A Social Ecological Model of Adherence to Hip Protectors in Long-Term Care

by

Alexandra Marie Bello Korall
B.Sc., Simon Fraser University, 2010

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Approval

Name: Alexandra M. B. Korall
Degree: Doctor of Philosophy
Title: A Social Ecological Model of Adherence to Hip Protectors in Long-Term Care
Examiner Committee: Chair: William Cupples
                Professor
Stephen Robinovitch
Senior Supervisor
Professor
Fabio Feldman
Supervisor
Adjunct Professor
Ian Cameron
Supervisor
Professor
Rehabilitation Medicine
University of Sydney
Joanie Sims-Gould
Supervisor
Assistant Professor
Centre for Hip Health and Mobility
Department of Family Practice
University of British Columbia
Dawn Mackey
Internal Examiner
Assistant Professor
Department of Biomedical Physiology
and Kinesiology
Koen Milisen
External Examiner
Professor
Department of Medicine
University of Leuven (KU Leuven)

Date Defended/Approved: January 30th, 2017
The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

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Abstract

Hip fractures among older adults living in long-term care (LTC) are debilitating and costly, and are nearly always caused by falls. If worn at the time of falling, specific types of hip protectors reduce fracture risk by 80%. However, the clinical value of hip protectors is compromised by poor user adherence in the wearing of these devices. My thesis provides insight into the factors governing adherence with hip protectors in LTC. In my first study, I conducted a systematic review of extant literature. A total of 1086 articles were identified, and of these, 28 met our inclusion criteria. Barriers and facilitators were grouped into four taxonomies: (i) system-related; (ii) caregiver-related; (iii) resident-related; (iv) hip protector-related. My second study involved the development and validation of the C-HiP index to measure commitment to hip protectors amongst paid care providers in LTC. Exploratory factor analysis yielded a factor structure consisting of two lower-order factors and a single higher-order factor. Expert evaluation by LTC clinicians provided evidence of content validity. Internal consistency was high (Cronbach’s alpha=0.96). My third study identified social ecological determinants of commitment to hip protectors by means of a cross-sectional survey (n=529). Mean (SD) commitment was 4.15 (0.71) out of 5.00. Commitment was associated with race/ethnicity, occupation, organizational tenure, awareness of a padded hip fracture, familiarity of hip protectors, perceptions of transformational leadership, communication, resident-provider relationship quality, and the existence of a champion of hip protectors within the home. Finally, I conducted a 12-month retrospective cohort study in fourteen publically subsidized LTC homes to identify factors governing adherence with hip protectors, and to examine the clinical value of hip protectors to prevent hip fractures. The percentage of residents who wore hip protectors during at least one fall was negatively correlated with regional socioeconomic deprivation ($p=-0.630$) and the percentage of residents with depression ($p=-0.538$), and was positively correlated with the percentage of residents paying for care privately ($p=0.539$) and who fractured their hip in the past 180 days ($p=0.677$). The relative risk of hip fracture was 0.36 (95% CI 0.14–0.90) in falls with hip protectors compared to falls without hip protectors.

Keywords: Long-term care; hip fractures; hip protectors; adherence; social ecological model; commitment
Dedicated to Dustin Mendel and in memory of Benjamin Bello. Without your help and support, this wouldn’t have been possible.
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<td>ADL</td>
<td>Activities of Daily Living</td>
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<tr>
<td>CI</td>
<td>Confidence Interval</td>
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<tr>
<td>CPG</td>
<td>Clinical Practice Guideline</td>
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<tr>
<td>CPS</td>
<td>Cognitive Performance Scale</td>
</tr>
<tr>
<td>DOI</td>
<td>Diffusion of Innovations</td>
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<tr>
<td>EFA</td>
<td>Exploratory Factor Analysis</td>
</tr>
<tr>
<td>EM</td>
<td>Expectation-Maximization</td>
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<tr>
<td>HR</td>
<td>Hazard Ratio</td>
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<td>IR</td>
<td>Incidence Rates</td>
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<td>Length of Stay</td>
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<td>Long-Term Care</td>
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<td>Minimum Data Set</td>
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<tr>
<td>MI</td>
<td>Multiple Imputation</td>
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<tr>
<td>NOF</td>
<td>Neck of Femur</td>
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<tr>
<td>OR</td>
<td>Odds Ratio</td>
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<tr>
<td>PFF</td>
<td>Proximal Femoral Fracture</td>
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<td>SD</td>
<td>Standard Deviation</td>
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## Glossary

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<td>Greater Trochanter</td>
<td>A protrusion on the shaft of the femur, proximal to the femoral neck, where attachment to the gluteus medius, maximus and several other muscles is provided. It is palpable at the lateral aspect of the hip joint.</td>
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<tr>
<td>Hip Fracture</td>
<td>Also referred to as a proximal femoral fracture (PFF), a hip fracture is a fracture to the upper quarter of the femur.</td>
</tr>
<tr>
<td>Hip Protectors</td>
<td>Specialized garments or undergarments, with soft pads or hard shield domes embedded in pockets covering the skin over the greater trochanter.</td>
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<tr>
<td>LTC</td>
<td>A facility that offers health care, personal care and social care on a 24-hour basis, and for the duration of an individual's residence in the facility.</td>
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Chapter 1. Introduction

1.1. The Context of Aging in Canada

The Canadian population is aging rapidly. It is projected that by 2036, the number of persons over age 65 living in Canada will increase from approximately 4.7 million to 10.9 million [1]. Accordingly, about one in four Canadians will be over the age of 65, and 7.5% will be 80 years or older [1].

These trends reflect aging of the largest birth cohort in Canadian history – the baby boomers – along with declining fertility rates and steadily increasing life expectancy [1, 2]. The average life expectancy of Canadians reached 81.7 years in 2011, nearly 25 years longer than the average life expectancy of 57.1 years in 1921 [3]. Average life expectancies have not plateaued. By 2036, women and men are projected to live to the ages of 87.3 and 84.0, respectively [1].

Canada is not the only nation facing a demographic shift; populations are ageing across the globe. For example, it is projected that by 2050, the number of elderly people in the world will increase from around 476 million (7.4%) to 1.5 billion (16%) [4]. Like in Canada, global ageing reflects increasing longevity and declining fertility rates [5-7].

As prevalence of major chronic disease increases with age, a fraction of total years lived is spent in poor health. In 2009, 89% of Canadians aged 65 or older reported having at least one major chronic disease [8]. For example, prevalence of hypertension, arthritis, osteoporosis, urinary incontinence, and Alzheimer’s disease in Canadians aged 65 or older were 53%, 43%, 18%, 12%, and 2%, respectively [8]. Accordingly, just over half (56%) of Canadian seniors reported living in good or excellent health [8].

Many older adults experience multiple coexisting chronic diseases, also referred to as multimorbidity. Results from the 2011/2012 Canadian Community Health Survey
indicate that approximately 31% of older adults in Canada have two or more chronic
diseases, while 11% have three or more [9]. Risk factors for multimorbidity include female
sex, older age, and lower socioeconomic status (high-school dropouts, living in the lowest
income quintile) [9].

Chronic disease and multimorbidity lead to disability and functional decline. Findings from the World Health Survey suggest that one in three (38%) people in the world aged 60 years or older experience significant difficulties in their daily lives [10]. Among Canadians, functional capacity tends to decline rapidly after age 65, with onset of severe
disability typically occurring at age 77 [3]. By age 85, the majority (57%) of Canadian

1.2. Long-Term Care in Canada

As older adults often face several years with chronic disease and disability before reaching the end of life, admission to long-term care (LTC) is often the only option. Accordingly, more than 200,000 Canadians reside in LTC facilities [12], including about a third (34%) of the Canadian population aged 85 and older [13].

The term LTC is used to describe any facility that offers health care, personal care and social care on a 24-hour basis, and for the duration of an individual’s residence in the facility [13]. LTC facilities in Canada have traditionally been, and in some cases continue to be, referred to as “nursing homes.” To be eligible for LTC in Canada, individuals tend to require both physical and/or cognitive impairment to the point that they are unable to independently perform instrumental or basic activities of daily living (ADL). LTC homes differ from Assisted Living facilities, which do not provide the same range of services, and tend to require a greater degree of personal autonomy based on physical and cognitive function.

At present, there are more than 1,300 LTC facilities in Canada, housing over 200,000 residents [12]. Long-term care is not federally funded in Canada, except through Health Canada’s First Nations and Inuit Home and Community Care (FNIHCC) and Veteran Affairs Canada (VAC) [13]. Long-term care is not a universally insured health
service, falling outside the umbrella of the Canada Health Act [13]. In 2001, approximately 41% of Canadian LTC beds were for-profit, 25% were government owned or operated, 24% were not-for-profit, and 10% were owned and operated by religious organizations [14].

Residents in LTC represent a particularly frail and vulnerable cohort of elderly people, who use more than $10.2 million CAD in health care resources every year [15]. The average age of residents in Canadian LTC homes is 83 years [12]. Most residents of LTC facilities are over the age of 65, but about 7% are younger adults who have developmental or acquired severe disability [12]. About two-thirds (67%) of residents are female [12], however the female to male ratio is relatively equal among residents aged 65-74 [13]. Approximately 73% of residents have urinary incontinence, 62% have dementia, 58% have hypertension, 54% have bowel incontinence, 31% have severe cognitive impairment, 29% have symptoms of depression, 25% have diabetes, 13% experience daily pain, and 12% are totally dependent in ADL [12]. The majority (54%) of LTC residents have osteoporosis, a progressive disease characterized by increased fracture risk and decreased bone mineral density (BMD) [16]. Furthermore, over half (52%) of LTC residents experience clinical frailty, a term used to describe the multidimensional syndrome characterized by loss of reserves (energy, physical ability, cognition, health) and vulnerability [17].

1.3. Epidemiology and Consequences of Falls in Later Life

With increasing age, changes in lifestyle, disease, and biology predispose older adults to higher risk for falls. Accordingly, about one in three (30%) people aged 65 or older will have one or more falls per year [18-20]. Furthermore, 15-21% of seniors fall repeatedly each year [19, 20]. The annual incidence of falls in LTC residents is 2–3 times higher than the rate observed in community-dwelling older adults [21], equivalent to approximately 1.5–2.2 falls per bed per year [22, 23].

Falls are a major threat to healthy aging, often triggering a downward spiral in health and quality of life. They are the leading cause of injury-related hospitalizations and deaths in people over the age of 65 [24-27]. About 5% of falls experienced by community-
dwelling older persons cause serious injury requiring medical treatment, compared to 10-25% of falls experienced by LTC residents [21, 28]. Serious injuries associated with falls include cuts or lacerations, soft tissue injuries, fractures (often to the wrist, hip and vertebrae) and head injuries [21, 28, 29].

One of the most debilitating and costly injuries caused by falls is hip fracture, occurring in 1-2% of falls [30, 31]. Roughly 1.31 million elderly people in the world are hospitalized for hip fractures each year [18], including 28,000 Canadian seniors [26]. In Canada, hip fracture incidence rates (IR) of 81 and 51 per 100,000 person-years have been observed in women and men, respectively [32].

Hip fractures are associated with early death, especially amongst elderly people residing in LTC. About 20-30% of community dwelling older adults will die within one year of hospitalization for a hip fracture [33, 34], with most deaths occurring in the first three to six months [34, 35]. Comparatively, one in three older adults living in LTC who are hospitalized for a hip fracture will die within the following six months, with mortality rates reaching 53% after one year [36]. Serious, potentially life-ending complications associated with hip fracture include deep vein thrombosis (DVT) and postoperative infection [34]. However, mortality is not always caused by the hip fracture itself, and can occur because of underlying frailty [35].

Survivors of hip fracture often experience poor health and psychological distress, including onset of depressive symptoms, pain, delirium (due to multiple factors), fear of falling, social isolation and activity restriction [36-42]. Fifty percent of community-dwelling seniors hospitalized for a hip fracture experience a major loss in independence [43], and 19-24% are admitted to LTC during the proceeding 12-months [33]. In a survey of Australian community dwelling adults aged 75 and older, 80% of respondents indicated they would rather die than suffer a ‘bad’ hip fracture that results in LTC admission, and almost all were willing to trade a fraction of their remaining years for fewer years spent in good health [44]. Furthermore, about 3% of elderly women and 2% of elderly men who survive the first 12-months post-fracture will experience a second hip fracture shortly thereafter [33].
In addition to functional and psychological consequences, there are mounting health care costs associated with hip fracture. In Canada, mean direct health care costs attributable to hip fracture in the first year following hip fracture are approximately $36,929 for females and $39,479 for males, while mean direct health care costs attributable to hip fracture in the second year following hip fracture are approximately $4,599 for females and $3,083 for males. As more than 28,000 seniors are hospitalized for hip fractures each year, direct treatment costs are estimated at $1.1 billion annually [33].

Considering the aging global population, the annual worldwide incidence of hip fractures is expected to reach 3.94 million by 2025, and 6.26 million by 2050 [18]. In Canada alone, it is projected that by 2041, the annual incidence of hip fracture will more than triple [45], even though age-adjusted incidence rates are plateauing [32]. As such, societal costs of hip fracture are anticipated to grow to $2.4-$3.3 billion annually [33, 46]. Fortunately, forecasts also predict that by preventing only 20% of falls over the next 20 years, an estimated 4400 Canadian lives and $10.8 billion in associated health care costs could be saved [24]. It is for these reasons that fall and fall-related injury prevention have emerged as public health priorities in Canada and beyond.

1.4. Clinical Definition and Management of Age-Related Hip Fractures

Hip fractures, also referred to as proximal femoral fractures (PFF), are defined by a fracture to the upper quarter of the femur. They are classified by the anatomical location of fracture, and include fractures of the neck of the femur (NOF), intertrochanteric fractures, and subtrochanteric fractures. Fractures of the NOF occur in the narrow section between the rounded femoral head and the base of the femoral neck, and include basicervical (base of the femoral neck), transcervial (mid-femoral neck), and subcapital (below the femoral head) fractures. Intertrochanteric fractures occur along the line intersecting the greater and lesser trochanters, while subtrochanteric fractures occur distal to the lesser trochanter. Both intertrochanteric and subtrochanteric fractures are examples of extracapsular fractures (Figure 1.1) [47].
Among LTC residents, fractures of the NOF and intertrochanteric fractures are observed approximately equally, while subtrochanteric fractures are relatively rare [36]. Age-related hip fractures are sometimes characterized by comminuted fractures [36]. On average, fractures of the NOF are less costly, require shorter length of stay (LOS) in hospital, and are associated with greater survival than intertrochanteric, subtrochanteric and comminuted fractures [36, 48].

Acute fracture management almost always involves surgical repair, namely internal fixation, hemiarthroplasty, and total hip arthroplasty [47]. However, Neuman et al. (2014) observed that 11.8% of LTC residents admitted to hospital for a hip fracture in the United States between 2005–2009 received non-operative management, and residents who received non-operative management had higher risk (HR=2.08) for short-term mortality than residents who underwent internal fixation [36].

1.5. Etiology of Age-Related Hip Fractures

Although age-related hip fractures can have pathological causes (e.g., metastatic carcinoma) and occur spontaneously during ADL [49], more than 95% of age-related hip fractures are caused by falls [26]. This knowledge prompted Hayes et al. (1996) to formulize a mathematical equation to predict the risk of hip fracture during a fall [50]. A factor of risk (Φ) was defined as the ratio of the applied load divided by the load necessary to cause fracture of the proximal femur, expressed by the equation:

\[
Φ = \frac{\text{Applied load}}{\text{Fracture load}}
\]

When the factor of risk – Φ – far exceeds one, the capacity of the proximal femur to withstand the load applied during impact from a fall is considered insufficient and a hip fracture is considered a likely outcome. Hayes et al. (1996), for example, reported that a one standard deviation (SD) increase in Φ associates with a 4.8 increase in odds of hip fracture [50]. Accordingly, risk for hip fracture in the event of a fall is governed by factors affecting both (i) the severity of a fall in terms of the force applied to the proximal femur
during impact (numerator), and (ii) the failure load of the proximal femur beyond which fracture will always occur (denominator).

The severity of a fall (numerator of $\Phi$) is influenced by (i) anthropometry (taller stature, heavier weight), (ii) proximity of impact to the hip, (iii) the effectiveness of protective mechanisms to spread the load over a larger contact area and/or to minimize velocity of the hip at impact, and (iv) the capacity of trochanteric soft tissue (lean and fat mass) to dissipate impact energy upon landing [50, 51]. For example, stature is correlated with greater velocity of the hip at impact, and body weight is correlated with greater force of impact, both of which are indicative of more severe falls [50]. Furthermore, adiposity is protective of hip fracture. In frail older adults, a 1 kg/m$^2$ increase in whole body fat mass index is associated with a 13% (95% CI 7–19%) decrease in risk for hip fracture, independent of bone mineral density (BMD) [52].

Determinants of fracture load include BMD, bone geometry and architecture, as well as the direction and rate of loading [50, 53, 54]. For example, in loading configurations replicative of falls on or near the hip, cadaveric specimens of elderly femora fracture at a mean (SD) force of 4170 (1590) N, which correlates strongly with BMD of the femoral neck ($r^2 \geq 0.60$) [53, 54].

### 1.6. Risk Factors for Age-Related Hip Fractures

Risk factors for age-related hip fractures include factors affecting the frequency and severity of falls, as well as fracture strength of the proximal femur. Consequently, they encompass a diverse array of intrinsic, behavioural, situational and environmental factors.

#### 1.6.1. Intrinsic Risk Factors for Age-Related Hip Fractures

Hip fractures are about four times more common in women [55, 56], but the proportion of men with hip fractures is increasing [57, 38]. Men are also twice as likely to die within two years of hip fracture [37]. Hip fractures tend to occur near end of life around the age of 82 (men=81, women=83) [33], with risk for hip fracture increasing with advancing age after the age of 65 [58]. Additionally, a decrease in femoral neck BMD of
one SD is associated with about a two- to three-fold increase in odds for hip fracture [59-62]. Other risk factors include white race/ethnicity (in females) [63, 64], low body mass index (weight/height$^2$) [59, 65], low whole body adiposity [52], cognitive impairment [66], lower limb dysfunction (including an inability to rise from a chair without using the arms) [67, 65, 68], slow gait speed and impaired mobility [60, 61], neurological disease (e.g., Parkinson’s disease, previous stroke) [67, 69], visual impairment (depth perception, visual acuity) [67, 68, 60, 62], a history of previous fracture [68, 62], and a maternal history of hip fracture [68, 62].

