Home Care Need	2.72
Ratio [Frail vs Not Frail] Unmet Home Care Need	1.97*

Notes: Notes: FI=Frailty Index; [a] Model A adjusting for age, sex, comorbidity and previous hospitalization; [b] Model B adjusting for age, sex and comorbidity; ǂ indicates non-significant (p>0.05); not frail/unmet home care need for death in Model A (p = 0.3874); not frail/unmet home care need for death in Model B (p=0.1308); all other reported values significant at p <.0001; * caution required in the interpretation of findings due to wide confidence intervals and instability of estimate as a result of the small proportion of non-frail respondents with unmet home care need.

Figure 5.2.3.2: Association between frailty-unmet home care need categorical variable and mortality during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)



Notes: Plots frailty-unmet home care need categorical interaction (using 2 level categorical frailty (not frail vs frail) for 2-year death outcome. Ratio (unmet home care need vs no unmet home care need) for death among not frail=1.41*; frail (2.85/2.50)=1.14.
*indicates non-significant (p-value >0.05)

5.2.4 Supplementary Analysis

5.2.4.1 Effect Modification by Social Support Availability (SSA) (Table 5.2.4.1)

Though not initially proposed as an effect modifier, SSA was selected for supplementary analysis due to its strong association with unmet health/home care need in the literature (19,26,96,180) and in this study, and given concerns over the small proportion of respondents reporting an unmet home care need in this sample. SSA was found to be highly correlated with unmet home care need in the bivariate analysis, with 61% of those reporting an unmet home care need also having low overall SSA. Low SSA was 39.9% among frail respondents compared to those who were robust (25.3%).

To assess for possible effect modification by SSA, interaction terms were initially entered into the hospitalization and death models and were not found to be statistically significant (e.g., frailty*SSA, p=0.9186 for hospitalization; Model A and frailty*SSA, p=0.0872 for death; Model A). Following this initial investigation, categorical variables were created to cross-classify respondents by their level of frailty and low/high SSA, as was done with unmet need. These variables included six categories allowing direct assessment of the effect of frailty on hospitalization and death by presence/absence of SSA. The reference group was respondents with the lowest risk of the outcomes (robust with high SSA). Each outcome was modeled separately, with the six level variable, while adjusting for age, sex and comorbidity, as well as models with and without previous hospitalization, to maintain consistency with analyses conducted for frailty, unmet home care need and the two outcomes.

The results of this supplementary analysis do not suggest that SSA modifies the frailty-hospitalization association (see Table 5.2.4.1). Little difference was noted for the impact of frailty on hospitalization among those with high vs low SSA (Model A; comparison of ratio of

odds ratios 2.79 vs 2.60, respectively). Model B (with no adjustment for previous hospitalization) showed similar findings. However, some caution is warranted in the interpretation of these ratios given the relative imprecise estimate observed for respondents who were robust and reported low SSA.

Similarly, the findings presented in Table 5.2.4.1 generally suggest the absence of evidence for modification of the frailty-mortality association by SSA. Only a modest difference was noted for the impact of frailty on mortality among those with high vs low SSA (Model A; comparison of ratio of odds ratios 3.32 vs 2.85, respectively). Again, some caution in the interpretation of these ratios is required give the less precise estimate observed for respondents who were robust and reported low SSA.

Table 5.2.4.1: Multivariable analysis of the association between frailty - SSA categorical variable and health outcomes during the 2-year follow-up, 2008-09 CCHS-HA (cycle 4.2)

	Odds Ratio (95% Confidence Interval)	
	Hospitalization	**Death**
Model A[a]		
Frailty (FI) and SSA		
Robust & High SSA	1.00	1.00
Pre-frail & High SSA	1.71 (1.34-2.19)	1.19 (0.72-1.99)
Frail & High SSA	2.79 (2.14-3.64)	3.32 (1.90-5.81)
Robust & Low SSA	1.00 (0.71-1.42)ǂ	0.94 (0.52-1.71)ǂ
Pre-frail & Low SSA	1.57 (1.21-2.04)	1.57 (0.91-2.69)ǂ
Frail & Low SSA	2.60 (1.98-3.41)	2.68 (1.48-4.85)
Ratio [Frail vs Robust] High SSA	2.79	3.32
Ratio [Frail vs Robust] Low SSA	2.60*	2.85*
Model B[b]		
Frailty (FI) and SSA		
Robust & High SSA	1.00	1.00
Pre-frail & High SSA	1.81 (1.42-2.30)	1.28 (0.77-2.12)ǂ
Frail & High SSA	3.10 (2.39-4.03)	3.80 (2.17-6.65)
Robust & Low SSA	1.00 (0.71-1.41)ǂ	0.94 (0.52-1.71)ǂ
Pre-frail & Low SSA	1.61 (1.25-2.08)	1.65 (0.96-2.84)ǂ
Frail & Low SSA	2.85 (2.18-2.73)	3.05 (1.69-5.52)
Ratio [Frail vs Robust] High SSA	3.10	3.80
Ratio [Frail vs Robust] Low SSA	2.85*	3.24*

Notes: Notes: FI=Frailty Index; SSA=Social Support Availability; [a] Model A adjusting for age, sex, comorbidity and previous hospitalization; [b] Model B adjusting for age, sex and comorbidity; ǂ indicates non-significant (p>0.05); Robust/Low SSA for hospitalization in Model A (p = 0.9949); Robust/Low SSA for hospitalization Model B (p=0.9827); Robust/Low SSA for death in Model A (p=0.8456); Pre-frail/Low SSA for death in Model A (p=0.1050); Pre-frail/High SSA for death in Model B (p=0.3455); Robust/Low SSA for death in Model B (p=0.8442); Pre-frail/Low SSA for death in Model B (p=0.0708); all other reported values significant at p <.05; * caution required in the interpretation of findings due to instability of estimate for robust respondents with low SSA

Chapter 6

Discussion

6.1 Interpretation

The overall aim of this study was to examine the prevalence of frailty and its association with health outcomes, as measured by first-event inpatient hospitalization and death, and whether unmet home care need acts as an effect modifier of these associations, among a middle- and older-aged Canadian community-dwelling population. To address this overall aim, the following research questions were investigated: 1) the distribution of frailty status and its association with key descriptive and contextual variables; 2) the distribution of unmet home care need and its association with key descriptive and contextual variables; 3) the independent association between respondents frailty status and inpatient hospitalization and mortality over a 2-year follow-up period, overall and stratified by sex; and, 4) possible variation in the associations between frailty status and inpatient hospitalization and mortality by the presence/absence of unmet home care need. The following sections will present the interpretation of findings for these four study questions in relation to existing research.

6.2 Study Findings

6.2.1 Research Question #1: Frailty and its association with CCHS-HA respondent characteristics

The study sample was representative of middle- and older-aged community-dwelling Canadians, a population not often utilized in frailty research. Compared to studies examining frailty among continuing care recipients (11,14,16), this sample was relatively younger, more

proportionally represented by both sexes, with a greater number of participants married or in a common-law relationship. Overall, the study sample was highly educated with relatively high household income, consistent with other survey populations (23,135).

The prevalence of frailty (14%) and right skewed frailty distribution found in this study is consistent with previous research involving Canadian community-dwelling older adults (7,8). These findings are also similar to those found in community-based frailty research in the Netherlands with comparable median FI scores (80). There is a consistent, submaximal upper limit to the accumulation of deficits (FI ~0.7), beyond which mortality is expected (7,40,46,47). The upper limit found in this study (0.68) is consistent with this previously established upper boundary. Collard and colleagues' systematic review and meta-analysis found that broad measures of frailty, such as frailty indices, produced overall frailty prevalence estimates of 13.6% among the community-dwelling population. However, a great deal of variability was also noted, with those aged 65+ having frailty estimates between 4% and 59%, depending on the specific frailty measure being used (8). The inconsistency in frailty measurement tools contributes to high variability in estimation between studies and study populations (8). Studies using the FI in Canadian community-dwelling older populations have found frailty prevalence estimates of 23% (7,40). This high prevalence is attributed to the comprehensive nature of FI, which has been found to classify a greater number of people as frail compared to frailty phenotype measures (40). The inclusion of middle-aged adults in this study may have contributed to a relatively healthy sample and lower frailty prevalence among this sample.

Agreement in the literature on the common characteristics of frail individuals does exist, with frailty increasing with age (181) and generally greater prevalence found in women versus men (8,13,71). This study found a higher prevalence of frailty among the oldest age group and

greater proportion of women in the frail versus robust group, consistent with other Canadian studies utilizing an older population (7,40). Among the frail group, 62% were women compared to 48% in the robust group, which was expected given this trend throughout the frailty literature (8,40,41,63,79). Some of this observed difference can be explained by the higher life expectancy for women and increased risk of frailty with older age (8). Another suggested factor contributing to sex differences may be women's relatively lower lean body mass and strength compared to men, with the association between sarcopenia and frailty well established (3,13,58,182). Despite their higher likelihood for being frail, women seem to have greater resistance to decline over time and better survival than men at any age (8,79,131,151).

Frail respondents were also more likely to be widowed or living without a partner (a finding that may be explained by the age and sex findings noted above given that older women are more likely to be widowed and without a partner), and to have lower household income and education levels. They were also more likely to report being of Aboriginal identity, an unmet home care need and low SSA. Socioeconomic instability has been recognized as a risk factor for disease and poor health (183). Research exploring sociodemographic factors in the context of frailty have found that frail individuals with lower income and education have a greater risk of adverse health outcomes (18). High levels of social vulnerability among older impaired adults has also been found to increase the risk of hospitalization and death independent of age (17,161,184–187). The first and only study exploring frailty in Aboriginal peoples in Canadian First Nation's communities found frailty prevalence among 45-54 year olds comparable to levels of frailty among 65-74 year olds in the general population (132). Among the present study population, twice as many frail respondents identified as North American Indian, Metis or Inuit compared to robust. These findings are consistent with this previous research.

A great deal of frailty research has focused on home care, assisted living and other impaired populations (10,11,14,16,142). These populations differ from community-dwelling populations in their level of impairment and health care needs. Studies investigating long-stay home care cohorts have reported frailty prevalence estimates ranging between 19% and 24% (14,16). Among the home care population, frail older adults face greater risk of adverse health outcomes, including falls, functional decline, hospitalization, LTC placement and death (14,16). Frail respondents in this study were much more likely to have reported the receipt of either formal or informal home care in the past year, which speaks to the greater health care needs of the frail community-dwelling population.

6.2.2 Research Question #2: Unmet home care need and its association with CCHS-HA respondent characteristics

The proportion of community-dwelling Canadians aged 45 and older who reported having experienced an unmet home care need in the year prior to survey completion was 2.4%. Among those with an unmet home care need, there was a greater proportion aged 85+ then among those without such a need (8.7% vs. 3.5% respectively). There have been a few previous unmet home care need studies using CCHS cycles, including a Hoover et al. (99) paper that used the CCHS-HA. They found that ~4% of Canadian older adults (65+) reported an unmet need for professional home care services, with the prevalence rising with advanced age (99). Other Canadian population-level studies have found a higher proportion of reported unmet home care need among 55-64 year olds with these younger respondents less likely to have a reported physical disability (25). Sociodemographic differences, specifically lower income, in those reporting unmet home care need was also found (25). A recent study using the 2015/2016 CCHS

found higher prevalence of unmet home care need among women, older ages (65+) and those of lower SES, however they suggest that the absolute number of those reporting unmet home care need was highest in those 50-64 years of age. Multivariate analysis also showed significantly higher odds of unmet home care need among the 35-49 age group, while the 65+ age group had the lowest odds compared to 18-34 year olds in the reference group (104).

There may be several reasons for age differences in reported unmet home care need. Older adults are more likely to have a regular physician, providing opportunities for older adults to express their ADL and IADL needs within the home (25). Programing and community services may be disproportionately available to the older adult population, causing a gap in service availability or attention for younger cohorts (25,104). Disability related needs and institutionalization is highest among the older age groups making participation in population level surveys unlikely for those who are the most impaired (25,104). The prevalence of unmet home care need is higher among those with greater disability, and particularly high among those with significant ADL needs (99,113). Living alone is also significantly associated with greater unmet home care need (99,112).