1.6.2. **Behavioural and Situational Risk Factors for Age-Related Hip Fractures**

Behavioural risk factors include smoking [68], caffeine intake [68], physical inactivity [70, 68], and a strong fear of falling [70], whilst situational risk factors include psychotropic medication use (benzodiazepines and other psychoactive medications) [71, 68], polypharmacy [72], and landing configurations characterized by impact to the lateral aspect of the femur [65, 73, 74]. For example, odds for hip fracture is between 21.7 to 97.8 fold greater in sideways falls that impact on or near the hip compared to falls that do not result in hip impact (e.g., impact to the knees, posterior buttocks) [65, 73, 74]. The analysis of real-life video footage of falls in LTC reveals that hip impact occurs in about 40% of falls, usually onto hard flooring [75]. Furthermore, hip impact is more likely during falls caused by slips and trips compared to other causes (odds ratio; OR=1.7), during falls initiated while walking compared to other activities (OR=1.9), and during falls initially directed forwards or sideways compared to falls initially directed backwards (OR=4.2) or straight down (OR=7.9) [75]. Use of a mobility aide is protective of hip impact (OR=0.7) [75].

1.6.3. **Environmental Risk Factors for Age-Related Hip Fractures**

Residency in LTC is associated with increased risk for age-related hip fracture. For example, when compared to community-dwelling older adults, residents in LTC are between 2.2-10.5 times more likely to suffer an age-related hip fracture [76-78], and are more likely to die within the first year following hip fracture [33]. The effective stiffness of
the ground surface contacting the hip at impact is another environmental determinant of fracture risk [67, 79]. For example, Simpson et al. (2004) reported that falls amongst LTC residents onto wooden carpeted floors resulted in lower odds of hip fracture than falls onto all other floor surfaces (OR=1.78) [79].

1.7. Prevention of Age-Related Hip Fractures in LTC

Age-related hip fractures affect all older adults, but not equally so. Residents in LTC are at especially high risk for hip fracture [76-78], and tend to experience greater morbidity and mortality following a hip fracture compared to community-dwelling older adults [33, 36]. Prevention of age-related hip fractures in elderly people residing in LTC is therefore of utmost importance.

Interventions to prevent age-related hip fractures address the frequency and severity of falls, as well as bone fragility. In this section, the efficacy of each of these strategies to reduce the incidence of hip fractures in LTC is discussed.

1.7.1. Efficacy of Interventions to Prevent Falls in LTC

Multiple definitions of a fall exist within the scientific community [80]. In this thesis, a fall is defined as an event which results in a person inadvertently coming to rest on the ground or other lower level [81]. For a fall to initiate, an individual must experience an episode of imbalance, followed by insufficient or nonexistent attempts to recover balance, namely via stepping and/or reaching [73, 82]. Analysis of real-life falls captured on video in two LTC homes in British Columbia, Canada, suggests that falls are caused most commonly by incorrect transfer or shifting of body weight (51%), followed relatively equally by trip or stumble (26%), loss of support with an external object (17%), hit or bump (19%), and leg collapse or loss of consciousness (17%). Falls due to slips are rare (5%). Additionally, imbalance occurs most frequently while walking forward (28%), standing quietly (20%), and sitting down or lowering (19%) [83]. After onset of imbalance, attempts to recover balance by stepping are made in less than half (43%) of falls [75]. Accordingly, falls in LTC are caused by a multitude of external and internal perturbations that occur during ADL, and often, do not involve obvious attempts to recover balance.
The diverse nature of the causes and circumstances of falls in LTC illustrates the challenge for prevention. Over the past 30 years, more than 44 randomized control trials (RCTs) examining the effectiveness of interventions to prevent falls have been conducted in LTC [84]. Interventions commonly involve exercise programs to improve strength, coordination and/or balance, vitamin D and calcium supplementation to improve musculoskeletal health by correcting vitamin D deficiencies, medication review to minimize polypharmacy and inappropriate prescription of psychoactive drugs, and multifactorial interventions tailored to the needs of individual residents (e.g., The Bavarian Fracture Prevention Study [85]) [84]. Findings from a recent Cochrane Collaborative Review indicate there is inconsistent and inconclusive evidence of the effects of these interventions on the incidence of falls in LTC, with one notable exception [84]. Daily supplements of vitamins D$_{3}$/D$_{2}$ plus Calcium reduce the rate of falls by 37% among LTC residents with very low to low serum vitamin D levels, but not the number of fallers or serious fall-related injuries, including the number of people sustaining a fracture [84].

1.7.2. Efficacy of Interventions to Reduce the Severity of Falls in LTC

Interventions to minimize the severity of falls have achieved some success in this population, and often involve assistive technologies. Wearable hip protectors and purpose-designed compliant flooring, for example, represent two such strategies.

Classified as a Class 1 medical device in Canada, the U.S. and Europe, wearable hip protectors constitute soft padding or hard shield domes integrated into the pelvic region of specialized underwear or outerwear (Figure 1.2). Early generations of wearable hip protectors tend to utilize hard shields, which form a bridge over the bone to divert impact energy away from the proximal femur and into the surrounding soft tissues [86]. Newer generations tend to utilize soft foam padding to reduce peak forces via a combination of energy shunting and energy absorbing (i.e., spring in series) mechanisms [87]. Whatever the mechanism, both generations are designed to reduce local stiffness and pressure at the contact site, and ultimately, minimize stress (force/area) applied to the proximal femur during landing [88]. For example, a recent laboratory-based study indicates commercially available hip protectors reduce peak axial compressive force at the femoral neck by 2.5–
40% (mean=20.2%) during moderate impact velocities (3 m/s) replicative of sideways falls from standing [88]. Furthermore, Holzer et al. (2009) demonstrated the capacity of specific types of hip protectors to reduce impact forces to the hip below recommended fracture thresholds [89].

Since their first appearance in the early 1990’s, more than a dozen RCTs have evaluated the clinical efficacy of hip protectors to reduce the incidence of hip fractures in LTC [90]. In a recent Cochrane Collaborative Review, the provision of hip protectors to LTC residents was found to reduce risk for hip fracture by about 18% (95% CI 0–33%), without affecting frequency of falls (i.e., they do not cause people to fall more often) [90]. However, long-term adherence in the wearing of hip protectors is generally poor in RCTs (adherence=20-80%), and this prevents hip protectors from achieving their full potential [90]. For example, when hip fracture rates are contrasted between falls with and without hip protectors among only those participants who received hip protectors as a member of the intervention group, the risk of hip fracture is 69–80% lower in falls where a hip is worn compared to falls without hip protectors [91-93]. This illustrates a three-fold increase in the protective ability of hip protectors. Evidently, poor user adherence is a major barrier to the effectiveness of hip protectors.

A related strategy to that of hip protectors involves increasing the compliance of the ground surface to deform under loading, thereby absorbing a portion of the energy imposed on an individual during a fall. Purpose-designed compliant floors, also referred to as dual stiffness safety floors, are designed to be relatively rigid during low impact loading (e.g., walking), but become increasingly pliable during high impact loading (e.g., falls) [94]. Thus, they are stiff enough not to impair balance and mobility during walking [95, 96], and soft enough to cushion the landing of falls [97, 98]. Purpose-designed compliant floors represent a promising strategy for the prevention of fall-related injuries in LTC, as they are a passive intervention that does not require active participation on the behalf of residents or staff, and they provide comprehensive protection that is not location specific (e.g., hip). However, the design and testing of purpose-designed compliant floors is still in its infancy. Preliminary laboratory based studies indicate purpose-designed compliant floors reduce peak axial compressive forces at the head by up to 80% [99] and the hip (femoral neck) by up to 50% [97, 98] during simulated sideways falls from standing.
It is still early to remark on the clinical and cost effectiveness of these floors. Although purpose-designed compliant floors may represent the ‘way forward,’ there are too many unknowns now to advocate for their implementation, and wearable hip protectors represent a more established approach for hip fracture prevention in LTC.

1.7.3. **Efficacy of Interventions to Improve Bone Strength in LTC**

Osteoporosis is a progressive disease characterized by low BMD (T score<2.5) and bone mass, and increased risk for fragility fractures [100-102]. A number of drug therapies are indicated in the treatment of osteoporosis, including bisphosphonates (alendronate, risedronate, zoledronic acid, and ibandronate), PTH analog (PTH 1-34, teriparatide), denosumab, selective estrogen receptor modulators (SERM) such as raloxifene or bazedoxifene, and the combination of calcium and vitamin D [103, 104]. Bisphosphonates, for example, decrease osteoclast differentiation, activity and survival, resulting in decreased bone resorption, increased bone mass and improved bone microarchitecture [105]. In a network meta-analysis, teriparatide, bisphosphonates and denosumab emerged as the most effective drug treatments to reduce risk of fragility fractures in the short-term; however, all the listed drug therapies are beneficial [104]. Among older adults who have osteoporosis or are at risk for developing osteoporosis (osteopenia), bisphosphonates have been shown to reduce risk for hip fracture by 27-42% [103]. Despite the efficacy of bisphosphonates, current estimates suggest that only 30% of LTC residents with a diagnosis of osteoporosis receive bisphosphonate treatment, including 18% of those with at least one documented fall-related injury in the previous year [16].

1.7.4. **Recommendations for Fracture Prevention in LTC**

Osteoporosis Canada released a clinical practice guideline (CPG) describing best practices for the prevention of fractures in LTC, which addressed interventions to prevent falls, decrease the severity of falls, and to reverse bone fragility (Figure 1.3) [106]. For residents at high risk of fracture, the CPG recommended use of dietary interventions (or daily supplements) to meet recommended daily allowances of calcium, daily supplements
of 800-2000 IU vitamin D$_3$, bisphosphonates as first line drug therapies for osteoporosis, and wearable hip protectors [106].

Clearly, the prevention of age-related hip fractures in LTC requires a multifactorial approach, especially in residents who have, or are at risk for developing, osteoporosis. While BMD is a significant determinant of fracture risk, a considerable proportion of age-related hip fractures occur in people without osteoporosis [60, 62]. For example, in a 10-year prospective cohort study of elderly white women living independently, Taylor et al. (2004) reported that roughly 10% of hip fractures occurred in people with normal BMD (>0.821 g/cm$^2$) of the proximal femur at baseline [62]. Again, in a 2-year prospective cohort study of community-dwelling women over the age of 75, about a third (36%) of hip fractures occurred in people who were considered at low risk for hip fracture, based on BMD measurements and absence of other known risk factors [60]. In these individuals with relatively healthy bone, risk factors related to the frequency and severity of falls probably dominate hip fracture risk, and hip protectors may be particularly beneficial.

### 1.8. Adherence with Hip Protectors in LTC

If a hip protector is worn at the time of a fall, an individual's risk of hip fracture is reduced by 69-80% [91-93]. Accordingly, the protective ability of hip protectors is more than equivalent to that of the best pharmaceutical therapies indicated in the treatment of osteoporosis [104]. However, older adults must be willing and able to wear hip protectors on a regular basis to achieve their full potential, and this has proved a challenging task. For example, in a cluster randomized clinical trial examining the effectiveness of hip protectors to prevent hip fractures in older people living in Australian LTC homes, Cameron et al. (2001) reported that just over half (53%) of falls experienced by residents in the intervention group occurred while hip protectors were properly applied, including none of the falls that resulted in hip fracture [107]. Consequently, the risk of hip fracture did not differ between intervention and control groups (hazard ratio=1.46; 95% CI 0.51–4.20) [107]. Subsequent clinical trials have reported rates of adherence below 50%, which has added to the uncertainty surrounding the clinical value of hip protectors (e.g., [108-110]).
In efforts to optimize the efficacy of wearable hip protectors, researchers have begun to examine and address the complex factors that influence user adherence. Van Schoor et al. (2002), for example, conducted a systematic review of the scientific literature published prior to June 2001 examining determinants of adherence [111]. The primary population of interest included people aged 65 or older residing in private dwellings, rest homes and/or LTC. Of the 44 articles included after database searching, acceptance and adherence were primary outcomes of interest in seven and 18 studies, respectively. Acceptance, defined as the percentage of potential users who initially agreed to wear hip protectors, ranged from 37% to 72% (median of 68%) across studies, while adherence ranged from 20% to 92% (median of 56%). However, definitions of adherence varied across studies. For example, adherence was defined as the percentage of users who were adherent at multiple times, the percentage of time hip protectors were worn as directed, and the percentage of falls that occurred while hip protectors were worn [111].

Research into factors governing adherence with hip protectors continues to grow. Between December 2000 and January 2013, database searching identified more than 112 potentially relevant articles examining determinants of adherence with hip protectors [112]. Despite the growing body of literature, no effort has been made to synthesize recent evidence. Knowledge synthesis is critical for the translation of research into clinical practice [113-115]. This is especially true when individual studies report contrary findings, as knowledge syntheses allow decision-makers to interpret findings in the context of global evidence [116, 117]. For example, the literature is divided on the effect of incontinence on adherence. Cryer, Knox and Stevenson (2008) reported that adherence was 13.3% (95% CI 2.0–24.5%, p=0.01) higher among residents who used incontinence pads most days [118], while Zimmerman et al. (2010) reported that adherence was 5.94% (95% CI 1.82–10.06, p<0.01) lower among residents who were always incontinent of the bowel [119]. After synthesizing all available evidence, it appears that adherence is affected more by the frequency of incontinence episodes, rather than the wearing of incontinence materials in and of itself [112]. Clearly, our understanding of the factors governing adherence to hip protectors in LTC would benefit via efforts to systematically review and synthesize recent evidence.
1.9. The Social Ecological Model as a Framework of Determinants of Adherence with Hip Protectors in LTC

The social ecological model (SEM) of health theorizes that an individual’s behaviour is shaped by factors at different levels, ranging from the intrapersonal to public policy [120]. Determinants of adherence span each level of the SEM [112]. However, as hip protectors come in many shapes (e.g., horse shoe, oval), sizes and materials (e.g., foam, polypropylene) and have different biomechanical properties [88], factors related to the design, performance and cost of hip protectors also impact adherence [112].

1.9.1. Aspects of the Design of Hip Protectors

Users of soft shell hip protectors are generally more adherent than users of hard shell hip protectors, especially during the night [121, 122]. For example, in a cluster RCT, Bentzen et al. (2008) compared adherence between sites (n=9) provided with four pairs of soft shell hip protectors free of charge per resident, and sites (n=9) provided with four pairs of hard shield hip protectors free of charge per resident. Bentzen et al. (2008) reported that the risk of terminating use of hip protectors was 1.38 (95% CI 1.002–1.902, p=0.048) times greater in sites providing hard shield hip protectors compared to sites offering soft shell hip protectors after 12 months [122].

Issues related to discomfort and side effects, as well as the style and usability of hip protectors represent common barriers to adherence [107, 119, 122-136]. Cameron et al. (2011), for example, reported a positive correlation (Spearman’s rho=0.357, p<0.01) between comfort and adherence after six months of follow-up [126]. Additionally, Hubacher and Wettstein (2001) reported that 39% of residents who stopped use were dissatisfied with their appearance while wearing hip protectors, compared to 13% of residents who continued to use them for the 10-month duration of the study (Mann–Whitney U-test, p<0.001) [132].

The expense of hip protectors was also perceived as a barrier to adherence, especially among pensioners [134, 128]. For example, in a cross-sectional survey of nursing staff, Sawka et al. (2007) reported that 23–31% of respondents from three LTC facilities, identified expense as the most important barrier to adherence with hip protectors.
Likewise, a central theme of the qualitative study by Tavener-Smith and De Vet (2006) was that hip protectors are not affordable, illustrated nicely by the quote from a 92-year old resident: “Too expensive for people on the pension, but I knew I had to do it out of the pension” (p.216) [128]. In Canada, a single pair of hip protectors costs between $70–$120 CAD [112].

1.9.2. Intrapersonal Factors

The focus of most research so far has been to identify personal factors that influence adherence in LTC. Females appear to be more likely to accept the initial offer of hip protectors [125, 130-132, 137], while evidence regarding the effect of gender on adherence is mixed [124, 126, 130, 131, 137]. The literature is also divided on the relationship of age to acceptance [125, 130, 131], but older age is observed to facilitate adherence [138]. Other commonly reported facilitators of adherence include a diagnosis of osteoporosis [119, 130, 138,], a strong fear of falling [125, 139], a high risk of falling [129, 130, 132, 140, 141], and a history of falls and/or fall-related injuries [118, 119, 125, 130, 138, 141].

Intrapersonal factors that associate negatively with adherence include depressive symptoms and fatalistic life perspectives [119, 127, 128, 138], acute illness or deterioration of health [129, 141, 142], frequent incontinence [119, 126, 128, 130, 133, 136, 139, 140], and very low care needs [130, 137, 141]. Adherence also appears to be poorer among residents with non-white race/ethnicity, migration backgrounds, and/or welfare assistance [119, 137]. For example, Klenk et al. (2011) reported that elderly residents from 48 LTC homes in Germany were less likely to be offered hip protectors if they had very low care needs (OR= 0.32, 95% CI 0.18–0.56), had a migration background (OR=0.30, 95% CI 0.09–0.99), or were receiving welfare aid (OR=0.60, 95% CI 0.44–0.81) [137].