The findings of the present study are consistent with this previous research, with the prevalence of unmet home care need highest among frail respondent (10.5%) compared to those who were robust (<0.7%). Respondents who reported unmet home care need were also more likely to be older, female, have low household income, less than high school education and living without a partner compared to those without such a need. Previous unmet health and home care need research has found similar correlations (25,26,36,93,104,112,113). Health inequalities arise from, what has been descried as a *clustering of disadvantage* (26,93), where socioeconomic factors and health behaviours interact to affect health, and has been used to explain unmet health

care needs. There is a greater incidence of a larger range of health issues and greater health needs among those who are most socioeconomically disadvantaged (26). The findings of the present study can be viewed from this perspective and are consistent with the interplay of predisposing, enabling and need factors discussed in the *Behavioural Model of Health Utilization* (120).

Not only do those facing income inequalities have greater rates of unmet health and home care need, but those with limited social support have also been found to have an increased risk of unmet health care need (20,30,34,188). The present study provides evidence of the interplay between low SSA and unmet home care need, with nearly two-thirds (60.9%) of respondents with unmet home care needs also reporting low SSA. Although research examining frailty and SSA has not provided consistent results (133,153), the importance of social support for vulnerable older adults is gaining attention. New international practice guidelines for frailty suggests that providing assistance with social support may mitigate unmet health care need and encourage management and care plan adherence (180). The findings here support this initiative and the assessment of social support needs among frail and vulnerable older adults.

In the present study, reported unmet home care need was greater among those who reported receiving either formal or informal home care support. Interestingly, two thirds of those who reported an unmet home care need had received informal home care support in the prior year compared to those without unmet home care need. This greater use of informal care among respondents with a reported unmet home care need may illustrate a gap in the provision of formal home care services for vulnerable middle-aged and older adults. Although the role of informal care was not explored here, this correlation may be the result of caregiver distress felt by informal care providers. Previous frailty research evaluating caregiver distress has found increased risk of adverse outcomes among frail older adults with a distressed caregiver compared

to robust older adults without a distressed caregiver (16), suggesting that greater availability and access to home care services may mitigate this distress, unmet need and the associated adverse outcomes.

Personal barriers (accessibility or acceptability) were most often reported reason for unmet home care need in this study. Although unmet home care need prevalence estimates are quite low and a full examination of the reasons for unmet home care need was not possible, these findings are consistent with a Hoover et al. (99) study exploring unmet home care need. Hoover et al. found that personal barriers, such as accessibility or cost, were the most often cited reason for this unmet need (99). This is in contrast to more recent Canadian population-level unmet home care need studies, which have cited system-related barriers, such as availability (e.g., wait times) as the most often reason for reported unmet home care need (25,104). These differences may be due to changes in community care programing and service delivery, as well as the growth in population need for home based care.

6.2.3 Research Question #3: Independent association between frailty level and inpatient hospitalization and mortality over 2-year follow-up period, overall and stratified by sex

6.2.3.1 Frailty and hospitalization

Findings from age and sex adjusted models showed that increasing age, frailty, number of chronic conditions, low household income, low education and unmet home care need were significantly associated with hospitalization. Adjustment for all relevant covariates attenuated the magnitude of associations somewhat, with frailty, increasing age and previous hospitalization representing the strongest predictors of hospitalization. Although a significant predictor of hospitalization in the age and sex adjusted models, comorbidity became non-significant with the

inclusion of frailty in further adjusted models. This was expected, as frailty (though correlated with comorbidity) should predict adverse outcomes over and above the number of chronic conditions or level of comorbidity. This finding provides evidence of the utility of frailty indices to predict adverse events and is consistent with previous frailty literature (11,33,79). Increasing age and previous hospitalization remained significant in fully adjusted models, findings that are also consistent with previous frailty research (3,11,14,39,170). Lower odds of hospitalization was found for women compared to men. This too is consistent with previous studies (40,63). Although women have been found to have greater frailty levels and prevalence, men appear to have higher rates of adverse outcomes associated with frailty (40,63).

After controlling for predisposing and enabling factors, frailty was found to be significantly associated with hospitalization with the magnitude of this association greater than in previous research (11,14,16). There has been recent discussion regarding the utility of the frailty index in predicting outcomes in older adults (4). The findings of this study, however, validate the predictive value of the FI within the community-dwelling population. Previous research has focused largely on the home care (16,64,163) and assisted living (10) populations. These populations exhibit relatively high impairment levels that would be expected to be associated with select health outcomes, which might explain the relatively lower predictive value of the FI relative to that observed in the current study. The use of a community-dwelling population in this study allowed for a healthier comparison group, with the odds of hospitalization much greater for frail (OR=3.27, 95% CI 2.44-4.40) respondents compared to the robust reference group, after adjusting for age, sex and comorbidity. These findings validate the usefulness of the FI for relatively healthier and younger community-dwelling adult populations.

Unmet home care need was first examined as an independent variable in multivariable logistic regression models. The findings of this analysis suggest that unmet home care need is a significant predictor of hospitalization in age and sex adjusted models. When exploring the frailty-hospitalization association, unmet home care need remained statistically significant in the final model (Model D), after adjusting for age, sex and comorbidity. These findings are consistent with previous studies exploring adverse outcomes among those with unmet home care need and ADL disability or frailty (19,20,31,113). Increased hospitalization has been previously found in frail older adults with unmet ADL needs (112). These findings were over and above medical exacerbations leading to hospitalization (112). Previous research exploring unmet need and disability have also found an increase in adverse events in the presence of unmet need (30). Much of the unmet home care need research has focused on predictors of unmet need (29,36,99,104), with none found using unmet home care need as an effect modifier of frailty-outcomes.

Models that adjusted for previous hospitalization produced non-significant results for unmet home care need (Model B). As this study used cross-sectional baseline data, it was not possible to determine temporality. Some studies have suggested that IADL and ADL needs following discharge from hospital increase the risk of readmission (31). This could be contributing to previous hospitalization changing the significance of unmet home care need in both frailty-hospitalization and death models. However, it was not possible to determine the state of home care need before this prior admission and whether the lack of home care support lead to this previous hospitalization. Given the lack of temporal order, it is difficult to dismiss unmet home care need as unimportant.