1.9.3. Interpersonal Factors

Adherence is facilitated when family and peers advocate for hip protectors [127, 128, 138, 141], and when care providers are committed to the technology and believe in its effectiveness [107, 118, 119, 123, 125, 128, 129, 131, 132, 134, 135, 138-140, 142,
For example, a central theme of the qualitative study by Tavener-Smith and De Vet (2006) was that caregiver support is vital, illustrated nicely by the quote from an 83-year-old lady: “. . . it sort of just fizzled out . . . at first I wore them, but gradually no one mentioned them and they were left in the cupboard. The staff did not encourage me to wear them” (p.216) [128]. The first quantitative evidence of a relationship between care provider commitment to hip protectors and adherence was provided by Zimmerman et al. (2010). A one-unit increase in the commitment of registered nurses to hip protectors, scored on a 4-point Likert scale by research personnel, was associated with a 3.05% (95% CI 0.83–5.27%, p<0.01) increase in adherence, defined as the percentage of visits residents were observed by research personnel to be wearing hip protectors [119]. However, no definition of commitment was provided, the criteria in which research personnel evaluated commitment is unclear, and the authors did not report information related to the validity or reliability (intra-rater and inter-rater) of their measurements. In fact, no valid and reliable methods currently exist to measure care provider commitment to hip protectors in LTC, which limits the credibility (risk of bias) of existing evidence.

1.9.4. Organizational Factors

At the organizational level, adherence appears to be facilitated when homes enlist a champion (i.e., person, department) to assume accountability for the implementation of a hip protector program [129, 131, 142]. Additional characteristics of LTC facilities that are linked with improved adherence include enthusiastic, clear and effective leadership [124, 139, 142], non-profit status and no chain affiliation [119], greater attendance of non-professional staff at in-service training sessions [119], and fewer wearers of hip protectors within the home [119, 131]. For example, in the HIP PRO study, a RCT conducted in 35 LTC homes within the USA, facilities with non-profit proprietary status had, on average, 5.67% (95% CI 2.59–8.71, p<0.01) greater adherence than facilities with for-profit proprietary status [119].

Organizational factors that have been shown to negatively influence adherence are laundering issues resulting in limited availability of clean hip protectors, especially over the weekends [126, 129], turnover of nursing and managerial staff [124, 126], small facilities (24–68 beds) [119, 131], poor communication [126, 142], and a greater proportion
of welfare recipients [119]. For example, in the HIP PRO study, a one unit increase in the percentage of residents on Medicaid associated with a 0.10% (95% CI 0.04–0.16%, p<0.01) decrease in adherence, defined as the percentage of visits residents were observed by research personnel to be wearing hip protectors [119].

### 1.9.5. Community Factors

A lack of external support or positive reinforcement for the use of hip protector from community stakeholders, such as physicians and regulatory bodies, was identified as a barrier of adherence in LTC [121, 134, 142]. For example, in a cross-sectional survey of nursing staff, Sawka et al. (2007) reported that 32 and 41% of respondents from two LTC facilities, respectively, identified lack of physician prescription as the most important barrier to adherence with hip protectors [134].

### 1.9.6. Public Policy

The provision of hip protectors at no cost facilitates adherence [126, 144]. For example, in a cluster designed RCT, Meyer et al. (2003) compared adherence between sites (n=24) offering usual care (control), and sites (n=25) providing structured education to staff along with three pairs of free hip protectors per eligible resident (those with a high risk of falling). Meyer et al. (2003) observed a mean difference in adherence of 53% (95% CI 38–67%, p<0.001), and a difference in the absolute risk of hip fractures of 3.5% (95% CI -0.3–7.3%, p=0.072), between intervention and control homes after 14 months [144]. Again, in a cluster designed RCT, Cameron et al. (2011) compared adherence between clusters offering a brochure about hip protectors (control), clusters providing three pairs of hard shield hip protectors free of charge per eligible resident (no cost intervention), and clusters providing structured education to staff along with three pairs of hip protectors free of charge per eligible resident (combined intervention). After six months, 21% and 6.5% of falls by residents in the no cost intervention group and combined intervention group were protected with hip protectors, respectively, while no residents from the control group purchased a single pair of hip protectors [126].
1.10. Care Provider Commitment to Hip Protectors

Although the delivery and utilization of hip protectors among older people living LTC is governed by factors at various social ecological levels, care providers appear to play a central role in shaping both acceptance and adherence. Among others, their responsibilities include identifying residents who are likely to benefit from and tolerate hip protectors, assessing the feasibility of hip protectors, especially for residents with incontinence, cognitive impairment and physical disabilities, educating residents about the usefulness of hip protectors, checking for discomfort and side effects, recognizing and implementing solutions to problems that might interfere with adherence, and continuously reassessing for eligibility [133]. The attitudes of care providers towards hip protectors are believed to affect their intention to engage in these behaviors, which may subsequently affect levels of reported adherence in the wearing of hip protectors (e.g., theory of reasoned action) [145]. To illustrate this, Cryer, Knox and Stevenson (2008) observed a positive association between the number of fractured femurs in the home over the past four years and levels of reported daytime adherence ($\beta=6.5\%$, 95% CI -0.8–13.9, p=0.03). The authors concluded that a previous fractured hip in the home might have modified the attitudes of staff, making them more likely to support and encourage the use of hip protectors, and ultimately, resulting in increased levels of reported adherence [118].

Staff commitment to hip protectors is frequently cited as a facilitator of adherence [112]. But, what exactly does it mean to be committed to hip protectors? The only study to operationalize staff commitment towards hip protectors failed to provide a definition [119]. In the global context, commitment has been studied most extensively in the fields of organizational psychology and human resource management. For example, researchers have conceptualized commitment to many workplace foci, including work organizations (e.g., [146, 147]), work teams and leaders (e.g., [148, 149]), occupations and professions (e.g., [150]), organizational change (e.g., [151]) and technological change (e.g., [152]). Although few theories of organizational commitment (e.g., Three Component Model; TCM [153]) conceptualize commitment as a motivational state, it is widely agreed that commitment describes an attitudinal phenomenon [146, 154, 155]. When conceptualized as an attitude, commitment can be reflected by three components: affective, behavioural and cognitive (e.g., ABC model of attitudes) [156]. The affective component reflects an
individual’s feelings and emotions towards the target of the attitude, the behavioural component reflects an individual’s behavioural response elicited by the target of the attitude, and the cognitive component reflects an individual’s knowledge and beliefs towards the target of the attitude [156]. Accordingly, in this thesis, commitment to hip protectors is defined as a care provider’s attachment to and behavioural intentions towards hip protectors, reflected by: (i) a belief in the value of hip protectors (affective commitment), (ii) acceptance of the clinical efficacy of hip protectors (cognitive commitment), and (iii) a willingness to act or modify their behaviour to generally encourage and support the use of hip protectors (behavioural commitment).

To optimize the commitment of care providers in LTC to encourage and support the use of hip protectors among elderly residents, there is a pressing need to identify determinants of staff commitment. Yet, no studies have been undertaken to identify antecedents of commitment amongst paid care providers in LTC. Like adherence, staff commitment should be governed by factors at many different social ecological levels [120]. For example, diffusion of innovation (DOI) theory argues that attitudes towards innovations are influenced by aspects of the technology, personal traits, communication channels, and the social context (organization, community, public policy) [157, 158]. As such, when developing a framework of potential antecedents of staff commitment towards hip protectors in LTC, factors from many different social ecological levels need to be considered.

1.11. Socioeconomic Status

In efforts to optimize the clinical efficacy of hip protectors, many studies have examined and addressed the complex factors influencing user adherence. However, studies have mostly been conducted in artificial scenarios where hip protectors were supplied to residents at no expense [137]. In Canada, a single pair of hip protectors cost between $70 and $120 CAD, and only a few private insurance companies offer reimbursement for the cost of hip protectors. Accordingly, there is a pressing need to identify factors governing acceptance of and adherence to hip protectors in real-world situations.
Individual socioeconomic status (SES) appears to be an important predictor of acceptance of hip protectors [137, 119]. For example, Klenk et al. (2011) reported that elderly residents in German LTC homes were 40% (95% CI 19–56%) less likely to be offered hip protectors if they were receiving welfare [137]. Likewise, Zimmerman et al. (2010) observed a negative association between the percentage of residents on Medicaid and levels of adherence (β=-0.17, SE=0.02) [119]. Although the importance of individual SES has been established, it is unclear whether regional SES affects levels of reported adherence in the wearing of hip protectors. This knowledge would identify whether socioeconomic inequalities exist in the delivery and utilization of hip protectors across geographic regions, and can be used to inform public health interventions to improve adherence for a mass of residents (as opposed to individually tailored interventions). Furthermore, comparing differences in barriers to acceptance of hip protectors between geographic regions of high and low SES may provide insights into the mechanisms by which regional SES affects acceptance, which may subsequently inform strategies to enhance acceptance.

1.12. Aims and Objectives

The overall aims of this thesis are to provide updated knowledge of perceived barriers and facilitators to initial acceptance and continued adherence with hip protectors in LTC, and to provide evidence-based strategies to improve these outcomes.

There is a lack of up-to-date, synthesized evidence on barriers and facilitators to adherence with hip protectors in LTC. Therefore, by way of a systematic review adopting a narrative synthesis approach, the objective of Chapter 2 is to synthesize available evidence on barriers and facilitators to initial acceptance and continued adherence in LTC.

Understanding of the nature of care provider commitment to hip protectors in LTC, along with how it develops and how it ultimately influences adherence, is constrained by the absence of a psychometrically valid assessment tool. Therefore, by means of a cross-sectional survey in thirteen LTC facilities recruited from a single regional district in British Columbia (BC), Canada, the objective of Chapter 3 is to develop a valid and reliable tool to measure commitment to hip protectors amongst paid care providers in LTC.
To optimize the commitment of care providers in LTC to encourage and support the use of hip protectors, there is a pressing need to identify the factors that influence commitment. Therefore, by means of a cross-sectional survey in thirteen LTC facilities recruited from a single regional district in BC, Canada, the objective of Chapter 4 is to identify personal traits, aspects of the technology, and organizational characteristics that are associated with commitment to hip protectors amongst paid care providers in LTC.

It is important to identify barriers and facilitators to adherence with hip protectors in a real-life setting, where hip protectors are not provided free of charge to residents as part of a clinical trial. Therefore, by means of a 12-month retrospective cohort study in fourteen LTC facilities recruited from a single regional district in BC, Canada, the objectives of Chapter 5 are: (i) to identify determinants of adherence with hip protectors in LTC; (ii) to compare levels of adherence and barriers to acceptance of hip protectors (as perceived by care providers) between LTC homes from regions of high and low socioeconomic status; and (iii) to offer additional insight into the clinical value of hip protectors, by comparing rates of hip, pelvic and other fractures between falls that occurred with hip protectors and falls that occurred without hip protectors.
1.13. References


1.14. Figures

Figure 1.1 Radiographs of (A) a left displaced femoral neck fracture, (B) a left displaced intertrochanteric fracture, (C) a left femoral neck fracture treated with hemiarthroplasty, and (D) a left basicervical fracture treated with internal fixation (gamma nail).

All images are used with consent from individuals.
Figure 1.2  An illustration of a hip protector, consisting of specialized garments with soft pads or hard shield domes embedded in pockets covering the greater trochanters.
Figure 1.3  Current best practices for fracture prevention in long-term care
(Reprinted from Papaioannou et al., Recommendations for preventing fracture in long-term care, Figure 1: Fracture prevention for residents of long-term care facilities, Canadian Medical Association Journal 2015, 187(15):1135-44. © Canadian Medical Association 2015. This work is protected by copyright and the making of this copy was with the permission of the Canadian Medical Association Journal (www.cmaj.ca) and Access Copyright. Any alteration of its content or further copying in any form whatsoever is strictly prohibited unless otherwise permitted by law).

CrCl = creatine clearance, IU = international units, IV = intravenous.
Chapter 2. Facilitators of and Barriers to Hip Protector Acceptance and Adherence in Long-Term Care Facilities: A Systematic Review


2.1. Introduction

About one in three older persons living in their own homes, and one in two residents living in long-term care (LTC) experience at least one fall each year [1-4]. Although a small percentage of falls (i.e., 11% [5]) in LTC result in serious injury, falls persist as the leading category of injuries and injury-related deaths among Canadians over the age of 65 [6]. One of the most debilitating injuries caused by falls are hip fractures, often bringing excess mortality [7,8], declines in functional independence [8,9], diminished quality of life [10], and psychological distress [11-13] (e.g., delirium, depression, anxiety, and fear). In Canada, roughly 28,000 Canadians seniors are hospitalized for hip fractures each year, costing more than $1 billion in direct treatment costs [14,15]. The global incidence of hip fracture surpasses 1.7 million, and with baby boomers nearing old age, is projected to reach 3.94 million by 2025, and 6.26 million by 2050 [16-18] (even though age-adjusted rates are plateauing [19]). Because of their profound frailty and tendency to fall more frequently and severely (from a loss of effective protective responses), institutionalized older adults are up to 10.5 times more likely to break their hip during a fall than their community dwelling counterparts [20,21].

While the integrity of bone is crucial, the majority of hip fractures in older adults involve a sideways landed fall [14], with risk for hip fracture increasing 32-fold if direct impact occurs to the greater trochanter (GT) [22]. Accordingly, hip protectors have been promoted as a cost-effective and relatively immediate approach for prevention in the high-risk LTC environment [23-27], consisting of soft or hard shell pads embedded in specialized outer- or under-garments [28], which utilize both energy cushioning and
energy shunting mechanisms to mitigate the risk of hip fracture during falls [29-35]. According to laboratory-based studies, hip protectors reduce peak impact forces to the hip by up to 40% during simulated sideways falls from standing [33-37].

Although findings are more optimistic for institutionalized than community-dwelling older adults, intention to treat type meta-analyses have yielded conflicting results regarding the clinical value of hip protectors [38-40]. This is mostly explained by limited user adherence in the wearing of these devices, resulting in a large number of falls (and subsequently, hip fractures) occurring without any hip protection [38-40]. However, when comparisons are drawn from analyses of protected vs unprotected falls, the relative risk of hip fracture is reduced between 69% and 80% when a hip protector is in place at the time of a fall [41-43]. Thus, despite the observation of good biomechanical efficacy (more than equivalent to the best osteoporosis pharmaceutical treatments [44]), poor adherence causes the intervention to appear ineffective. Still, there remains some controversy about the effectiveness of hip protectors even when compliance is good, mainly because of methodological flaws in design of clinical studies, and lack of performance regulations assuring the quality of available models for testing. For example, a randomized controlled trial by Kiel et al. (2007) conducted in US nursing homes found no evidence of a protective effect of an energy-absorbing/shunting hip protector on the risk of hip fracture, despite good adherence to protocol [45]. However, the hip protector pad utilized in this trial (FallGard) has been shown to have very poor biomechanical performance in a recent laboratory-based study, attenuating only 2.9% and 12.4% of peak forces to the proximal femur at impact velocities of 2 m/s and 3 m/s, respectively [34].

Motivated by the potential benefits of this intervention, many studies have been published to examine the complex factors that influence initial acceptance and continued adherence in the wearing of hip protectors. In 2002, van Schoor et al. lead a systematic review of factors that influence acceptance of hip protectors, and adherence with guidelines concerning their use [46]. However, the review did not attempt to distinguish determinants of adherence between community dwelling older adults and residents of LTC. As more LTC residents compared with community-living seniors struggle to manage multiple comorbidities and frailty [47, 48], adherence in LTC should be determined less so by factors related to the individual user, and more so by caregiver and system-related
factors. Furthermore, many studies have been conducted since publication of the initial review, with some producing contrary findings on the nature of barriers and facilitators in LTC. Therefore, the objective of this study is to synthesize available research to update our knowledge of perceived barriers and facilitators to initial acceptance and continued adherence in LTC, and to provide evidence-based strategies to improve these outcomes.

2.2. Methods

The intention of this systematic review was to identify articles encompassing a wide spectrum of evidence on barriers and facilitators to hip protector acceptance and adherence in LTC, drawing upon published literature inclusive of qualitative, quantitative, and mixed methods research articles.

Terms for electronic database searching were first developed for OVID Medline and were adapted to suit the requirements of the other citation databases (CINAHL, Ageline, Cochrane Database Sys Rev, Proquest). OVID Medline Medical Subject Headings included hip fractures; hip injuries; accidental falls; protective devices; and humans. Free-text search terms for Medline titles and abstracts included hip and protect*. Keyword search terms for other databases included: hip*, joint, injur*, protect*, pad*, fracture*, fall*, accidental, equipment, pad, and devices (*all variations of the keyword). Search results were restricted to English language articles published between January 2000 and December 2013. This time frame was selected for 2 reasons: (i) the previous systematic review by van Schoor and others (2002) included studies published up to June 2001 [46], and (ii) because of the evolution of hip protector technologies, older models available prior to 2000 might not be reflective of new trends in hip protector design. A supplemental search was performed by cross-referencing selected studies, contacting experts in the field for additional references, and reviewing the references of systematic reviews. The search for literature on evidence of barriers and facilitators to hip protector compliance in LTC facilities was part of a larger search that included studies in community and hospital settings. It was only in the final stage of data extraction that LTC studies were extracted. The term LTC is used to describe facilities for older adults where personal and nursing care is provided on a 24-hour basis (e.g., nursing homes, residential care facilities).
Studies were included if they focused specifically on hip protectors as an intervention, or in which hip protectors were included as part of a multifactorial intervention or subgroup analysis. The samples of interest were adults of 65 years or older living in LTC facilities, family caregivers, and/or health care providers. For inclusion, the article must have presented findings related to hip protector acceptance and/or adherence, even though the primary purpose of the study may have been hip protector effectiveness.

A team of falls prevention researchers and LTC clinicians screened all abstracts for inclusion. Full text documents were obtained for those that met the inclusion criteria. Two independent members of the research team were then randomly selected to review each article. In the event of a disagreement, a third member of the research team was called upon to resolve the discrepancy.

To accommodate a diversity of reports, we adopted the narrative synthesis method described by Popay et al. [49], whereby reports were analyzed using tabulation and vote counting based on the following key data abstraction components: methodological approach, level of evidence, sample characteristics, hip protector characteristics, measurement of acceptance and adherence, and facilitators and barriers.

As the objectives of this synthesis are primarily to describe, classify, and explore relationships between studies rather than to conduct a meta-analysis of effects, assessments of risk of bias and other study quality appraisal techniques were not undertaken. However, to account for susceptibility to bias, each study was assigned a level of evidence (i.e., I, II, III, IV) and a strength of recommendation (i.e., A, B, C, D) using guidelines described in Shekelle, Woolf, Eccles, and Grimshaw (Figure 2.1) [50]. Accordingly, barriers and facilitators derived from randomized controlled trial (I, A/B) were considered least susceptible to bias, whereas those from expert opinion (IV, D) were considered most susceptible to bias. The second stage of the synthesis involved an exploration of relationships between and within studies. If discrepancies existed in the nature of barriers and facilitators across studies, the highest level of evidence and/or strongest recommendation was used to discern the direction of relationships between factors and measures of acceptance or adherence.
2.3. Results

A total of 1086 potential articles were identified. Of those, 112 appeared potentially relevant and a hard copy was obtained for screening. After full text reviews, 28 publications of studies specific to LTC settings met the inclusion criteria and were included in this review (Figure 2.2). The most important characteristics of these studies are presented in Table 2.1. Seven studies took place in the United Kingdom [51-57], Kingdom, four each in Australia [41,58-60] and the United States [61-64], three each in Norway [65-67] and Germany [68-70], two in Ireland [71,72], and one each in Switzerland [73], Belgium [74], Canada [75], The Netherlands [76], and Hong Kong [77]. Research designs for the 28 studies included quantitative methods (n=22), qualitative methods (n=2), and mixed methods (n=4). In three of the 22 quantitative studies, and one of the mixed methods studies, the main outcome was hip protector effectiveness, with acceptance and adherence reported as secondary outcomes [59, 68, 71, 78]. For these studies, the level of evidence reported only refers to the design for the compliance portion of the study. Six studies are supported by level I evidence on factors related to HP compliance, two by level II, 18 by level III, and two by level IV (Table 2.1).

Findings showed considerable variability on how often hip protectors were worn and how compliance was measured among the studies (Table 2.2). Data on both acceptance and adherence was provided in 12 studies, while information on acceptance only and adherence only was provided in one and 11 studies, respectively. For the remaining four studies, measures of compliance were not applicable as they explored staff opinions on hip protector design and usage [53, 54, 62] and staff exposure to hip protectors [75]. Of the 13 studies reporting on acceptance, rates ranged from 32% [64] to 85% [74] with a median acceptance of 48% [58]. Of the 23 studies reporting on adherence, rates ranged from 3% at nighttime [51, 52] to 93% [61]. However, clear comparisons cannot be drawn across studies because of the wide variety of definitions and methods used to report and measure adherence, as well differences in the amount of time from initial exposure to follow-up (14 days to 18 months).

Data extraction from the 28 studies revealed that factors influencing hip protector acceptance and adherence span different levels of the social ecological model. Guided by
previous studies, we sorted factors into four major thematic groups: (1) system-related, (2) caregiver-related, (3) resident-related, and (4) hip protector-related. Determinants of acceptance and adherence for each of these levels are summarized in Tables 2.3–2.6, respectively. Furthermore, a description of select barriers and facilitators follows which, based on frequency of reporting, robustness of study design, or clinical relevance were believed to be deserving of greater attention.

2.3.1. System Level Characteristics

2.3.1.1 Facilitators

2.3.1.1.1 Institutional Commitment

In five of the studies, institutional commitment to hip protector use was linked with acceptance and/or adherence [55, 67, 69, 71, 78]. Although there was no shared definition of facility commitment, Zimmerman et al. (2010) operationalized it as “whether or not mechanisms were in place to ensure adherence such as consequences for lack of use, staff commitment to protector use, quality of interaction between research and facility staff, the general working environment, and quality of care” (p 108) [64]. Some indicators of facility commitment included whether a champion (i.e., team or person) existed within the home to assume accountability for measuring compliance and for attending to general issues, such as ordering, storing, and marking hip protectors [53, 61, 67], and clear and effective leadership of the senior manager [53, 55, 69]. For example, the importance of a champion is best demonstrated in the 13-month prospective study by Burl et al (2003), where facilities enlisted a rehabilitation department to champion the program and average adherence remained at or above 90% between the third and thirteenth month of observation [61].

2.3.1.1.2 Education & Provision of Hip Protectors at No Cost

Two randomized control trials examined the efficacy of structured education to enhance compliance [58, 68]. Meyer et al. (2003) compared adherence between homes proving usual care (control), and those offering education for staff along with the provision
of hip protectors at no cost (three pairs per resident). After adjusting for cluster randomization, the authors reported a mean difference in adherence of 53% [95% confidence interval (CI) 38–67%; p<0.001], and a reduction in hip fractures of approximately 40%, between intervention and control homes at 14 months [68]. The second allocated homes to control, no cost intervention, or combined intervention (education and no cost) groups. After 6 months, no difference was observed in mean adherence between the two intervention groups (25% in the no cost group and 24% in the combined group), while none receiving usual care purchased hip protectors at any point. However, the authors advised caution when interpreting these results, as overall attendance in educational sessions was low, and sessions were often cut short to accommodate nursing staff availability [58].

2.3.1.1.3 Support from External Sources

In three studies, ongoing support from external agencies, such as general practitioners and quality and safety boards, emerged as a system-related incentive for acceptance and/or adherence [53, 62, 75]. In the qualitative study by Davies et al. (2004), positive reinforcement by external agencies was linked to positive staff attitudes regarding the use of hip protectors [53]. Furthermore, efforts to encourage use were often much less likely to be resisted when physicians prescribed or recommended hip protectors [62, 75].

2.3.1.2 Barriers

2.3.1.2.1 Laundering

Issues surrounding the laundering of hip protectors were identified as system-related barriers to adherence in two studies [58, 61]. For example, Burl et al. (2003) observed that clean hip protectors were not always available when needed (especially over weekends) and that residents with incontinence were particularly affected, as their garments required frequent laundering [61].
2.3.1.2.2 High Turnover and/or Insufficient Staffing

High turnover of nursing or managerial staff [53, 55, 58] and workforce shortages resulting in excessive workload [53, 64, 76] have been linked to lower levels of adherence. For example, in the observational study by O’Halloran et al. (2007), greater adherence was associated with fewer changes in senior manager during the study period [odds ratio (OR)=2.93, 95% CI 1.01–8.51] [55]. In addition, Zimmerman et al (2010) observed a negative association between the number of eligible residents owning hip protectors and adherence (estimated coefficient=-0.47, p<0.01), which they felt may have been due to shortages of staff, as there was not enough time to dress all residents in hip protectors [64].

2.3.1.2.3 Communication Breakdown at the Frontline

Communication breakdown at the frontline was also identified as a potential system-related barrier to adherence [53, 58]. For example, Davies et al. (2004) observed that in homes where hip protectors were being used effectively, decisions about the need for protection were usually clearly documented in care plans, and health care assistants were aware of and understood the benefits of hip protectors. However, in a few homes where hip protectors were not being used effectively, health care assistants had been told to use hip protectors with certain residents, but they were not informed why hip protectors should be used [53].

2.3.2. Care Provider Level Characteristics

2.3.2.1 Facilitators

2.3.2.1.1 Belief in the Effectiveness of Hip Protectors

Adherence was enhanced when caregivers were convinced of the ability of hip protectors to reduce risk for injury from falls [52, 53, 57, 63], and diminished when caregivers were conflicted about their effectiveness [53, 54, 67, 75, 78]. Davies et al. (2004) concluded that residents were more likely to wear hip protectors when caregivers
understood the value of their use [53]. According to Sawka et al. (2007), care providers frequently cited (33.3%) lack of evidence of benefit in LTC populations as a major barrier to adherence [75]. In addition, Davies et al. (2004) reported that some staff members felt no obligation to use hip protectors when they were unconvinced of their efficacy to prevent hip fractures [53].

2.3.2.1.2 Care Provider Commitment to Hip Protectors

In 13 studies, investigators acknowledged the importance of the commitment of care providers to encourage and support the use of hip protectors in determining acceptance and adherence [51, 52, 54, 56, 57, 60, 61, 63, 64, 67, 69, 73, 76]. For example, in the comparative study by Zimmerman et al. (2010), a one unit increase in the commitment of registered nurses to hip protector use (scored from 0 to 4) was associated with a 3.1% (95% CI: 0.8–5.3) increase in adherence (p<0.01) [64]. No others attempted to quantify the strength of this relationship.

2.3.2.2 Barriers

2.3.2.2.1 Negative Perceptions of Hip Protectors

Lack of acceptability often arose from concerns about hygiene [59, 62], cost-effectiveness [62], maintaining the dignity of residents [54, 59], the development of unwanted side effects (e.g., skin irritation) [54, 56], and most often, the amount of effort required when helping residents to don and doff hip protectors [53, 58-60, 74]. In one study, night shift respondents were more likely to rate a hip protector policy as time-consuming (50% vs 13.7%; p=0.021) and stressful (75% vs 24.1%; p=0.006) compared with day-time caregivers, even though nearly all (97.3%) considered a hip protector policy in LTC as feasible [74].
2.3.2.2.2 Perceived Clash with Residents’ Rights to Individual Choice and Autonomy

According to one study, adherence was sometimes compromised when caregivers experienced difficulty understanding a residents’ decision to wear hip protectors. Often, caregivers had to interpret consent through behavioral signs, such as a lack of protest. In some situations, care providers made the decision not to offer and/or apply hip protectors because they perceived they would have been forcing residents to wear the garment against their will and were dedicated to maintaining the autonomy of residents [54].

2.3.3. Resident Level Characteristics

2.3.3.1 Facilitators

2.3.3.1.1 Clinical Risk Factors for Falls and Fragility Fractures

Clinical risk factors for falls and fragility fractures that emerged as important facilitators of acceptance and/or adherence included a history of falls and fall-related injuries [52, 57, 63-65, 72], a high risk for falling [56, 61, 65, 72, 73], and a diagnosis of osteoporosis [63-65]. For example, in the comparative study by Hubacher and Wettstein (2001), the probability of accepting hip protectors increased with the number of existing fall risk factors (2 risk factors: OR=1.47, 95% CI 0.83–2.60; 3 or more risk factors: OR=2.02, 95% CI 1.10–3.71) [73]. Also, in O’Halloran et al. (2005), estimated differences in mean percentage daytime use between residents with and without a history of falls, and with and without a history of fall-related injuries in the past year, were 18.0% (95% CI: 2.9–33.2; p=0.02) and 19.2% (95% CI 4.2–34.2; p=0.012), respectively [72].

2.3.3.1.2 Recognition of the Need for Hip Protection

It was important that residents recognized their vulnerability for falls and injuries, and subsequent need for hip protection. For example, in two studies, a strong fear of falling was found to facilitate acceptance [57] and adherence [69]. Cryer, Knox, and Stevenson (2006) observed greater odds of acceptance among residents who had stopped at least three activities because of fear of falling (OR=9.21; 95% CI 2.31–36.71; p<0.001) [57].
and although only marginally significant, Warnke et al. (2004) found that residents who had a strong fear of falling were at slightly lower risk of falling without hip protection that those without a strong fear [hazard ratio (HR)=0.78; 95% CI 0.60–1.02; p=0.065] [69]. Furthermore, a poor understanding of fracture risk was negatively associated with acceptance in another study [59]. Here, Chan et al. (2000) noted that some residents felt that they were presently safe from injury and were in no need of hip protection, as they had already experienced one fractured hip, and considered it unlikely they would experience another. Further, one resident explained that her first fracture was pathologic, and, therefore, felt hip protectors would afford her no extra protection [59].

2.3.3.1.3 Belief in the Effectiveness of Hip Protectors

Belief in the benefits associated with hip protector use was also linked with acceptance and adherence in three studies [54, 73, 74]. For example, in the comparative study by Hubacher and Wettstein (2001), 60% of wearers considered hip protectors to be useful compared with 10% of non-wearers (p<0.001) [73].

2.3.3.1.4 Peer and Family Advocacy

In four studies, differences in acceptance and adherence were linked with peer and family advocacy [59, 60, 63, 72]. In the 6-week observational study by Honkanen et al. (2007), residents with occasional visits from family, as opposed to frequent visits, were less likely to have used hip protectors or to have indicated intended future use (OR=0.01; 95% CI 0.00–0.09; p<0.001) [63]. Furthermore, in the qualitative study by Tavener-Smith and De Vet (2006), full adherence (reported as wearing hip protectors for 24 hours of the day, except when bathing) was only achieved among those individuals with family members who were committed to monitoring and encouraging their use, and who could assist with the purchase cost [60].

2.3.3.1.5 Wearing of Incontinence Materials

Literature on the relationship between incontinence and compliance was conflicting, but in three studies [52, 57, 76], the wearing of incontinence materials was
related to increased levels of acceptance and/or adherence. In Cryer, Knox, and Stevenson (2008), residents who used incontinence pads most days had 13.3% (95% CI 2.0–24.5; p=0.01) higher adherence than those who did not [52].

### 2.3.3.1.6 Physical and Cognitive Disability

Indicators of physical and cognitive disability that emerged as facilitators of acceptance and/or adherence included dementia [64, 74], memory impairment [56, 65], restricted mobility [57, 64, 65, 73] (with the exception of wheelchair use [64, 73]), and the need for moderate assistance with activities of daily living (ADL) [55, 58, 60, 63, 65, 67, 70, 72, 74, 76]. For example, Bentzen et al (2008) observed greater odds of acceptance among residents who needed some help dressing than in those who were completely independent (OR=1.56; 95% CI 1.08–2.26; p=0.043). In addition, those with very high (HR=0.41; 95% CI 0.21–0.78; p=0.007) and high (HR=0.44; 95% CI 0.29–0.69; p<0.001) disability had lower risk of terminating the use of hip protectors than residents with low disability [65]. Furthermore, in the randomized controlled trial by O’Halloran et al. (2005), the estimated difference in mean percentage day-time use between individuals with high (Barthel scores of 0–12) and low (Barthel scores of 13–20) levels of disability was 30.3% (95% CI 15.8–44.8; p<0.001) [72].

### 2.3.3.2 Barriers

#### 2.3.3.2.1 Social or Economic Disadvantages

Differences in adherence were also linked with social or economic disadvantages in two studies, including non-white racial origins, migration backgrounds, and the receipt of welfare assistance [64, 70]. Klenk et al. (2011) observed lower availability of hip protectors for residents with migration backgrounds (OR=0.30; 95% CI 0.09–0.99), and among those who were in receipt of welfare assistance (OR=0.60; 95% CI 0.44–0.81) [70]. Furthermore, in the comparative study by Zimmerman et al. (2010), residents who were non-white had, on average, 8.76% [standard error (SE)=1.92%] lower adherence (p<0.01) [64] than Caucasian residents.
2.3.3.2.2 Fatalism and Depression

In four studies, a fatalistic view of end of life, depression, or other mood symptoms associated negatively with acceptance and/or adherence [59, 60, 63, 64]. For example, in one, the consistent display of depressed, sad, or anxious mood indicators related to a 6.90% (SE=2.17) reduction in adherence (p<0.01) [64]. Similarly, Honkanen et al (2007) observed that anxious (OR=0.15; 95% CI 0.04–0.50; p=0.02) or resistive (OR=0.43; 95% CI 0.21–0.85; p<0.001) behaviors negatively predicted adherence in a multivariate analysis of variables affecting hours of hip protector use [63]. Finally, in the mixed methods study by Chan et al (2000), one resident stated that she would not wear hip protectors because she was nearing the end of her life, and was therefore, “too old to care” [59].

2.3.3.2.3 Frequent Incontinence

Again, the relationship between incontinence and compliance appeared to be mediated by the frequency of incontinent episodes, whereby persistent urinary or bowel incontinence were identified as potential barriers to acceptance and adherence [56, 58, 60, 64, 65, 69, 74, 77]. In the observational study by Bentzen et al. (2008), a greater proportion of residents who declined hip protectors (39%) compared to accepted (27%) were always incontinent (p<0.001) [65]. Also, Zimmerman et al. (2010) observed 5.94% (SE=2.06) less adherence among residents who were always incontinent of the bowel than among those who were always continent (p<0.01) [64].

2.3.3.2.4 Acute Illness or Deterioration of Health

A deterioration of health resulting in non-ambulatory status was presented as a reason for noncompliance in three studies [53, 61, 72]. In the 13-month prospective study by Burl et al. (2003), certified nursing assistants stated that non-adherence was often related to the contraction of an acute illness, which resulted in a significant change in condition or a decline in functional status. The authors commented that this might have been because staff deprioritized the use of hip protectors in favor of other care issues, especially when residents were confined to their beds [61].
2.3.4. Hip Protector Characteristics

2.3.4.1 Facilitators

2.3.4.1.1 Colour Steadfastness

In one study, color steadfastness was considered a hip protector-level facilitator of acceptance and adherence [62]. In the qualitative study by Honkanen, Dehner, and Lachs (2006), there was consensus among certified nurse assistants that tan or beige, neutral colored garments were the most likely to be accepted and continuously worn, as they were least likely to fade, discolor, or tinge. In addition, certified nursing assistants believed that residents would be dissuaded from continuing use if garments became stained or discolored after washing with chlorine [62].

2.3.4.1.2 Soft Shell Hip Protectors

Type of hip protector (i.e., soft pad, hard shield) has also been shown to influence adherence, especially during the night [62, 66]. In a cluster randomized clinical trial by Bentzen et al. (2008), type of hip protector had no effect on acceptance; however, the probability of a resident terminating their use was marginally higher for hard shield compared with soft pad hip protectors (relative risk=1.38; 95% CI 1.002–1.902; p=0.048). In addition, a significantly greater proportion of individuals assigned soft pad hip protectors (63%) were considered 24-hour users compared with those provided hard shield hip protectors (43%) after 12 months of follow-up [66].