6.2.3.2 Frailty and mortality

The inclusion of death as a secondary outcome allowed for the assessment of competing risk in relation to the frailty-hospitalization analyses. The analysis of death as an outcome provided an opportunity to compare associations for frailty and other covariates with the two outcomes. The same strategy was employed for the death outcome as was used for hospitalization and results aligned with those found in the hospitalization analysis. Death is a widely used adverse outcome in frailty research and significant associations have consistently been found regardless of the study setting and population (11,16,46,48,130,151,161,189). Consistent with previous research, frailty was significantly associated with death in all models (10,11,16,40). The magnitude of this association was strongest in Model A after adjusting for age, sex and comorbidity and was attenuated somewhat with the addition of other relevant covariates. Age, sex, frailty, comorbidity, previous hospitalization, low education, low income and unmet home care need were all significant predictors of death in the age and sex adjusted models. The inclusion of frailty and all relevant covariates in subsequent models (Model B) caused comorbidity, income, education, and unmet need to become non-significant.

Socioeconomic disadvantage is a known risk factor for adverse health outcomes, including death (190). The inclusion of frailty and other covariates in fully adjusted models caused income, education and comorbidity to become non-significant. As explained above, this was expected for comorbidity when included in frailty-outcome models. SES measures however, have been inconsistent predictors of mortality. A few studies have shown income and education predictive of adverse outcomes (17,130) in frail older adults. A longitudinal study of Dutch older adults found frailty –SES associations, they also suggest that frailty may mediate SES-mortality associations, with further research required (188). Other studies, however have not found

significant associations between frailty and SES measures (188). Interestingly, SSA was non-significant across all models for both hospitalization and death outcomes. This may be due in part to the selection of hospitalization and death as outcomes for this study. SSA may be more predictive of other types of frailty outcomes, such as LTC placement and ALC hospitalizations (18,188). Low SSA may not result in functional decline leading to acute hospitalization or death, but rather limit the ability of frail older adults to maintain independence at home requiring institutionalization (15,17,191).

6.2.3.3 Sex stratified results

This study included an examination of differences in frailty-outcome associations by sex. This stratified analysis revealed interesting differences between men and women, which were consistent with known patterns of hospitalization and death within the frail population. In this study, women had higher frailty prevalence than men, however associations between frailty and both hospitalization and death was more pronounced in men versus women after adjusting for key covariates. Sex differences in frailty prevalence and health consequences have been well established, with greater frailty and disability found among women, but greater risk of hospitalization and all-cause mortality for men, regardless of the study population (40,63,79,151). Although women have higher levels of disability, they appear to have slower decline trajectories compared to men, who are more likely to die suddenly (63,79,151).

Although the distribution of both pre-frailty and frailty was higher in women, the presence of pre-frail status or frailty in men was a significant predictor of both hospitalization and death. Among men, there was a greater odds of death for both pre-frail and frail groups, where pre-frailty was not a significant predictor of death for women. This supports previous

research suggesting that women live longer with greater disability compared to men (40,63,79,151). Age was also a significant predictor of hospitalization at all ages for men compared to women. Age was only significant at the 65 and older age groups for men and 75 and older age groups for women in the frailty-death models. This association and sex difference is consistent with previous findings, where survival in greater among women versus men with the same level of frailty (79).

Socioeconomic characteristics, measured by income and education, were not significantly associated with either hospitalization or death in fully adjusted sex-stratified models. This is in contrast with previous research that has found income inequalities impact frailty trajectories (188). A study by Hoogendijk et al. (188), suggests a higher risk of frailty is associated with low SES (as measured by income and education) for men only, which also contrasts previous research in which these inequalities were more significant among women (192). It has been suggested that differences in measures of SES and the outcomes being assessed may be contributing to the inconsistency in sex-stratified findings between studies (3,130,188).

Unmet home care need was significantly associated with hospitalization in the final model for women, but not men. Women more often report unmet home care need, which may be due in part to greater barriers to health care experienced by women and the higher prevalence of living alone (193). Previous research has found that frailty and high levels of disability increase the odds of unmet home care need (19). Sex differences in caregiver availability have been determined and suggest that men are less likely to be widowed or living alone, and more likely to receive care from their spouse (16,89). The higher prevalence of frailty in women, being

widowed and longer life expectancy may have contributed to these findings. The following section will explore unmet home care need as an effect modifier in relation to previous research.

6.2.4 Research Question #4: Variation in the association between frailty status and hospitalization and mortality by the presence/absence of unmet home care need

Although the results of this study did not show effect modification by unmet home care need, the value of exploring this contextual factor cannot be dismissed. There are several reasons why unmet home care need was not found to modify frailty-outcome associations in the present study. Among these, is the relatively low prevalence of unmet home care need in this study population and the lack of additional survey questions asking about unmet health care needs more broadly. Partially met home care needs were also not explored, which may have affected frailty-outcome associations. Gilmour et al. (104) examined unmet home care need in the Canadian community-dwelling population, finding that among individuals who had received home care services, more than 25% also reported an unmet need for these services. Further study of unmet home care need as an effect modifier should also explore under-met or partial met needs.

The exploration of the modifying effect of contextual factors on the frailty-health outcome associations has produced inconsistent results (133,153). A study by Op Het Veld and colleagues (18) examined the moderating role of several *resources,* which may impact frailty outcomes. These resources included income, education, living alone and the availability of informal care support (18), most of which have been examined elsewhere with inconsistent results (17,133,188). No effect modification of frailty hospitalization and death outcomes by any of these listed resources was found (18). These findings suggest that, once frailty is determined,

the predictive value of other factors entered into the model does not add to or modify this already highly significant association. The health outcome examined may also play a role in whether contextual factors modify these associations. Unmet home care need may not modify the frailty-hospitalization or death outcome, but may play a role in relation to other adverse health outcomes, such as movement to LTC, ALC bed stays, caregiver distress and functional decline (18). The higher prevalence of unmet health and home care need among women suggests that analysis of this contextual factor in sex-stratified models may provide a better understanding of how frailty-associations differ in the presence/absence of unmet need. This was not possible in this study due to the small proportion of those reporting unmet home care need, but should be a focus of future research.

6.2.5 Supplementary Analysis

The inclusion of SSA in this study allowed for the analysis of social factors that have previously been shown to influence health status and unmet health need (26,96,133,188), and which may also be significant for understanding frailty trajectories (194,195). The findings of this study (not shown here) are consistent with other social vulnerability work, with those reporting low SSA more likely to be older, living without a partner, having less than a high school education and low income (185,196). The influence of the social environment is also an enabling factor that may be mutable in the face of policy and practice adaptations within the health care system. The findings of this study suggest that those who are frail have lower mean SSA scores versus their robust counterparts, as well as low overall SSA. Recent research looking at SSA and cognitive function found that those with low SSA displayed lower cognitive function than those with middle and high SSA (179). Although this research looked specifically at

cognition, their findings draw on the need for early interventions, including social support strategies to mitigate decline.