2.3.4.2 Barriers

2.3.4.2.1 Discomfort and Side Effects

The most prevalent hip protector-level barrier of both acceptance and adherence was discomfort, named in 16 studies [54, 55, 57-61, 65-67, 73-78]. For example, Burl et al. (2003) reported that, despite attempts to optimize fit, a few individuals would not wear hip protectors because they complained of discomfort [61]. In addition, in the cluster-
randomized control trial by Bentzen et al. (2008) comparing adherence between soft pad and hard shield users, the main reason provided for ending hip protector use in both groups related to discomfort (42% and 40% for soft pad and hard shield users, respectively) [66]. Likewise, Cameron et al. (2011) observed a negative correlation between lack of comfort and adherence at six months (Spearman’s rho=-0.357, p<0.001) [58]. Discomfort often arose from poor fit (i.e., hip protector was too small or too tight) [57, 60, 61, 67], bulkiness [54, 55, 58-60], restrictions with sleeping among those who were not used to wearing undergarments at night [60], and pre-existing medical conditions that increased sensitivity to discomfort (i.e., pressure ulcers, pain post-surgery) [60, 67]. The development of unwanted side effects was also reported to negatively influence acceptance and adherence [54, 65-67, 73, 74]. Side effects included aches or pains, swelling, itchiness, and skin irritation (i.e., heat rash, redness).

2.3.4.2.2 Distaste

Concerns with the style or appearance of hip protectors were also identified as potential barriers to acceptance and adherence [54, 56, 67, 73, 74]. For example, in a comparative study by Forsen et al. (2004), 12% of residents refused the offer of hip protectors, and 28% terminated use because of distaste with their appearance [67]. Doherty et al. (2004) reported that female residents, in particular, were offended by the masculine appearance of hip protector pants, which made them look bulky and unattractive [54]. Furthermore, Hubacher and Wettstein (2001) observed that roughly three times more drop outs than wearers found their appearance while wearing hip protectors unattractive (p<0.001) [73]. Unsightly stains and discoloration of garments appeared to exaggerate this concern [54, 62].

2.3.4.2.3 Relative Complexity of Use

Identified in ten studies, another common resident-level barrier to adherence related to difficulty donning and doffing hip protectors independently [54, 55, 58-60, 65-67, 74, 77], sometimes leading to the incorrect placement of hip protectors [64,76]. In the qualitative study by Tavener-Smith and De Vet (2006), older adults expressed difficulty with usage as a major barrier – specifically that they now required assistance from others
to perform activities (e.g., going to the toilet) they otherwise had been able to do independently [60]. Doherty et al. (2004) also observed that hip protectors had reduced the independence of a small number of residents, who previously had been completely independent when toileting, and were now unable to use the toilet without assistance. The authors considered this to be a major obstacle to continued adherence [54]. Arthritis, particularly afflicting the hands [54] and lower limbs [52], was reported to exacerbate this difficulty.

2.4. Discussion

Despite the observation of good biomechanical performance of hip protectors [33-37] and evidence of the ability of hip protectors to minimize risk for hip fractures in LTC facilities [79-82], recent intention to treat type meta-analyses have indicated that poor user compliance is the most important barrier to the clinical efficacy of hip protectors [39, 40]. Therefore, the purpose of this review was to identify perceived barriers to initial acceptance and continued adherence with hip protectors in LTC.

Consistent with findings from van Schoor et al. [46], we observed lack of clarity and consistency in definitions of adherence, which limited our ability to explore relationships between studies. Some reported adherence as the percentage of users who were adherent at multiple times [74], whereas others the percentage of time in which hip protectors were worn as directed [61], the percentage of falls in which hip protectors were worn [78], or the percentage of users who wore a protector during at least one fall [68]. Definitions also ranged from the wearing of a hip protector at least once during the past three months [56] to a month [66], at least once a day for more than one hour [63], for all hours of the daytime [71], or at all times except when bathing [51]. Therefore, we advocate that investigators comply with recommendations from Kurrle et al. (2004), and report adherence as the percentage of time hip protectors are worn as directed using a standardized definition, or alternatively, whether hip protectors are being used at the time of falling through examination of fall reports or clinical records [83].

According to the prior systematic review of factors affecting acceptance and adherence, discomfort from poor fit, and the extra effort and time needed to don and doff
hip protectors, were cited as the most common features of garments contributing to noncompliance [46]. Despite improvements in the design of hip protectors over the last decade, we observed that discomfort, unwanted side effects, and poor ergonomics (e.g., complexity of use) persist as substantial barriers to their continued use. Distaste with the aesthetics of hip protectors was another commonly reported reason for noncompliance, especially amongst females, with about one in three residents forgoing protection because of issues with style [67].

To overcome hip protector level concerns, residents should be given the opportunity to select and try on a variety of models to maximize potential for proper fit. This should include both soft pad and hard shield types, as rigidity had no meaningful effect on adherence, with the exception of greater nighttime use with soft pads [66, 72]. However, not all hip protectors are equally effective. A study by Laing et al. (2011) observed a wide range in biomechanical capacity among 26 commercially available models, with force attenuation ranging from 2.5% to 40% [34]. Accordingly, residents should be encouraged to select from hip protectors with documented protective effect. Designers and engineers should direct their efforts to creating garments that are more comfortable (airy, light, breathable), easy to take on and off, especially for those with arthritis, and aesthetically appealing with designs tailored to gender-specific tastes. Some suggestions offered by investigators to enhance compliance included differentiating the front and back sides of garments to facilitate proper application [76], using snaps or Velcro for fastening [62], and selecting neutral colored fabric [62].

At the resident level, van Schoor et al. (2002) identified illness (dementia), urinary incontinence and physical disabilities as common reasons for noncompliance [46]. Consistent with these findings, we observed that deterioration of health from an acute illness frequently interfered with adherence, as caregivers were forced to prioritize other care needs over that of hip protection. However, the presence of urinary incontinence, physical disability, and cognitive impairment was not always associated with declines in adherence. According to van Schoor et al. (2002), persons who suffered from physical disability needed more assistance to don and doff hip protectors, and this was perceived as unfavorable [46]. We too observed that difficulty with use was an obstacle to adherence and that difficulty was exacerbated by upper and lower limb arthritis; however, this was
selective to the most independent residents who were otherwise able to perform many activities of daily living (e.g., toileting, dressing) on their own, and who experienced a sense of overwhelming loss of independence with protector use. In fact, it was this cohort of residents who consistently displayed the lowest levels of adherence, whereas those with more severe disability responded more favorably to hip protectors. Furthermore, the relationship between urinary incontinence and compliance was complex and nonlinear. In particular, adherence was compromised among those with frequent incontinent episodes (because of the need for frequent laundering of soiled garments), but unexpectedly improved among those who wore incontinence materials. To explain this, investigators suggested that hip protectors might have helped to hold in place incontinence materials [69], or that residents who were used to wearing incontinence materials might have been desensitized to tight fitting undergarments and experienced less discomfort [76].

We uncovered some knowledge of the causes of, and the types of residents who engaged in, compliance in wearing hip protectors. Some important predictors of acceptance and/or adherence at the resident level were clinical risk factors for falls and fragility fractures, recognition of the need for hip protection, positive attitudes regarding the effectiveness of hip protectors, and peer and family advocacy. As such, strategies to overcome resident level barriers could incorporate interventions to increase client (family, friends, residents) awareness of risk factors for falls, risk factors for fall-related hip fractures, and the potential benefits associated with protector use. Whenever possible, we advocate that education programs enlist older adult peer educators and/or family to facilitate knowledge transfer and exchange. Notably, in one study, convincing residents about the positive effects of hip protectors became more difficult each time a hip fracture occurred while protected [67], suggesting that it is especially important to inform caregivers, residents, and families that hip protectors cannot prevent fracture in all circumstances [42] (e.g., in situations of spontaneous fracture without any obvious external impact [84], when the hip breaks because of a backward fall or a fall to the knees [85], or when the hip protector is not correctly positioned [86]).

Unlike the previous review, we identified negative perceptions of caregivers regarding the amount of effort needed to apply hip protectors, hygiene, side effects, and maintaining the dignity and autonomy of residents as damning reasons for noncompliance.
According to one study, some care providers made the decision to apply hip protectors even without gaining the clear consent of residents, whereas others decided not to offer hip protectors to those whom they felt would be unable to express their wishes [54]. Furthermore, in another study, 68% of caregivers responded that they had more impact on the wearing of hip protectors among residents with dementia [74]. These findings highlight the importance of training care providers to balance safety issues with residents’ rights to individual choice and autonomy [87], and the need for educating staff on how to communicate effectively with residents who have difficulty making themselves understood or understanding others (e.g., cognitively impaired).

In line with results from van Schoor et al. (2002), care provider commitment was a key facilitator of adherence [46]. Only one study attempted to quantify the strength of the relationship between care provider commitment and adherence. It was shown that a 1-unit increase in the commitment of registered nurses, scored by research staff on a scale from 0 to 4, associated with a 3.1% increase in adherence [64]. However, as the criteria in which research staff evaluated commitment are unclear, and no definition of commitment was reported, a priority of future research should be to confirm this relationship using definitions of commitment established a priori. In future research, it might also be interesting to explore whether targeting commitment, via modifications to job-setting or work-setting variables (e.g., leadership behaviors, emotional exhaustion), translates into improvements in adherence. As leaders in implementation science suggest, key drivers of success in effective implementation of new ‘best practices’ are competency, organization, and leadership, where qualified leaders are empowered to make decisions, provide guidance and access the necessary resources to support organizational goals [88].

Implementation scientists have also long observed that commitment to change must happen at the staff and organizational levels for diffusion of new evidence into practice, and it is the combination of these that “result in consistently effective outcomes that can be sustained across generations of recipients, practitioners, and organization leaders” (p. 421) [89]. The most significant contribution of this review, perhaps, is the novel synthesis of system level barriers and facilitators to acceptance and adherence. Here, determinants of noncompliance related to workforce shortages or excessive workload,
frequent turnover of frontline and managerial staff, and inadequate communication with frontline staff, whereas features linked with improved acceptance and adherence included facility commitment, offering structured education on hip protectors, provision of hip protectors are no cost, and ongoing support from external sources, especially the recommendation of hip protectors by physicians. However, a recently published survey of US health care providers’ perceptions of hip protectors revealed that only 38% (53/139) of respondents were aware of hip protectors, and of those who had heard of them, 62% (33/53) indicated that they hadn’t recommended hip protectors to at least a few patients [90]. None of the providers who doubted the efficacy of hip protectors recommended them to any of their patients [90]. Consequently, a potentially fruitful mechanism to enhance adherence may be through improved health care provider awareness of the efficacy of hip protectors, especially for patients who are willing and able to wear them.

2.5. Conclusions

Findings from this systematic review should provide decision makers, health professionals, and caregivers with a greater awareness of strategies to improve acceptance and adherence with hip protectors in LTC. Furthermore, researchers can use this information to design better clinical trials that will yield high compliance. Also, manufacturers working on the development of hip protectors can use this information to identify improved approaches to product design that are more acceptable to hip protector users and those who care for them. Because acceptance and adherence are significant factors in hip protector efficacy, a better understanding of these factors may ultimately lead to a reduction in the frequency and burden of hip fractures among older adults in LTC facilities.
2.6. References


### 2.7. Figures and Tables

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**Figure 2.1** Categories of evidence and strength of recommendations (adapted from Shekelle, Woolf, Eccles, & Grimshaw, BMJ 318:593-596; 1999).
Figure 2.2  Flow diagram of the selection process for included studies.
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<td>Cluster randomized study to compare uptake and adherence between soft- and hard-shelled hip protectors over 18 months</td>
<td>Residents (n=604) from 18 Norwegian nursing homes</td>
<td>Mean age=84.9 76.5% female</td>
<td>Safehip (soft- and hard-shell)</td>
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<td>Mean age=87 84% female</td>
<td>Safehip</td>
<td></td>
</tr>
<tr>
<td>Woo (2003)</td>
<td>Mixed methods (IIIC)</td>
<td>Ambulant residents (n=302) from 17 nursing homes in Hong Kong</td>
<td>Mean age=78.3 63% female</td>
<td>Design for body build of elderly Chinese (shell type unspecified)</td>
<td></td>
</tr>
<tr>
<td>Zimmerman (2010)</td>
<td>Quantitative (IIIC)</td>
<td>Ambulatory residents (n=797), from 35 American nursing homes, with no history of falls</td>
<td>Mean age=85 82.4% female</td>
<td>Single pad used on either right or left hip (shell type unspecified)</td>
<td></td>
</tr>
</tbody>
</table>
Table 2.2  Definitions and methods used to measure adherence, and the determined percentages of acceptance and adherence in included studies.

<table>
<thead>
<tr>
<th>First Author (year)</th>
<th>How adherence was defined</th>
<th>How adherence was measured</th>
<th>Adherence rates</th>
<th>Acceptance rates (% who agreed to wear)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentzen (2008a)</td>
<td>Definition: % of users who were adherent (used a hip protector at least once within the past month)</td>
<td>Tracked monthly by staff</td>
<td>37% at 18 months</td>
<td>45% (soft-shell), 47% (hard shield)</td>
</tr>
<tr>
<td>Bentzen (2008b)</td>
<td>Definition: % of users who were adherent (used a hip protector at least once within the past month)</td>
<td>Tracked monthly by staff</td>
<td>75% at 3 months, 60% at 18 months</td>
<td>46%</td>
</tr>
<tr>
<td>Burl (2003)</td>
<td>Definition: average days hip protectors were worn (daytime use only) divided by the number of days in the month</td>
<td>Tracked daily by nursing staff</td>
<td>&gt;90% at 3 months, sustained for 18 months</td>
<td>-</td>
</tr>
<tr>
<td>Cameron (2001)</td>
<td>Definition 1: % of residents who used hip protectors for at least half of the day; Definition 2: mean % of fall-up-time during which hip protectors were worn as directed; Definition 3: % of falls that occurred while hip protectors were being worn</td>
<td>Data were collected by interviewing staff, reviewing medical records of participants and examining incident reports; measured on 4 separate occasions</td>
<td>Definition 1: 81% at 2 weeks; 70% at 2 months; 48% at 12 months; 43% at 18 months; Definition 2: 57% (median=64%) at 18 months; Definition 3: 54% at 18 months</td>
<td>-</td>
</tr>
<tr>
<td>Cameron (2011)</td>
<td>Definition 1: % of residents wearing hip protectors at each time of visit (3, 6 months); Definition 2: mean % of waking hours that hip protectors were worn; Definition 3: % of falls that occurred while hip protectors were worn</td>
<td>Definition 1: recorded as wearing hip protectors at time of visit (3, 6 months); Definition 2: mean adherence during previous month noted by research staff; Definition 3: staff attempted to ascertain whether hip protectors were worn at time of fall</td>
<td>Definition 1: at 3 months, no cost group=33%, combined group=27%; at 6 months, no cost=25%, combined group=24%; Definition 2: at 3 months, no cost group=51%, combined group=36%; at 6 months, no cost=36%, combined group=34%</td>
<td>48%</td>
</tr>
<tr>
<td>Author</td>
<td>Definition 1</td>
<td>Definition 2</td>
<td>Definition 3</td>
<td>Definition 4</td>
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<tr>
<td>Chan (2000)</td>
<td>Definition: % of falls recorded for which protectors were worn</td>
<td>Protected falls: staff completed a form for every fall, which indicated whether protectors were worn</td>
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<td>-</td>
</tr>
<tr>
<td>Cryer (2002)</td>
<td>Definition: among those who accepted, average % of sessions (24 hour, daytime, nighttime) that hip protectors were worn</td>
<td>Tracked daily by care staff.</td>
<td>At 6 months: (24 hour): 29% (Daytime): 37% (Nighttime): 3%</td>
<td>51%</td>
</tr>
<tr>
<td>Cryer (2006)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>51% (data published in Cryer 2002)</td>
</tr>
<tr>
<td>Cryer (2008)</td>
<td>Definition 1: proportion of sessions (24 hour, daytime, nighttime) that protectors were worn (data published in Cryer 2002)</td>
<td>Care staff recorded daily on a standardized A4 diary sheet whether protectors were worn during morning, afternoon, evening, and night sessions</td>
<td>At 6 months: (24 hour): 29% (Daytime): 37% (Nighttime): 3%</td>
<td>-</td>
</tr>
<tr>
<td>Forsen (2004)</td>
<td>Definition 1: % who continued use Definition 2: % regular users at given points in time Definition 3: % users who wore a hip protector during their first, second, third and fourth falls; Definition 4: % of registered falls among all users that occurred with a hip protector on</td>
<td>Definition 1/2: after registration, a questionnaire was completed every day for the first week, and monthly thereafter for a total of 12 months Definition 3/4 (protected falls): each time a fall occurred, employees completed a questionnaire on whether the hip protector was correctly in place at the time of the fall, and if the resident was a regular user</td>
<td>Definition 1: 43% of those who accepted, 23% of all residents enrolled in the study at the end of registration (up to 12 months) Definition 2: 35% in May 1998; 22% in November 1999 Definition 4 (protected falls): 70%, 74%, 73%, and 72% of users wore a hip protector during their first, second, third, and fourth falls; 76% of all registered falls among users (n=2323) occurred while protected</td>
<td>55%</td>
</tr>
<tr>
<td>Study</td>
<td>Definition 1</td>
<td>Definition 2</td>
<td>Definition 3</td>
<td>Definition 4</td>
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<td>-------</td>
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</tr>
<tr>
<td>Honkanen (2007)</td>
<td>% of residents that used hip protectors at least once for more than one hour during any 8-hour shift</td>
<td>% of residents who wore hip protectors at any of the checks by research staff</td>
<td>% of residents who, in the final week of the study, met criteria for definitions 1 or 2, and indicated intended future use</td>
<td>For all hip protector users (met criteria for definition 3), mean number of hours of adherence (out of 8 hours) during the day, evening, and nighttime</td>
</tr>
<tr>
<td></td>
<td>Definition 1/3: tracked 3 times daily by nursing staff using the HP Adherence Record (HPAR)</td>
<td>Definition 2: research staff conducted two unannounced checks per week, and recorded whether residents were wearing hip protectors or not</td>
<td>Definition 4: residents, or if cognitively impaired, their care providers, indicated to research staff that they would continue to use hip protectors after the study</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Definition 1: 78% at 1.5 months</td>
<td>Definition 2: 49% at 1.5 months</td>
<td>Definition 3: 68% at 1.5 months</td>
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<tr>
<td></td>
<td>Definition 4: 5.1 hours (64%), 4.8 hours (60%), and 4.2 hours (53%) of the day, evening, and nighttime shifts</td>
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<tr>
<td>Hubacher (2001)</td>
<td>% of original wearers (acceptors) using hip protectors</td>
<td>at the end of the study, % of time residents had hip protectors in place over the course of the study</td>
<td>Research staff assessed the length of time residents were wearing hip protectors at 20 specified time points</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Definition 1: 36% at 10 months</td>
<td>Definition 2: wearers had protectors in place for 49% of the time (including at night), future drop outs for 10%; members of the entire intervention group were protected for 20% of their exposure time</td>
<td></td>
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<tr>
<td>Klenk (2011)</td>
<td>% of residents who were offered a hip protector (availability)</td>
<td>% of residents who used a hip protector at least once in 4 weeks</td>
<td>Documented by nursing home staff</td>
<td></td>
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<tr>
<td></td>
<td>Definition 1: 9.2% (men=6.2%; women=10%)</td>
<td>Definition 2: 5.8% (men=4.0%; women=6.4%)</td>
<td>Definition 3: 63.6% (men=64.2%; women=63.5%)</td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>Definition 1: % residents who used hip protector</td>
<td>Definition 2: % of falls with documented use of the protector</td>
<td>Definition 3: % of fallers with documented use of the protector during at least one fall</td>
<td>Nursing staff completed a questionnaire on falls</td>
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<td>-------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
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<tr>
<td>Meyer (2003)</td>
<td>% residents who used hip protector</td>
<td>% of falls with documented use of the protector</td>
<td>% of fallers with documented use of the protector during at least one fall</td>
<td>At mean follow up of 15 months:</td>
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<td>Definition 1: intervention group=34%; control group=8%</td>
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<td>Definition 2: intervention group=58%; control group=11%</td>
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<td></td>
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<td></td>
<td></td>
<td>Definition 3: intervention group=67%; control group=15%</td>
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</tbody>
</table>
| Milisen (2011)| % residents still wearing their hip protector after 8 months, and having worn the device for at least 75% of the 33 check moments | % use of the hip protector at the time of the fall            | % of fallers with documented use of the protector during at least one fall       | Definition 1: Nursing staff performed weekly unannounced, random checks during the day (25 checks) and night (8 checks) | Definition 1: 29% at 8 months (daytime=35%; nighttime=21%)  
Definition 2: 11% (8/74) at 8 months  
85% |
| O’Halloran (2004) | Number of residents wearing hip protectors as a % of the mean number of occupied beds | Adherence: observed to be wearing protectors at 2, 4, 8, 12, 18, 24 weeks and every 8 weeks thereafter | 24% at 6 months  
23% at 12 months  
20% at 18 months | 37% |
| O’Halloran (2005) | % of residents still wearing hip protectors | Observed to be wearing protectors during 9 unannounced checks over 3 months (3 days, 5 days, 7 days, 2 weeks, 3 weeks, 5 weeks, 7 weeks, 9 weeks, 12 weeks) | Definition 1: 43% at 3 months  
Definition 2: 49% at 3 months (Safehip hip protector=52%; HipSaver hip protector=45%) | 42% |
23% at 12 weeks  
20% at 18 weeks | 37% |
<table>
<thead>
<tr>
<th>Author</th>
<th>Definition 1: % of residents who reported wearing hip protectors 24 hours of the day, except when bathing (full wearers)</th>
<th>Definition 2: % of residents who reported wearing hip protectors for ‘some of the time’ during the day (partial wearers)</th>
<th>Adherence: self-reported by residents</th>
<th>Definition 1: 22%</th>
<th>Definition 2: 28%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tavener-Smith (2006)</td>
<td>Adherence: self-reported by residents</td>
<td>Adherence: self-reported by residents</td>
<td>78% at 3 months 78% at 6 months 78% at 12 months</td>
<td>78% at 3 months 78% at 6 months 78% at 12 months</td>
<td>72%</td>
</tr>
<tr>
<td>Thompson (2005)</td>
<td>Definition: % of residents wearing hip protectors at least once during the last 3 months</td>
<td>Definition: % of residents wearing hip protectors at least once during the last 3 months</td>
<td>61% at 1 month 45% at 6 months 37% at 12 months</td>
<td>61% at 1 month 45% at 6 months 37% at 12 months</td>
<td>-</td>
</tr>
<tr>
<td>van Schoor (2003)</td>
<td>Definition: % of compliant residents</td>
<td>Definition: % of compliant residents</td>
<td>Adherence: member of research team check to see if the resident was wearing hip protector, and whether the protector was used correctly at 3 unannounced visits (1, 6, 12 months)</td>
<td>Adherence: member of research team check to see if the resident was wearing hip protector, and whether the protector was used correctly at 3 unannounced visits (1, 6, 12 months)</td>
<td>61% at 1 month 45% at 6 months 37% at 12 months</td>
</tr>
<tr>
<td>Warnke (2004)</td>
<td>Definition 1: % of fallers with documented use of a protector during at least one fall</td>
<td>Definition 2: % of falls in which a hip protector was used</td>
<td>Definition 1: published in Meyer et al. (2003); reported by nursing staff on a documentation sheet</td>
<td>Definition 2: published in Meyer et al. (2003); same as adherence</td>
<td>68% at 15 months 54% at 15 months</td>
</tr>
<tr>
<td>Woo (2003)</td>
<td>Definition: number of hours of wear in each time section divided by the total number of hours</td>
<td>Adherence: recorded daily by nursing staff</td>
<td>Definition 1: published in Meyer et al. (2003); reported by nursing staff on a documentation sheet</td>
<td>Definition 2: published in Meyer et al. (2003); same as adherence</td>
<td>24 hour: 63-67% over 1 year morning: 68-69% over 1 year afternoon: 68-69% over 1 year nighttime: 55-60% over 1 year</td>
</tr>
</tbody>
</table>
| Zimmerman (2010) | Definition 1: % of eligible residents who agreed to wear hip protectors, and passed a two-week run-in trial (wore a hip protector correctly during at least 4 of 6 unannounced visits)  
Definition 2: average number of visits residents were considered adherent (correctly wearing hip protector) as a % of total visits  
Definition 3: adherence (definition 2) by nursing home | Research staff made 3 unannounced visits per week | Definition 1: 80%  
Definition 2: 81% after 1 month; 76% at the end of the study (rolling recruitment, up to 21 months)  
Definition 3: 78% (range 0-100%) | 32% |
Table 2.3  **Factors at the system level that influenced acceptance and adherence with the use of hip protectors.**

<table>
<thead>
<tr>
<th>Acceptance</th>
<th>LOE†</th>
<th>Adherence</th>
<th>LOE†</th>
<th>Facilitators (†)</th>
<th>Barriers (↓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater staff training (general) [Klenk 2011]</td>
<td>IIIC</td>
<td>Champion (e.g., person, team) in charge of hip protector use [Burl 2003, Davies 2004, Forsen 2004]</td>
<td>IIIC</td>
<td>Poor communication between front-line and senior staff [Davies 2004]</td>
<td></td>
</tr>
<tr>
<td>Fewer residents with hip fractures in past 4 years [Cryer 2006]</td>
<td>Larger percentage of residents with physical disability [O’Halloran 2007]</td>
<td>Smaller facilities (i.e., fewer residents) [Forsen 2004, Zimmerman 2010]</td>
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<tr>
<td>Champion (e.g., project nurse) in charge of hip protector use [Davies 2004]</td>
<td>Fewer users of hip protectors within a facility [Forsen 2004]</td>
<td>Greater percentage of residents in receipt of Welfare aide [Zimmerman 2010]</td>
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<tr>
<td>Ongoing support from external agencies [Davies 2004]</td>
<td></td>
<td>More administrator and management involvement in meetings [Zimmerman 2010]</td>
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<tr>
<td>Non-profit status [Zimmerman 2010]</td>
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<tr>
<td>No chain affiliation [Zimmerman 2010]</td>
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<tr>
<td>Greater proportion of rotating, non-permanent staff [Zimmerman 2010]</td>
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<tr>
<td>Better quality of care [Zimmerman 2010]</td>
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<tr>
<td>Better environmental quality [Zimmerman 2010]</td>
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<tr>
<td>Management (i.e., Director of Nursing) prioritizes need to treat residents respectfully [Zimmerman 2010]</td>
<td>IIIC</td>
<td></td>
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</tbody>
</table>

† LOE=Level of Evidence; denotes the highest level of evidence from all possible sources.
<table>
<thead>
<tr>
<th>Acceptance</th>
<th>LOE†</th>
<th>Adherence</th>
<th>LOE†</th>
<th>Acceptance</th>
<th>LOE†</th>
<th>Adherence</th>
<th>LOE†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belief among nursing assistants that medical staff and nursing supervisors play an important role in hip fracture occurrence [Honkanen 2007]</td>
<td>IIB</td>
<td>Negative perceptions of effort to work with protectors [Cameron 2011, Chan 2000]</td>
<td>IA</td>
<td>Negative perceptions of effort to work with protectors [Cameron 2011, Chan 2000, Davies 2004, Milisen 2011, Tavener-Smith 2006]</td>
<td>IA</td>
<td></td>
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<tr>
<td>Worried about compromised dignity of residents [Chan 2000, Doherty 2004]</td>
<td>IIIC</td>
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<tr>
<td>Belief that chance plays an important role in hip fracture occurrence [Honkanen 2007]</td>
<td>IIB</td>
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<tr>
<td>Doubts about cost effectiveness of protectors [Honkanen 2006]</td>
<td>IVD</td>
<td>Older age of nursing assistants [Honkanen 2007]</td>
<td>IIB</td>
<td></td>
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<tr>
<td>Concerns about side-effects (e.g., pressure damage, redness) [Doherty 2004, Thompson 2005]</td>
<td>IIIC</td>
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</tbody>
</table>

† LOE=Level of Evidence; denotes the highest level of evidence from all possible sources.
<table>
<thead>
<tr>
<th>Acceptance</th>
<th>LOE†</th>
<th>Adherence</th>
<th>LOE†</th>
<th>Acceptance</th>
<th>LOE†</th>
<th>Adherence</th>
<th>LOE†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trait/Category</td>
<td>Category</td>
<td>Source(s)</td>
<td>Description</td>
<td>Category</td>
<td>Source(s)</td>
<td>Description</td>
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<tr>
<td>Osteoporosis</td>
<td>IIIC</td>
<td>[Bentzen 2008b, Zimmerman 2010]</td>
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<tr>
<td>Marital status</td>
<td>IIIC</td>
<td>[Zimmerman 2010]</td>
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<tr>
<td>Visual deficits</td>
<td>IIIC</td>
<td>[Cryer 2006]</td>
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<tr>
<td>Wheelchair user</td>
<td>IIIC</td>
<td>[Hubacher 2001, Zimmerman 2010]</td>
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<tr>
<td>Calcium supplementation</td>
<td>IIIC</td>
<td>[Bentzen 2008b]</td>
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<tr>
<td>Greater family</td>
<td>IIB/IV D</td>
<td>[Honkanen 2007, Tavener-Smith 2006] and peer [Tavener-Smith 2006] advocacy</td>
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<tr>
<td>Dizziness during quiet stance</td>
<td>IIIC</td>
<td>[Cryer 2006]</td>
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<tr>
<td>Depression, sadness, and anxiety</td>
<td>IIB</td>
<td>[Honkanen 2007, Zimmerman 2010]</td>
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<tr>
<td>Wearing of incontinence materials</td>
<td>IIIC</td>
<td>[Cryer 2006]</td>
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<tr>
<td>Wearing of incontinence materials</td>
<td>IIIC</td>
<td>[Cryer 2008, van Schoor 2003]</td>
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<tr>
<td>Hypertension</td>
<td>IIIC</td>
<td>[Cryer 2006]</td>
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<tr>
<td>Pre-existing medical conditions</td>
<td>IIIC</td>
<td>[Forsen 2004, Tavener-Smith 2006]</td>
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<tr>
<td>Memory impairment</td>
<td>IIIC</td>
<td>[Bentzen 2008b, Thompson 2005]</td>
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<tr>
<td>Deterioration of health (e.g., acute illness)</td>
<td>IA/C</td>
<td>[Burl 2003, Davies 2004, O'Halloran 2005]</td>
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<tr>
<td>Residing in an Elderly Mentally Infirm (EMI) unit</td>
<td>IA/C</td>
<td>[O'Halloran 2005]</td>
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<tr>
<td>Recipients of welfare assistance</td>
<td>IIIC</td>
<td>[Klenk 2011]</td>
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<tr>
<td>Strong fear of falling</td>
<td>IIIC</td>
<td>[Cryer 2006]</td>
<td></td>
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<tr>
<td>Difficulties communicating</td>
<td>IIB</td>
<td>[Honkanen 2007]</td>
<td></td>
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<tr>
<td>Dementia</td>
<td>IIIC</td>
<td>[Milisen 2011, Zimmerman 2010]</td>
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<tr>
<td>Parkinson’s disease</td>
<td>IIIB</td>
<td>[Honkanen 2007]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness at times other than rising or standing [Cryer 2006]</td>
<td>IIIC</td>
<td>Hypertension [Cryer 2008]</td>
<td>IIIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Older age [Honkanen 2007]</td>
<td>IIB</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† LOE=Level of Evidence; denotes the highest level of evidence from all possible sources.
**Table 2.6** Factors at the product level that influenced acceptance and adherence with the use of hip protectors.

<table>
<thead>
<tr>
<th>Facilitators (†)</th>
<th>Acceptance</th>
<th>LOEt</th>
<th>Adherence</th>
<th>LOEt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft shelled hip protector [Bentzen 2008a, Honkanen 2006]</td>
<td>IA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Barriers (↓)</th>
<th>Acceptance</th>
<th>LOEt</th>
<th>Adherence</th>
<th>LOEt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unwanted side effects [Milisen 2011, Forsen 2004]</td>
<td>IIIC</td>
<td></td>
<td></td>
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<tr>
<td>---</td>
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<td></td>
</tr>
<tr>
<td>Poor durability [van Schoor 2003, Honkanen 2006]</td>
<td>IIIC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† LOE=Level of Evidence; denotes the highest level of evidence from all possible sources.
Chapter 3. Validation and Psychometric Properties of the Commitment to Hip Protectors (C-HiP) Index in Long-Term Care Providers of British Columbia, Canada: A Cross-Sectional Survey

3.1. Background

Falls persist as the leading cause of injury-related hospitalizations and deaths among individuals aged 65 years and older [1-4]. Second only to traumatic brain injuries, hip fractures are the most debilitating injury caused by falls, associated with morbidity, compromised quality of life, fear, delirium, depression and even death [5-11]. Older people residing in long-term care (LTC) are generally frail [12, 13] and are up to 10-times more likely to suffer a hip fracture during a fall than community dwelling seniors [14-16]. In the event of a hip fracture, 1 in 3 residents in LTC will die by six months, after which time, about a third of survivors will lose the ability to walk independently [7]. In Canada, the direct cost to treat a single hip fracture is estimated at $40,000, and as approximately 28,000 Canadian elders are hospitalized for hip fractures each year, the collective financial burden of hip fracture in terms of direct costs exceeds $1.1 billion annually [17, 3].

Hip fractures arise from a combination of intrinsic, situational, and environmental factors. Although the strength and integrity of bone play an important role in determining risk for hip fracture, the strongest single predictor of hip fracture is a sideways landed fall, with risk increasing 32-fold if direct impact occurs to the lateral aspect of the pelvis [18-21]. According to analysis of real life video footage of 520 falls in LTC by 160 residents, hip impact occurs in about 40% of falls, usually onto hard flooring [22].

Consisting of soft padding or hard shield domes embedded in garments or undergarments, hip protectors represent a non-pharmaceutical, and potentially cost-effective approach for hip fracture prevention (e.g., [23-27]). Rather than preventing the fall itself, which has proved challenging in LTC [28], the rationale behind hip protectors is to minimize the risk of hip fracture associated with falling, by absorbing and diverting impact energy away from the proximal femur during a sideways landing [29, 30]. If worn at the time of a fall, certain models of hip protectors have been found in clinical trials to
reduce the risk of hip fracture between 69-80\% [31-33]. When assessed solely on an intention-to-treat basis, however, the clinical value of hip protectors is compromised by rather poor adherence in the wearing of these devices, ranging from 20\% (e.g., [34]) to 80\% (e.g., [35]), and often below 50\% in clinical trials [36]. Thus, poor user adherence in wearing hip protectors is a major barrier to their effectiveness.

Determinants of adherence with hip protectors span different socio-ecological levels [37]. Because the majority of residents in LTC have some form of cognitive impairment (e.g., [38]) and all require at least partial assistance performing activities of daily living, the attitudes and subsequent behaviour of care providers is believed to be important in determining whether a resident will wear hip protectors on a regular basis (e.g., [39-46]). For example, care providers are responsible for identifying residents likely to benefit and tolerate hip protectors, educating residents and family about the benefits of hip protectors, monitoring for signs of discomfort and pain, implementing interventions to optimize adherence, and continuously reassessing for eligibility [47]. In a recent systematic review on factors affecting use of hip protectors among residents in LTC, the commitment of care providers to hip protectors emerged as a facilitator of acceptance and/or adherence in nearly half of studies (46\%) [37]. However, our understanding of the nature of commitment, along with its associated antecedents and outcomes, is constrained by the absence of a psychometrically valid assessment tool, and subsequently, reliance on relatively low-level evidence, namely expert opinion. Therefore, our aim is to develop a valid and reliable tool to measure commitment to hip protectors among paid care providers in LTC.

3.2. Theoretical Framework

Over the past few decades, researchers have conceptualized commitment to many different workplace foci, including work organizations (e.g., [48, 49]), work teams and leaders (e.g., [50, 51]), occupations and professions (e.g., [52]), organizational change (e.g., [53]) and technological change (e.g., [54]). And yet, there remains considerable uncertainty surrounding how to define and measure commitment in the workplace, how commitment in the workplace develops, and how commitment subsequently affects organizational behaviour [55]. However, what is largely undisputed is that commitment to
any workplace foci should be conceived as a strictly attitudinal phenomenon (e.g., [56, 49, 57]).