Psychosocial well-being has also been found to be highly associated with frailty, independent of age, sex, measures of SES and mental health (197). Other work evaluating social vulnerability concluded that those with high social vulnerability were twice as likely to die as those with low vulnerability (198). Mitnitski et al. (130) found higher social vulnerability among older ages and women. Their research also revealed moderate correlations between higher social vulnerability and frailty (130). The findings of the present study are consistent with the literature, as low SSA was more prevalent in the frail group versus the robust group. Initial descriptive analysis (not shown here) of SSA correlates showed higher prevalence of low SSA versus high SSA among older ages, however significant sex differences were not observed between low and high SSA.

Although SSA was significantly associated with frailty and unmet home care need, it was not observed to be a significant predictor of either hospitalization or death in age and sex adjusted models. The inclusion of SSA as an effect modifier of frailty-outcome association also produced non-significant results. These results were surprising given the relationships observed in the descriptive analysis and the influence of social factors on perceived unmet health care need evaluated in previous research (26,96). The exploration of contextual factors including SSA as an effect modifier of frailty-outcome associations have been largely inconclusive in prior research (17,133,134,153,199). The lack of this modifying role may be the result of frailty itself being a large predictor of poor health outcomes. Functional decline may not be buffered by social support and psychosocial resources for frail older adults, but may have a greater role in pre-frail individuals (17). These findings may also be the result of the outcomes examined and

the relatively strong association observed between frailty and both health outcomes. Further exploration of SSA as both a covariate and an effect modifier is needed, including research exploring other potentially relevant health outcomes, such as LTC or assisted living care transitions. The examination of domains of SSA may also yield differences in how SSA operates independently and in combination with frailty. Some research has suggested that health related outcomes may be mitigated by a *summary protective index*, which combines measures of environmental, behavioural and SES factors (179). This suggests that further research examining social and other contextual factors in relation to frailty outcomes is needed.

6.3 Strengths

This study has several strengths, the most notable of which is the large community dwelling, nationally representative CCHS-HA sample and the robust nature of the survey design. A three-stage sampling design was utilized during recruitment, including geographical clustering, random household selection within each cluster, and random selection of a participant from each selected household. In-person computer assisted interviews were conducted for 94% of respondents, the remainder of collection required telephone interviews due to language barriers. The inclusion of middle aged adults (aged 45+ years) and the focused content of this health and aging survey provided the ability to derive a FI to evaluate associations of interest in both a middle-aged and older adult cohort. The CCHS-HA included respondents from all provinces, providing generalizability to the Canadian community-dwelling middle-aged and older adult population outside of the territories. Although there are excluded groups, including institutionalized individuals, residents of First Nations reserves, and full-time members of the

armed forces, this represents only 4% of the Canadian population, making the results representative of most community-dwelling middle-aged and older adults in Canada.

Recall and reporting error can pose an issue in self-report surveys, however, the first-person perceptions of health services and health care experiences are viewed here as a strength in the design. These perspectives are essential when examining issues of unmet home care need and the potential barriers and facilitators to accessing care. Another strength is the relatively high response rate (74.4%) for this survey.

To our knowledge, unmet home care need has not been evaluated as an effect modifier of the frailty-outcome association utilizing population-level survey data. The derivation of a FI utilizing the CCHS has also been limited providing an opportunity to examine frailty associations among a Canadian community dwelling middle-aged and older adult population. Associations between frailty and hospitalization were higher for this population compared to more impaired populations, validating the utility of the FI in predicting adverse events in a relatively younger and healthier community-dwelling population.

6.4 Limitations

There are inherent limitations when using survey data, such as reporting and recall bias, however, the use of self-reported health related information and chronic conditions is widely used in epidemiology and has been found to be reliable and valid (6). Given that individuals who participate in large-scale surveys, such as the CCHS, are generally healthier, the sample may under-represent the prevalence of frailty and unmet home care need within the Canadian population. The survey includes only individuals living within the community, excluding institutionalized middle-aged and older adults. It is estimated that 10% of adults over the age of

85 live in an institutional setting and, as such, care must be taken in the generalizability of the results to all older adults, in particular the oldest old age group (200).

The CCHS-HA is a cross-sectional survey and therefore, causality cannot be inferred. This is most evident when evaluating the role of previous hospitalization as a covariate. Because the frailty and unmet home care need status of participants is not known prior to the baseline survey date, it cannot be determined if the previous hospitalization occurred as a result of respondents' frailty status or unmet home care need, or if this prior hospitalization led to a transition between frailty levels ultimately leading to an outcome event. Caution is therefore, advised in the interpretation of findings regarding temporality and potential causal pathways.

The adverse outcomes chosen for this study were limited to first-event inpatient hospitalization and mortality. There are other known adverse outcomes not explored here, but which may be relevant to both frailty and the presence of unmet home care need, such as ALC hospitalization, functional decline, falls and admission to LTC or AL settings.

The FI is constructed as a continuous variable, however the interpretation and presentation of results and their interpretation is made easier utilizing validated cut-points to identify robust, pre-frail and frail respondents.. The selection of cut-points must be approached with caution and consideration of the population and study setting. Established and validated cut-points differ for community-dwelling versus institutionalized populations. Validated cut-points established using other CCHS cycles were applied in the present study (7).

The CCHS-HA survey was conducted from Nov. 2008 through Dec. 2009. The administration of home care and community services across the country has changed since this data collection cycle and as such, the findings of this study may not be reflective of the most current health care climate. Despite this, the findings provide insight into the correlation between

frailty and unmet home care need, as well as the increased odds of hospitalization when both frailty and unmet home care need are present. This suggests that that frailty outcomes may be mitigated by addressing unmet home care needs in the community.

CCHS-HA survey respondents from Quebec were excluded from the study due to lack of DAD linked hospitalization data for that province. In addition, any respondents hospitalized within Quebec, but residing outside of that province would not have that hospitalization event linked through the DAD. Initial univariate and bivariate analysis of the full sample, inclusive of Quebec was completed for all variables of interest not requiring administrative linkage. These findings are presented in Table 5.1.1b of Appendix B. No significant differences were noted between the full sample and analytic sample utilized for all descriptive analysis.