According to prevailing theoretical frameworks in social psychology (e.g., ABC model), attitudes have three different components: an affective component reflecting an individual’s feelings and emotions about a target, a cognitive component reflecting an individual’s knowledge and beliefs about a target, and a behavioural component reflecting an individual’s readiness to act or behave in a certain way (e.g., [58, 59]). Thus, it follows that commitment is also reflected by a combination of affective, cognitive, and behavioural components, whereby: affective commitment refers to an emotional attachment to and identification with one or more targets; cognitive commitment refers to an internalization of the targets’ goals, norms, and values; behavioural commitment refers to a generalized behavioural pledge to serve and enhance the targets’ interests [57]. Summarized nicely by Solinger, van Olffen and Roe [57], “…thus, commitment does not come cheap: it is a binding vow, a generalized behavioural pledge to act in the interest of the [target]” (pg. 80).

Consistent with extant research conceptualizing commitment in the workplace as a purely attitudinal phenomena, we defined commitment to hip protectors as a care provider’s attachment to and behavioural intentions towards hip protectors, reflected by three components: (i) a belief in the value of hip protectors (affective commitment), (ii) acceptance of the clinical efficacy of hip protectors (cognitive commitment), and (iii) a willingness to act or modify their behaviour to generally support the use of hip protectors (behavioural commitment).

3.3. Methods

3.3.1. Aim, Design, and Setting

Our aim was to develop and test the psychometric properties of a tool to measure commitment to hip protectors among paid care providers in LTC, named the Commitment to Hip Protectors (C-HiP) Index. To achieve this, we conducted a cross-sectional survey within thirteen non-profit, publically subsidized LTC homes situated in Metro Vancouver.
and the Fraser Valley, of British Columbia (BC), Canada. Homes ranged from 50-234 beds, and all were owned and operated by the Fraser Health Authority.

3.3.2. **Context: Hip protector Policy in Fraser Health**

Fraser Health does not provide hip protectors free of charge to residents living in owned and operated LTC homes, nor are hip protectors reimbursed through national health care coverage (e.g., Medical Services Plan). A single pair of hip protectors costs between $70-$120 CAD.

In 2013, Fraser Health released a clinical practice guideline (CPG) endorsing the use of hip protectors among residents of LTC: (i) with more than 2 falls in the previous 6 months, (ii) who were admitted to the home in the past month, (iii) with impaired mobility, balance or gait, and (iv) who are agitated, restless, or unable to follow instructions. The CPG states that education about hip protectors should be provided to residents who meet this criterion, and if applicable, their family, and any refusal to adhere should be clearly documented in health records.

3.3.3. **Sample**

We recruited a convenience sample of 541 paid care providers from publically subsidized LTC homes, who reported working for at least one full month on their floor/neighbourhood/unit, and for at least 8 hours per week. We excluded carers who indicated they were unaware of hip protectors (n = 5, 0.9%), and one respondent who left this question blank and did not answer any items in the C-HiP Index. An additional 6 (1.1%) respondents were excluded because they indicated they worked most of their time at privately owned or contracted LTC homes. Another 6 (1.1%) respondents indicated they worked most of their time at a LTC home owned and operated by the Fraser Health Authority that did not participate in data collection, but as they met our criteria for inclusion, they were included anyway. Of the remaining 529 respondents, the majority were female (90%) and most were health care assistants (55%). About half were full-time (53%), one-quarter were part-time (28%), and the remainder were casual (16%), or unknown. More respondent characteristics are provided in Table 3.1.
3.3.4. C-HiP Index Development and Scoring

Four items were written to measure affective commitment to hip protectors, modified from the affective commitment subscale of Herscovitch and Meyer’s [53] Commitment to Change scale. An example being, “I believe in the value of hip protectors.” Seven items were written to measure behavioural commitment to hip protectors, modified from Mowday, Steers and Porter’s [49] Organizational Commitment Questionnaire (OCQ) and the Compliance and Cooperation subscales of Herscovitch and Meyer’s [53] Measures of Behavioural Support for Change questionnaire. An example being, “I am willing to put in a great deal of effort, above and beyond what is normally expected, to work with hip protectors.” These eleven items were pretested in a convenience sample of 119 paid care providers from two privately owned LTC homes within Fraser Health, and the results were subjected to exploratory factor analysis and internal reliability testing. Two behavioural items were removed due to low pattern matrix and structure matrix coefficients. After pre-testing, six items were added based on qualitative feedback from respondents, constituting the cognitive subscale of the C-HiP Index, an example being, “I am convinced that, when worn, hip protectors reduce risk for injury from falls.” All items used Likert-type response scales ranging from 1 (strongly disagree) to 5 (strongly agree); however, one cognitive item, “I doubt the effectiveness of hip protectors”, uses reverse scoring (e.g., a response of 1 is scored as 5-points). Although scores for the C-HiP Index can be calculated either by summing or averaging responses to individual items, we elected to sum responses.

3.3.5. Protocol

In May 2015, an email message was sent to managers of LTC homes owned and operated by Fraser Health, alerting them of the upcoming study and inviting them to participate. In homes where managers expressed interest in participating, a member of the research team (AMBK) scheduled the launch of data collection.

We developed five different versions of the paper survey. In each, we kept the location of the C-HiP Index the same, but we randomized the order in which individual items were presented within the scale. We also randomized the order in which LTC homes were assigned versions of the paper survey. However, each version was assigned to at
least two LTC homes, and all participants from a given LTC home received the same version (i.e., stratified randomization). This method of randomization ensured we received an adequate and relatively equal number of responses to each version of the survey.

During data collection, AMBK offered multiple information sessions within each home to explain the overall aims and objectives of the study and to distribute invitation letters and paper surveys to eligible participants. Additional copies of the invitation letter and paper survey were left behind for those unable to attend sessions (e.g., night shift employees). Once completed, respondents were asked to place paper surveys in a sealed envelope and to leave them in a secured collection box. The return of completed paper surveys was interpreted as implied consent. Data collection lasted between 9-10 days in each participating LTC home, and took place between June and December 2015. The Fraser Health Authority Research Ethics Board and the Simon Fraser University Office of Research Ethics approved the study protocol.

3.3.6. Double Data Entry

Thirteen volunteers entered the data from returned paper surveys into spreadsheets, including one physiotherapist, five undergraduate students, five graduate students, and two postdoctoral fellows. Paper surveys underwent first and second keying, respectively, each by different volunteers. To facilitate high quality data entry, volunteers were provided with a protocol, adapted from the WHO STEPS Surveillance Manual [60], outlining general rules and guidelines for data entry, including how and when to assign missing data codes and resolutions to common difficulties (e.g., surplus data). All difficulties, and their associated resolutions, were logged on data tracking forms.

The overall error rate was low (1.02%). However, 369 (83.7%) surveys had at least one discrepancy between first and second keying, 197 (44.7%) had at least two errors, and 100 (22.7%) had three or more errors. The data entry supervisor (AMBK) resolved discrepancies by comparing entries to original responses.
3.3.7.  **Statistical Methods**

Unless otherwise stated, statistical testing was performed using IBM SPSS Statistics version 22.0 (SPSS Inc., Chicago, IL, USA) and significance was defined at the level $p < 0.05$.

3.3.8.  **Missing Data**

**Table 3.2** describes the amount (count, %) of missing data for each item of the C-HiP Index. 484 (91.5%) respondents answered the C-HiP Index completely. The behavioural item, “When it comes to hip protectors, I am willing to accept changes in the roles and responsibilities of my job”, had the most missing data, with 14 (2.6%) respondents leaving this question blank, while the cognitive item, “I am convinced that, when worn, hip protectors reduce risk for injury from falls”, had the least missing data, with no respondents refusing to answer.

We used a combination of single and multiple imputation (MI) procedures to handle missing data. MI is the gold standard of missing data procedures, and is preferred over many commonly used approaches, such as listwise deletion, for its ability to produce unbiased parameter estimates, reasonable estimates of uncertainty (i.e., standard errors and confidence intervals), and maximal statistical power [61, 62]; however, when preparing datasets for preliminary statistical analyses that do not involve standard errors, such as exploratory factor analysis (EFA) and coefficient alpha analyses, the Maximum-Likelihood, single imputation technique known as the Expectation-Maximization (EM) algorithm can be just as useful as MI procedures [62, 63].

Accordingly, we first implemented the EM algorithm to generate a single imputed dataset, from which we: (i) derived means (SD) of individual items within the C-HiP Index; (ii) conducted EFA and alpha coefficient analyses, described in the following sections entitled ‘construct validity’ and ‘internal consistency’, respectively. The EM algorithm contained age, sex, all fifteen items belonging to the C-HiP Index, and single items probing their familiarity with hip protectors, their familiarity with protocols concerning hip protectors at their LTC home, whether they identify as a champion of hip protectors, and whether there is at least one other person in their LTC home that is a champion of hip protectors.
We then used the MI procedures implemented in the mice package [64] of R [65] to prepare for statistical analyses involving hypothesis testing, such as simple linear regression and Mann-Whitney U tests, described in the following sections entitled ‘convergent validity’ and ‘concurrent validity’, respectively. We used a multilevel approach and included all variables from our statistical analyses, along with age, sex and facility code as the Level 2 identifier. We imputed $m=5$ different datasets. Each statistical test (e.g., simple linear regression) was repeated on all five datasets, and the results from each dataset were pooled to generate a single population estimate, confidence interval, and p-value. We pooled population estimates by averaging across the five imputed datasets. We pooled standard errors using the method proposed by Enders (2010), which considers within and between imputed dataset variation [61]. There is currently no established method to pool p-values generated from non-parametric tests (i.e., Mann-Whitney U tests) on multiply imputed datasets; however, all p-values were $p<0.01$.

### 3.3.9. Construct Validity

Because we conceptualized commitment to hip protectors as subsuming affective, cognitive and behavioural components, with each component subsuming several individual items of the C-HiP Index, we elected to perform hierarchical (i.e., higher order) factor analysis.

Individual C-HiP Index items were first subjected to a series of exploratory factor analysis (EFA) with oblique rotation (i.e., Oblimin with Kaiser Normalization) to identify lower-order factors (i.e., components of commitment). To determine the number of factors to retain in each EFA, we conducted Velicer’s minimum average partial (MAP) tests and parallel analyses [66]. Items were only retained if they had coefficients of .6 or higher on either the pattern matrix or the structure matrix, and they loaded onto the same factor in both matrices. If items did not meet these criteria, they were removed, and a subsequent EFA was performed. This procedure was repeated until all items met the criterion for retention. We then subjected lower-order factors to EFA to identify higher order factors.

For each EFA performed, we report eigenvalues (ranging from 0 to the number of items), which represent the variance in the original data matrix that is reproduced by each
of the factors, the percentage of variance explained by each of the factors, and where applicable, factor matrix coefficients, pattern matrix coefficients and/or structure matrix coefficients. We hypothesized hierarchical factor analysis would yield three lower-order factors, representing the three components of commitment, and a single higher-order factor, representing the overarching concept of commitment to hip protectors.

3.3.10. **Content Validity**

To assess content validity, a completely anonymous sample of eleven experts, consisting of directors of care and members of the Fraser Health Authority Patient Safety and Injury Prevention Program, rated the relevance and clarity of C-HiP items on Likert scales ranging from 1 (e.g., “Not at all relevant”) to 4 (e.g., “Extremely relevant”). For each item, we computed a content validity index (CVI), taken as the percentage of experts giving a rating of 3 or 4, for both clarity and relevance (e.g., [67]). We hypothesized that each item in the C-HiP Index would have a CVI greater than 0.79 (>79% agreement) for both relevance and clarity, which has been recommended as a threshold of adequate content validity [67]. However, in line with extant research [67], only those items with a CVI less than 0.70 (<70% agreement) for both relevance and clarity were considered unacceptable, and were deleted from the C-HiP Index.

3.3.11. **Convergent Validity**

Another method to test the validity of scales is to determine whether variables that ought to be related to the outcome measure of interest are indeed related. An individual’s commitment to hip protectors should ultimately affect how they behave (e.g., [59]). The stronger their commitment, the more likely they should be to engage in a form of discretionary behaviour known as championing (e.g., [53]). A Champion is defined as an employee who exhibits considerable personal sacrifice, and goes above and beyond what is explicitly required to serve and enhance the interests of one or more targets within and outside their organization [53]. In general, champions are known for their achievement, persuasiveness, persistence, innovativeness, charisma, enthusiasm, assertiveness, and/or risk-tolerance [68].
Thus, we hypothesized increasing C-HiP Index scores are positively associated with championing. To test this hypothesis, we performed simple linear regression to examine the association between scores on the entire C-HiP Index and responses to the single question, “Do you think of yourself as a champion of hip protectors”, with responses ranging from 1 (strongly disagree) to 5 (strongly agree). We also examined the association between each lower order factor, taken as the sum of items loading onto each factor (e.g., Factor 1) extracted from EFA, and responses to the single question, “Do you think of yourself as a champion of hip protectors”. To minimize interpretation bias, respondents were provided with a definition of championing before being asked to answer.

3.3.12. Concurrent Validity

To test concurrent validity, we examined the ability of the two lower-order factors and the entire C-HiP Index to distinguish between subgroups of respondents that it should theoretically be able to distinguish between. Although hip protectors substantially reduce risk of hip fracture if worn during a fall, they cannot prevent hip fracture on every occasion, including cases of spontaneous fracture without any obvious external impact (e.g., [69]), when the hip breaks from impact to the buttocks during of a backwards landed fall or a fall to the knees (e.g., [70, 22]), or when the hip protector is not positioned correctly over the greater trochanter (e.g., [71, 72]). Forsen et al. [73] reported that it became increasingly difficult to convince residents of the benefits of hip protectors after each time a hip fracture occurred while wearing a hip protector. Furthermore, an important facilitator of adherence in LTC is the existence of a leader within the home to act as a champion of hip protectors and to convince others of their efficacy [74, 75].

Therefore, we hypothesized that responses to the C-HiP Index should be: (i) lower among paid caregivers who responded ‘Yes’ to the question, “Are you aware of a resident breaking their hip during a fall while wearing a hip protector”, compared to those who responded ‘No’; (ii) higher among paid caregivers who agreed (responded ‘4’ or ‘5’ on a 5-point Likert scale) with the statement, “Would you say there is at least one other person in your residential care facility that is a champion of hip protectors”, compared to those who did not agree (responded ‘1’, ‘2’ or ‘3’). As C-HiP Index responses were rightward skewed, we performed Mann-Whitney U tests to determine whether there were differences
in median responses to lower-order factors and the entire C-HiP Index between these subgroups of respondents.

3.3.13. Internal Consistency

To assess internal consistency, we computed Cronbach’s alpha coefficients for lower-order factors and the entire C-HiP Index. We hypothesized alpha coefficients would be above 0.70, indicating acceptable internal consistency [76].

3.4. Results

Table 3.2 describes mean (SD) responses to individual items of the C-HiP Index derived from the EM imputed dataset.

3.4.1. Construct Validity

Contrary to expectation, both Velicer’s MAP test and parallel analysis indicated the presence of only two lower-order factors. The eigenvalues of Factor 1 and Factor 2 were 9.225 and 1.078, respectively. Accordingly, lower-order factors explained 68.7% of the variance in responses. One cognitive item (i.e., COG06) – “I doubt the effectiveness of hip protectors” – had poor pattern matrix and structure matrix coefficients for both Factor 1 (-.597, -.508, respectively) and Factor 2 (.136, -.250, respectively), and was removed. After removal of COG06, EFA yielded two lower-order factors, with eigenvalues of 9.002 and 1.033, respectively. Lower-order factors now explained 71.7% of the variance in responses. Items from the affective and cognitive subscales loaded highest on Factor 1, whereas items from the behavioural subscale loaded highest on Factor 2 (Table 3.3).

Higher-order factor analysis supported a hierarchical factor structure (Figure 3.1). Both Factor 1 (affective/cognitive subscale) and Factor 2 (behavioural subscale) loaded onto a single higher-order factor, “commitment to hip protectors,” having an eigenvalue of 1.386 and accounting for 69.3% of the variance in responses. Factor 1 (affective/cognitive subscale) and Factor 2 (behavioural subscale) each had factor matrix coefficients of .833.
3.4.2. Content Validity

Twelve items had a CVI above 0.79 for both clarity and relevance. A single item, BEH04 (“I am willing to put in a great deal of effort, above and beyond what is normally expected, to work with hip protectors”), had a CVI of 0.82 (‘adequate’) for relevance, but a CVI of 0.73 (‘questionable’) for clarity. Another item, BEH03 (“When it comes to hip protectors, I am willing to accept changes in the roles and responsibilities of my job”), had a CVI of 0.73 (‘questionable’) for relevance, and a CVI of 0.55 (‘unacceptable’) for clarity. Finally, a single item, COG06 (“I doubt the effectiveness of hip protectors”), had a CVI below 0.70 for both clarity and relevance, and therefore, was eliminated from the C-HiP Index (Table 3.2).

3.4.3. Convergent Validity

After removal of COG06, a 1-unit increase in championing (responses to the single question, “Do you think of yourself as a champion of hip protectors”, scored from 1 to 5) was associated with 3.6-point (95% CI: 2.9-4.2; p<0.01), 1.6-point (95% CI: 1.4-1.9; p<0.01) and 5.2-point (95% CI: 4.4-6.1; p<0.01) increases in the affective/cognitive subscale (scored from 9 to 45), the behavioural subscale (scored from 5 to 25) and the entire C-HiP Index (scored from 14 to 70), respectively.

3.4.4. Concurrent Validity

We observed significantly lower median responses to the affective/cognitive subscale (estimated difference=4.0-points; p<0.01), the behavioural subscale (estimated difference=1.0-point; p<0.01), and the entire C-HiP Index (estimated difference = 4.3-points; p<0.01) among paid care providers who were aware of a resident breaking their hip during a fall while wearing a hip protector compared to those who were unaware (Table 3.4).