The CCHS-HA did not ask questions regarding the quality of care being received, but rather whether this care was available when respondents required it. Two broad groups of respondents were explored in this study; those with unmet home care need and those without unmet home care need. Within these broad groups however, are respondents with partially met needs and individuals who had no need for home care at all. In essence four groups could have been considered including: partially met/receiving home care, fully unmet home care need, receiving all necessary home care and no need for home care.

Finally, there is an assumption in this study that both frailty level and unmet home care need remain stable over the 2-year follow-up period. Both enabling and need factors may change over time, influencing the likelihood of unmet home care need, frailty level and adverse outcomes. The influence of health behaviours and health services utilization on individual characteristics is largely unknown for this study and caution is needed in drawing temporal inferences.

6.5 Implications and Future Directions

With population aging and the associated expected increase in the number of frail individuals, there is a need to identify those most vulnerable to adverse health outcomes. Understanding the differences in frail adults with and without unmet home care needs can lead to improvements in home care targeting and other social programing that may mitigate functional decline or transition between frailty levels.

It has been suggested that care planning, community service availability and management of conditions being received within the home may mitigate acute hospitalization needs (163). Although only a small portion of the present study sample expressed unmet home care need, the prevalence among frail respondents was much greater. This speaks to a need for better evaluation of both frailty status and health and home care needs of community-dwelling middle-aged and older adults. Although frailty assessments are currently conducted in some primary care settings, there is a need for a more comprehensive evaluation of the psychosocial and physical support needs of community-dwelling older adults. Meeting the home care needs of the frail population may reduce the likelihood of hospitalization, the costs associated with acute care utilization and the functional decline often experienced as a result (14). This functional decline often leads to ALC bed stays and discharge to LTC or AL rather than back to independent living at home (3,4,14). The assessment in primary care of informal care and the extent to which such support is available to frail older adults is another important aspect that may influence the need for formal home care services.

Some provinces have expanded the role of health services, such as paramedics, to provide assessment and care within the home to high frequency acute care users. Future research focusing on the evaluation of the expanding role of the community paramedic program, may

provide a means of more effectively assessing home care needs of community-dwelling older adults. Referral of vulnerable patients to the community paramedic service by primary care physicians could allow for expedited, in home assessment of clients' needs. This same type of referral process could be part of day surgery and procedure discharge of frail older adults not currently receiving home care services. Greater flexibility exists for community paramedics to attend homes within a day of discharge, than that of other home care service providers. Future research should evaluate this program and the expanding role of allied health professionals within the community and the extent to which these initiatives mitigate adverse health outcomes.

The inclusion of a pre-retirement age group in this study provided an opportunity to evaluate differences in prevalence estimates for various age groups among frail versus robust and those with unmet home care need compared to respondents without unmet home care need. Understanding these differences may inform future policy and programing in the area of home and community based care. Future research should also focus on expanding the exploration of unmet need in a frail population. This should include the exploration of partially met need through differentiation of sample groups into partially met, fully unmet, no required need and fully met needs, which may yield different results. This will further an understanding of the barriers to accessing care and how home and community care can be improved to diminish adverse outcomes. Future studies are needed to explore contextual factors that may mediate or moderate the frailty outcome associations. The utilization of different populations, study settings, outcomes and the operationalization of these factors may begin to define which psychosocial, environmental or behavioural characteristics act to modify frailty-related outcomes. Identifying these moderators may lead to policy and practice reforms targeted to mitigating adverse health outcomes. Other future initiatives should include intervention studies, which focus on

accessibility and availability of home and community care resources. These studies may provide insight into methods of health care reform and prevention programing for lessening the functional decline of frail older adults.

Although previous research has suggested only modest associations between frailty and hospitalization, as discussed above, these earlier studies have focused on relatively more impaired populations, including those receiving home care and residing in continuing care facilities (11,64). The examination of a FI among a relatively younger and healthier community-based sample, as shown in the current study, revealed more pronounced associations between frailty and hospitalization. These findings suggest that the use of the FI for community-dwelling populations can be of benefit in identifying those who may be vulnerable to adverse health outcomes. The use of such indices within the primary care setting, for example, may allow for early identification and intervention to mitigate the risk of hospitalizations. Hospitalizations can contribute to functional decline, transition between frailty levels and lead to greater health care needs and the costs associated with these needs (4). By screening individuals not yet receiving home care support and understanding their health care needs, services, support and care planning can be undertaken to diminish the risk of adverse outcomes.

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Appendix

Appendix A

Frailty Index (FI) deficits found in Canadian Community Health Survey-Healthy Aging (37 items)

Variable	Description	FI Value
Self-Perceived Health	Excellent/Very good	0.00
	Good	0.50
	Fair/Poor	1.00
Change in health status in past year	Much better/somewhat better/about the same	0.00
	Somewhat worse	0.50
	Much worse	1.00
Body Mass Index	Normal/overweight	0.00
	Obese	0.50
	Underweight	1.00
Participation and Activity limitation	Never	0.00
	Sometimes	0.50
	Always	1.00
Speech	Understood by everyone or only those who know them	0.00
	Partially understood by everyone	0.50
	Not understood by anyone or partially understood by those who know them	1.00
Emotional health	Happy and interested in life	0.00
	Somewhat happy	0.25
	Somewhat unhappy	0.50
	Very unhappy	0.75
	So unhappy that life is not worthwhile	1.00
Pain	None	0.00
	Pain does not prevent activity	0.25
	Pain prevents few activities	0.50
	Pain prevents some activities	0.75
	Pain prevents most activities	1.00

Vision	Sees with/without glasses	0.00
	Reads newsprint with/without glasses; cannot see person across street with glasses	0.25
	Sees person across street with/without glasses; cannot read newsprint with glasses	0.50
	Cannot read newsprint or see person across street with glasses	0.75
	Cannot see	1.00
Hearing	Hears in group without hearing aid (HA)	0.00
	Hears one-on-one without HA; hears in a group with HA	0.25
	Hears one-on-one without HA; cannot hear with HA in group	0.50
	Hears one-on-one with HA; cannot hear with HA in group	0.75
	Cannot hear	1.00
Mobility	Walks without difficulty and without aid	0.00
	Walks outside with difficulty; no help/aids needed	0.20
	Walks outside with aids; no help of another person	0.40
	Walks short distances unaided; needs wheelchair for longer distances	0.60
	Walks short distances with help; needs wheelchair for longer distances Cannot walk	0.80 1.00
Cognition	Can remember most things, think clearly, solve problems	0.00
	Remembers most things; some difficulty thinking, problem solving	0.20
	Somewhat forgetful, but thinks, solves problems	0.40
	Somewhat forgetful; some difficulty thinking, problem solving	0.60
	Very forgetful; great difficulty thinking, solving problems	0.80
	Unable to remember anything, think, solve problems	1.00
Dexterity	Full use of both hands, ten fingers	0.00
	Limited use of hands, no help needed	0.20
	Limited use of hands, uses special tools	0.40
	Limited use of hands, needs help for some tasks	0.60
	Limited use of hands, needs help for most tasks	0.80
	Limited use of hands, needs help for all tasks	1.00
Chronic conditions	Absence of conditions	0.00
	Asthma; Arthritis; osteoporosis; back problems; high blood pressure; chronic bronchitis; emphysema; COPD; heart disease; diabetes; cancer; effects of stroke; Parkinson's; Alzheimer's disease/dementia; heart attack; angina; thyroid; mood; anxiety disorders	1.00

Limited in activities of daily living	Able to perform activities of daily living	0.00
	Preparing meals; getting to appointments and running errands; doing everyday housework; personal care such as washing, dressing; moving inside house; looking after personal finances	1.00
Other	No fall-related injuries (past 12 months); walked for exercise (past 3 months)	0.00
	Fall-related injuries (past 12 months); no walking for exercise (past 3 months)	1.00

Source: Adapted from Hoover et al., 2013 Stats Canada Health Reports, Vol. 24(9) p.10

Appendix B

Table 5.1.1b Baseline characteristics of full CCHS-HA sample aged 45+, overall and by frailty status (column percent distribution), Cycle 4.2 2008-2009 (full sample)

Characteristic	Overall (%)	Frailty (FI) Status (column %)		
		Robust [FI ≤0.1] (52.5%)	Pre-Frail [FI >0.1 to ≤0.21] (33.5%)	Frail [FI >0.21] (14.0%)
Mean age (CI)	60.5 (60.4-60.6)	56.8 (56.6-57.1)	63.2 (62.8-63.6)	68.3 (67.5-69.0)
Median (IQR)	57.7 (50.6-67.5)	54.0 (49.1-61.5)	61.2 (53.2-71.4)	68.0 (57.3-78.3)
Age group				
45-54	38.5 (38.5-38.5)	49.9 (48.8-51.0)	28.2 (26.2-30.2)	18.5 (15.4-21.6)
55-64	29.5 (29.5-29.5)	31.2 (30.4-32.1)	29.4 (28.1-30.7)	23.0 (20.9-25.0)
65-74	17.7 (17.6-17.7)	13.0 (12.4-13.6)	22.9 (21.8-23.9)	23.3 (21.5-25.1)
75-84	10.8 (10.8-10.8)	4.8 (4.5-5.2)	15.0 (14.3-15.7)	24.0 (22.4-25.6)
85+	3.6 (3.6-3.6)	1.0 (0.9-1.2)	4.5 (4.2-4.9)	11.2 (10.3-12.2)
Sex				
Men	48.1 (48.1-48.1)	52.3 (51.3-53.4)	45.4 (43.7-47.1)	37.9 (35.4-40.5)
Women	51.9 (51.9-51.9)	47.7 (46.6-48.7)	54.6 (52.9-56.3)	62.1 (59.5-64.6)
Marital Status				
Married/Partner	73.3 (72.3-74.4)	78.5 (77.1-79.9)	71.2 (69.5-72.9)	58.0 (55.5-60.5)
Separated / Divorced /Never- Married	16.8 (15.8-17.8)	16.6 (15.2-17.9)	15.9 (14.5-17.4)	20.1 (17.8-22.4)
Widowed	9.8 (9.5-10.2)	4.9 (4.5-5.3)	12.9 (12.0-13.8)	21.9 (20.4-23.4)
Education level				
< Secondary School	22.1 (21.2-23.0)	14.5 (13.4-15.7)	26.4(24.7-28.0)	41.4 (38.8-44.0)
Secondary School Grad	19.9 (18.9-20.9)	19.6 (18.2-21.1)	21.3 (19.5-23.1)	17.6 (15.5-19.7)
Some Post-Secondary	5.2 (4.6-5.7)	5.0 (4.3-5.6)	5.4 (4.5-6.3)	5.4 (4.5-6.3)
Post-Secondary Grad	52.8 (51.5-54.2)	60.9 (59.1-62.6)	46.9 (44.9-49.9)	35.6 (33.0-38.1)
Household income				
Mean (CI)	74195 (71926-76464)	86434 (83409-89459)	66619 (63373-69864)	41242 (39306-43179)
Median (IQR)	59619 (34959-99182)	69898 (44989-109141)	54073 (29988-84514)	29999 (18981-51735)
Lowest tertile	13.4 (12.7-14.2)	7.9 (7.1-8.7)	15.4 (14.2-16.6)	30.4 (28.2-32.7)
Middle tertile	23.2 (22.2-24.3)	22.4 (20.9-23.9)	24.7 (23.0-26.3)	23.2(20.9-25.4)
Highest tertile	33.7(32.3-35.1)	41.6 (39.5-43.7)	29.6 (27.6-31.7)	12.5 (10.7-14.2)
Missing	29.6 (28.1-31.2)	28.1 (25.9-30.3)	30.3 (28.2-32.4)	33.9 (31.2-36.7)
Aboriginal identity				
Yes	2.3 (1.9-2.7)	1.8 (1.3-2.3)	2.4 (1.7-3.0)	4.4 (3.0-5.9)[E]
No	97.7 (97.1-98.0)	98.1 (97.6-98.6)	97.6 (96.9-98.2)	95.5 (94.0-96.9)
Province (grouped)				
Atlantic	7.7 (7.7-7.7)	6.8 (6.5-7.1)	8.1 (7.6-8.6)	9.9 (9.1-10.7)
Quebec	24.6 (24.6-24.6)	26.1 (25.2-27.1)	23.0 (21.5-24.5)	22.7 (20.4-25.0)

Ontario	38.3 (38.3-38.3)	37.8 (36.7-39.0)	38.3 (36.5-40.1)	40.4 (37.8-43.0)
Prairies	15.5 (15.5-15.6)	15.1 (14.5-15.7)	16.7 (15.8-17.6)	14.6 (13.2-15.9)
British Columbia	13.8 (13.8-13.9)	14.1 (13.3-14.9)	13.9 (12.8-15.1)	12.5 (10.8-14.2)
Location‡				
Urban	78.3 (76.3-80.3)	78.5 (76.3-80.8)	78.2 (75.6-81.0)	77.6 (74.8-80.5)
Rural	21.7 (19.7-23.7)	21.5 (19.2-23.7)	21.8 (19.1-24.4)	22.4 (19.5-25.2)
No. Chronic Conditions				
Mean (CI)	1.8 (1.7-1.8)	0.7 (0.7-0.7)	2.4 (2.3-2.4)	4.6 (4.5-4.7)
Median (IQR)	0.8 (0-2.2)	0.1 (0-0.7)	1.8 (1.0-2.7)	3.9 (2.7-5.2)
0	27.1 (25.9-28.2)	47.4 (45.5-49.4)	4.7 (3.7-5.6)	1.2 (0-2.5)[F]
1	27.2 (26.0-28.4)	38.3 (36.4-40.2)	19.4 (17.8-20.9)	2.4 (1.5-3.2)
2-3	30.6 (29.5-31.6)	14.0 (13.0-15.0)	59.5 (57.6-61.3)	26.0 (23.7-28.3)
4+	15.2 (14.4-15.9)	0.2 (0.1-0.4)	16.5 (15.2-17.7)	70.5 (68.1-72.8)
Regular Family Physician				
Yes	92.7 (92.0-93.4)	90.6 (89.5-91.6)	95.0 (94.1-95.8)	95.6 (94.2-97.0)
No	7.3 (6.6-8.0)	9.4 (8.4-10.5)	5.0 (4.2-5.9)	4.4 (3.0-5.8)[E]
Self-reported Previous Hospitalization				
Yes	9.0 (8.4-9.6)	4.0 (3.4-4.7)	11.0 (9.8-12.2)	23.5 (21.3-25.6)
No	91.0 (90.4-91.6)	96.0 (95.3-96.6)	89.0 (87.8-90.1)	76.5 (74.4-78.7)
Receiving Formal Home care				
Yes	5.2 (4.8-5.6)	1.1 (0.9-1.4)	5.3 (4.6-6.0)	21.1 (19.2-23.1)
No	94.8 (94.4-95.2)	98.9 (98.6-99.1)	94.7 (94.0-95.4)	78.9 (76.9-80.8)
Receiving Informal Home care				
Yes	11.8 (11.0-12.5)	3.5 (2.9-4.1)	12.9 (11.6-14.2)	41.3 (38.8-43.8)
No	88.2 (87.5-89.0)	96.5 (95.9-97.1)	87.1 (85.8-88.4)	58.7 (56.2-61.2)
Social Support Availability				
Overall Measure of SSA				
Mean (CI)	64.3 (63.9-64.7)	66.0 (65.5-66.5)	63.6 (63.0-64.2)	59.0 (57.9-60.1)
Median (IQR)	70.0 (56.5-75.2)	71.8 (57.7-75.3)	68.7 (56.0-75.1)	64.4 (48.7-74.6)
Low	29.3 (28.0-30.6)	25.6 (23.9-27.4)	30.9 (29.0-32.9)	40.2 (37.5-43.0)
High	71.7 (69.4-72.0)	74.4 (72.6-76.1)	69.1 (67.1-71.1)	59.8 (57.0-62.5)
SSA Domains				
Affection				
Low	30.2 (28.9-31.6)	27.3 (25.5-29.1)	31.3 (29.3-33.3)	39.9 (37.2-42.6)
High	79.8 (68.4-71.1)	72.7 (70.9-74.5)	69.7 (66.7-70.7)	60.1 (57.4-62.8)

Emotional and Informational Support				
Low	30.4 (29.1-31.7)	27.4 (25.7-29.2)	31.9 (29.9-34.0)	38.9 (36.1-41.7)
High	69.6 (68.3-70.9)	72.6 (70.8-74.3)	68.1 (66.0-70.1)	61.1 (58.3-63.9)
Positive Social Interaction				
Low	30.7 (29.4-32.0)	27.6 (25.5-29.6)	33.5 (31.1-35.9)	42.4 (39.3-45.6)
High	69.3 (68.0-70.6)	72.4 (70.4-74.5)	66.5 (64.1-68.9)	57.6 (54.4-60.7)
Tangible Support				
Low	32.4 (31.1-33.8)	29.8 (27.9-31.6)	33.4 (31.4-35.5)	42.8 (38.0-43.6)
High	67.6 (66.2-68.9)	70.2 (68.4-72.0)	66.6 (64.5-69.6)	57.2 (56.4-62.0)
Unmet Home care Need				
Yes	2.4 (2.0-2.7)	<0.6[F]	2.0 (1.6-2.5)	11.0 (9.5-12.5)
No	97.6 (97.3-97.9)	99.6 (99.3-99.9)	98.0 (97.5-98.4)	89.0 (87.5-90.5)
Reason for Unmet Home care Need				
Personal Barrier	1.7 (1.4-1.9)	0.2 (0-0.4)[E]	1.5 (1.1-1.8)	8.0 (6.6-9.3)
System Barrier	0.4 (0.3-0.6)	<0.1[F]	0.4 (0.2-0.6)[E]	2.2 (1.6-2.8)
Both	0.2 (0.1-0.4)[E]	<0.5[F]	0.2 (0.1-0.3)[E]	0.8 (0.5-1.1)[E]
No Unmet Need	97.6 (97.3-97.9)	99.6 (99.4-99.9)	98.0 (97.5-98.4)	89.0 (87.5-90.5)

Data source: 2008/2009 Canadian Community Health Survey- Healthy Aging (cycle 4.2)
Notes: FI=frailty index; CI= confidence interval, 95%; [E] use with caution (CV 16.6-33.3%); prevalence estimates for full CCHS-HA sample, including Quebec; [F] Coefficient of variation exceeds 33.3%, but cell contains at least 5 records, estimate indicated as being less than upper limit of 95% confidence interval; comparisons across frailty levels significant, $p<0.05$ unless indicated; ǂ indicates non-significant finding ($p>0.0$)