We also observed significantly higher median responses to the affective/cognitive subscale (estimated difference=5.0-points; p<0.01), the behavioural subscale (estimated difference=2.0-points; p<0.01), and the entire C-HiP Index (estimated difference=7.0-points; p<0.01) among paid care providers who agreed that there is at least one other
person in their LTC home that is a champion of hip protectors compared to those who did not agree (Table 3.4).

### 3.4.5. Internal Consistency

After removal of COG06, Cronbach’s alpha coefficients for the affective/cognitive subscale, the behavioural subscale, and the entire C-HiP Index were 0.97, 0.87, and 0.96, respectively.

### 3.5. Discussion

Hip protectors represent a promising technology for the prevention of hip fractures in one of society’s frailest and most cognitively impaired cohorts of older adults, residents of LTC. However, a major barrier to the clinical effectiveness of hip protectors in LTC is poor user adherence in the wearing of hip protectors, often dropping below 50% in clinical trials [36]. Within LTC, care providers are believed to play a particularly important role in influencing a resident’s decision to wear hip protectors on a regular basis (e.g., [39-43, 45, 44, 46]). The overall commitment of paid care providers towards hip protectors has been identified as an important determinant of adherence, but empirical evidence is lacking because instruments to measure care provider commitment have not been available [37]. To address this knowledge gap, our aim was to develop a valid and reliable tool to measure commitment to hip protectors among paid caregivers in LTC.

Consistent with extant research, we defined commitment to hip protectors as an individual’s attachment to and behavioural intentions towards hip protectors, reflected by three components: (i) a belief in the value and importance of hip protectors (affective commitment), (ii) acceptance of the clinical efficacy of hip protectors (cognitive commitment), and (iii) a willingness to act or modify their behaviour to generally support the use of hip protectors (behavioural commitment). We adapted existing metrics of workplace commitment to develop the C-HiP Index, originally containing the 4-item affective subscale, the 6-item cognitive subscale, and the 5-item behavioural subscale. However, one negative item was removed from the cognitive subscale, as it did not meet our criteria for retention in EFA and it had a CVI less than 0.70 (<70% agreement) for both
clarity and relevance. Despite expert ratings of unacceptable and questionable clarity, respectively, we retained BEH03 and BEH04 in their original form as they met our criteria for retention in EFA and did not have unacceptably low CVI scores (<0.70) for relevance.

We expected EFA to confirm a hierarchical factor structure, yielding three lower-order factors, and a single higher-order factor. We hypothesized items from the affective subscale would load onto a first lower-order factor, items from the cognitive subscale would load onto a second lower-order factor, and items from the behavioural subscale would load onto a third lower-order factor. We also hypothesized lower-order factors would subsequently load onto a single higher-order factor. However, contrary to expectation, EFA supported a hierarchical factor structure with only two lower-order factors, and a single higher-order factor. Items from the affective and cognitive subscales loaded together onto a first lower-order factor (i.e., ‘Factor 1’) and those from the behavioural subscale loaded onto a second lower-order factor (i.e., ‘Factor 2’). Both lower-order factors then loaded onto a single higher-order factor (i.e., ‘Commitment to Hip Protectors’).

We have shown it is hard to separate affective commitment from cognitive commitment, and believe this inconsistency is explained by empirical, rather than conceptual problems. Firstly, it is possible that these results are merely a by-product of our sampling strategy, in which we recruited participants from a single health authority in BC, Canada. Although excessive variability (i.e., noise) in any signal can interfere with our ability to make statistical inferences, the same can be said when there is too little variability. For example, we need variability in predictor variables to explain variability in outcomes. After conducting this study, it became apparent that commitment to hip protectors among paid caregivers in participating LTC homes was higher and less variable than expected, with mean scores exceeding 4.00 for most (93%) items of the C-HiP Index. Therefore, we may not have been able to distinguish affective from cognitive commitment because the majority of respondents believed in the value of hip protectors and their clinical efficacy. To determine if affective commitment and cognitive commitment truly are inseparable, future research should include participants from LTC homes where hip protectors have not been embraced as a fall-related injury prevention strategy, and commitment to hip protectors is much lower.
Alternatively, we might have failed to capture the true essence of affective commitment to hip protectors in the C-HiP Index, and instead wrote 9-items to measure cognitive commitment. Solinger, van Olffen and Roe [57] defined affective commitment as an emotional attachment and identification with one or more targets, and cognitive commitment as the internalization of a target’s goals, norms and values. Although we adapted affective items from the well-validated affective commitment subscale of Herscovitch and Meyer’s [53] Commitment to Change scale, in future research it might be fruitful to revise and improve this subscale of the C-HiP Index to better capture an individual’s emotional attachment to and identification with hip protectors. Examples could include, “I love the idea of hip protectors”, “I hate the idea of hip protectors”, “I would consider wearing hip protectors if I was a senior residing in this long-term care home”, or perhaps, “I would put hip protectors on my mom or dad.”

Despite the unexpected factor structure, we were able to demonstrate the content, convergent and concurrent validity of the C-HiP Index. For example, after removing COG06, 86% (12 of 14) of remaining C-HiP Index items had a CVI above 0.79 for both clarity and relevance. Furthermore, we saw a positive and significant association of overall C-HiP Index scores with self-reported championing behaviours (estimated slope of the regression line, $\beta_1=5.2$-points). As theorized, respondents who were aware of a resident breaking their hip during a fall while wearing a hip protector had lower median scores compared to those who were unaware (estimated difference=4.3-points). Also, respondents who agreed with the statement that there is at least one other person in their LTC home that is a champion of hip protectors had higher median scores compared to those who did not agree (estimated difference=7.0-points). These findings are in line with those from previous qualitative and quantitative studies examining resident and staff experiences using hip protectors, which suggest differences should exist in commitment between these subgroups of respondents [74, 75, 73].

In general, the C-HiP Index demonstrated acceptable internal consistency, having alpha values greater than 0.70 [76]. Alpha values of the affective/cognitive subscale (9-items), the behavioural subscale (5-items), and the entire C-HiP Index (14-items) were 0.97, 0.87, and 0.96, respectively, thereby achieving high consistency, but also suggesting that some items could potentially be removed from the affective/cognitive subscale to
reduce redundancies [77]. However, as Cronbach’s alpha coefficients are sensitive to the number of the questions contained in a scale, with longer scales always demonstrating improved reliability, these findings are not surprising, and thus, should be interpreted with some caution.

We acknowledge some important limitations. First, we recruited a convenience sample of paid care providers, and did not adopt a random sampling strategy. Thus, it is possible that those who chose to participate in our study are more committed to hip protectors than those who declined, which could have introduced bias. However, we are fairly confident our sampling strategy has not favoured and/or excluded obvious groups within the target population in terms of gender, age, employment status, and occupation/role type, as distributions are consistent with those reported in previous studies (e.g., [78]), including the National Study of Long-Term Care Providers conducted by the National Center for Health Statistics in the United States [79]. Second, previous research has shown that attitudes towards hip protectors differ between caregivers working day and night shifts, with night shift employees reporting less favourable attitudes towards hip protectors [47]. For example, Milisen et al. (2011) observed that nurses working night shifts were more likely to rate a hip protector policy in LTC as time-consuming, stressful, and as having a potentially negative impact on the independence of residents compared to nurses working day shifts only [47]. It is possible that care providers who work mostly nightshifts might respond to the C-HiP Index in a conceptually distinct manner to those working day or evening shifts. As we received only n=11 responses from night shift employees, we could not examine whether the factor structure of C-HiP Index items was equivalent between day/ evening and night shift respondents. Third, we only recruited participants from a single health authority, which limits the generalizability of our findings outside the Fraser Valley of BC, Canada. Regions located beyond these borders might have differing policies on hip protectors, cultural norms, educational requirements, and use of dialects and/or languages, which could affect responses to the C-HiP Index and consequently, measures of validity and reliability obtained from psychometric testing. Fourth, although we conducted a comprehensive evaluation of the C-HiP Index, we did not explore face validity. Face validity can be assessed by asking end-users to subjectively rate the clarity/transparency and relevance of the instrument as it appears to them at face value. Finally, when assessing content validity, we did not collect data on the first language
of respondents, which might have provided valuable insight into why experts rated the clarity of BEH03, BEH04, and COG06 as questionable (CVI=0.70-0.79) or unacceptable (CVI<0.70). An understanding of how clarity rankings may have associated with first language could aide future endeavours to improve the C-HiP Index.

3.6. Conclusions

Despite these limitations, we offer novel insight into the psychometric properties of a tool to measure commitment to hip protectors among paid care providers in LTC. We have provided evidence of the content, construct, convergent, and concurrent validity, as well as the internal and external consistency of the C-HiP Index. The development of a valid and reliable assessment tool is a crucial first step in understanding the relationship between care provider commitment and levels of reported adherence in the wearing of hip protectors amongst residents of LTC. Downstream, findings have the potential to improve the safety and efficiency of care for institutionalized older adults, through deeper understanding of the factors governing adherence to a promising technology for the prevention of fall-related hip fractures, wearable hip protectors.
3.7. References


Figure 3.1  Conceptual model of commitment to hip protectors determined using hierarchical (higher-order) exploratory factor analysis.
Table 3.1 Demographic characteristics of 529 paid care providers who completed the C-HiP Index.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>474 (89.6)</td>
</tr>
<tr>
<td>Male</td>
<td>40 (7.6)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>15 (2.8)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>20-29 years</td>
<td>42 (7.9)</td>
</tr>
<tr>
<td>30-39 years</td>
<td>87 (16.4)</td>
</tr>
<tr>
<td>40-49 years</td>
<td>149 (28.2)</td>
</tr>
<tr>
<td>50-59 years</td>
<td>187 (35.3)</td>
</tr>
<tr>
<td>60-69 years</td>
<td>46 (8.7)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>18 (3.4)</td>
</tr>
<tr>
<td>Highest level of education</td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>5 (0.9)</td>
</tr>
<tr>
<td>High school or equivalent</td>
<td>43 (8.1)</td>
</tr>
<tr>
<td>College or professional certification</td>
<td>312 (59.0)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>119 (22.5)</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>36 (6.8)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>14 (2.6)</td>
</tr>
<tr>
<td>Race/ethnicity – mark all that apply</td>
<td></td>
</tr>
<tr>
<td>Black Canadian</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>17 (3.2)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>24 (4.5)</td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>261 (49.3)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>24 (4.5)</td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>23 (4.3)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>24 (4.5)</td>
</tr>
<tr>
<td>Filipino</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>69 (13.0)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>25 (4.7)</td>
</tr>
<tr>
<td>South Asian (E.g., East Indian, Pakistani, Sri Lankan)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>95 (18.0)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>24 (4.5)</td>
</tr>
<tr>
<td>Role/occupation – mark all that apply</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Health care assistant/resident care aide</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>290</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>17</td>
</tr>
<tr>
<td>Licensed practical nurse</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>84</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>17</td>
</tr>
<tr>
<td>Registered nurse</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>40</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>17</td>
</tr>
<tr>
<td>Resident care coordinator</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>17</td>
</tr>
<tr>
<td>Manager</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>14</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>17</td>
</tr>
<tr>
<td>Recreational/occupational/physiotherapist</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>17</td>
</tr>
<tr>
<td>Unit/program clerk</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>17</td>
</tr>
<tr>
<td>Employment status</td>
<td></td>
</tr>
<tr>
<td>Part-time</td>
<td>149</td>
</tr>
<tr>
<td>Casual</td>
<td>86</td>
</tr>
<tr>
<td>Full-time</td>
<td>282</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>12</td>
</tr>
<tr>
<td>Shift</td>
<td></td>
</tr>
<tr>
<td>Day shifts</td>
<td>237</td>
</tr>
<tr>
<td>Evening shifts</td>
<td>61</td>
</tr>
<tr>
<td>Night shifts</td>
<td>11</td>
</tr>
<tr>
<td>Combination</td>
<td>206</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>14</td>
</tr>
<tr>
<td>Clinical experience</td>
<td></td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>15</td>
</tr>
<tr>
<td>1-5 years</td>
<td>98</td>
</tr>
<tr>
<td>5-10 years</td>
<td>121</td>
</tr>
<tr>
<td>Organizational tenure</td>
<td>Count (Percentage)</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>15 (2.8)</td>
</tr>
<tr>
<td>30 or more years</td>
<td>38 (7.2)</td>
</tr>
<tr>
<td>10-20 years</td>
<td>148 (28.0)</td>
</tr>
<tr>
<td>20-30 years</td>
<td>94 (17.8)</td>
</tr>
<tr>
<td>5-10 years</td>
<td>120 (22.7)</td>
</tr>
<tr>
<td>1-5 years</td>
<td>159 (30.1)</td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>36 (6.8)</td>
</tr>
<tr>
<td>20-30 years</td>
<td>57 (10.8)</td>
</tr>
<tr>
<td>20-30 years</td>
<td>13 (2.5)</td>
</tr>
<tr>
<td>Missing/unknown</td>
<td>15 (2.8)</td>
</tr>
</tbody>
</table>
Table 3.2 Missingness, means, standard deviations (SD), and content validity index scores for C-HiP Index items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Missingness</th>
<th>Content Validity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td><strong>Affective commitment subscale</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFF01</td>
<td>I believe in the value of hip protectors.</td>
<td>2</td>
</tr>
<tr>
<td>AFF02</td>
<td>Hip protectors are necessary.</td>
<td>6</td>
</tr>
<tr>
<td>AFF03</td>
<td>Hip protectors are needed.</td>
<td>10</td>
</tr>
<tr>
<td>AFF04</td>
<td>Hip protectors serve an important purpose.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Cognitive commitment subscale</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COG01</td>
<td>I believe in the effectiveness of hip protectors.</td>
<td>3</td>
</tr>
<tr>
<td>COG02</td>
<td>I am convinced that, when worn, hip protectors help to protect my residents from injury.</td>
<td>1</td>
</tr>
<tr>
<td>COG03</td>
<td>I think that hip protectors work.</td>
<td>2</td>
</tr>
<tr>
<td>COG04</td>
<td>I think that hip protectors are useful.</td>
<td>3</td>
</tr>
<tr>
<td>COG05</td>
<td>I am convinced that, when worn, hip protectors reduce risk for injury from falls.</td>
<td>0</td>
</tr>
<tr>
<td>COG06</td>
<td>I doubt the effectiveness of hip protectors.</td>
<td>7</td>
</tr>
<tr>
<td><strong>Behavioural commitment subscale</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEH01</td>
<td>I am always willing to work with hip protectors.</td>
<td>5</td>
</tr>
<tr>
<td>BEH02</td>
<td>I try to remain positive about hip protectors, even under challenging circumstances.</td>
<td>1</td>
</tr>
<tr>
<td>BEH03</td>
<td>When it comes to hip protectors, I am willing to accept changes in the roles and responsibilities of my job.</td>
<td>14</td>
</tr>
<tr>
<td>BEH04</td>
<td>I am willing to put in a great deal of effort, above and beyond what is normally expected, to work with hip protectors.</td>
<td>5</td>
</tr>
<tr>
<td>BEH05</td>
<td>I am willing to adjust the way I do my job, as required to use hip protectors.</td>
<td>4</td>
</tr>
</tbody>
</table>

† Expectation-Maximization (EM) imputed means; responses ranged from 1 (strongly disagree) to 5 (strongly agree)
Table 3.3  Pattern and structure matrix coefficients for each item retained in exploratory factor analysis.

<table>
<thead>
<tr>
<th>Item</th>
<th>Pattern Matrix</th>
<th>Structure Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
<td>Factor 2</td>
</tr>
<tr>
<td>Affective commitment subscale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFF01</td>
<td>I believe in the value of hip protectors.</td>
<td>.861</td>
</tr>
<tr>
<td>AFF02</td>
<td>Hip protectors are necessary.</td>
<td>.847</td>
</tr>
<tr>
<td>AFF03</td>
<td>Hip protectors are needed.</td>
<td>.825</td>
</tr>
<tr>
<td>AFF04</td>
<td>Hip protectors serve an important purpose.</td>
<td>.853</td>
</tr>
<tr>
<td>Cognitive commitment subscale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COG01</td>
<td>I believe in the effectiveness of hip protectors.</td>
<td>.933</td>
</tr>
<tr>
<td>COG02</td>
<td>I am convinced that, when worn, hip protectors help to protect my residents from injury.</td>
<td>.908</td>
</tr>
<tr>
<td>COG03</td>
<td>I think that hip protectors work.</td>
<td>.926</td>
</tr>
<tr>
<td>COG04</td>
<td>I think that hip protectors are useful.</td>
<td>.898</td>
</tr>
<tr>
<td>COG05</td>
<td>I am convinced that, when worn, hip protectors reduce risk for injury from falls.</td>
<td>.891</td>
</tr>
<tr>
<td>Behavioural commitment subscale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEH01</td>
<td>I am always willing to work with hip protectors.</td>
<td>.202</td>
</tr>
<tr>
<td>BEH02</td>
<td>I try to remain positive about hip protectors, even under challenging circumstances.</td>
<td>.248</td>
</tr>
<tr>
<td>BEH03</td>
<td>When it comes to hip protectors, I am willing to accept changes in the roles and responsibilities of my job.</td>
<td>-.070</td>
</tr>
<tr>
<td>BEH04</td>
<td>I am willing to put in a great deal of effort, above and beyond what is normally expected, to work with hip protectors.</td>
<td>.137</td>
</tr>
<tr>
<td>BEH05</td>
<td>I am willing to adjust the way I do my job, as required to use hip protectors.</td>
<td>-.100</td>
</tr>
</tbody>
</table>
Table 3.4 Concurrent validity of the C-HiP Index.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Affective/Cognitive†</th>
<th>Behavioural</th>
<th>C-HiP Index†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>P-value</td>
<td>Median</td>
</tr>
<tr>
<td>Aware of padded hip fracture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (n=203, 38%)</td>
<td>36.0</td>
<td>p&lt;0.01*</td>
<td>20.0</td>
</tr>
<tr>
<td>No (n=326, 62%)</td>
<td>40.0</td>
<td></td>
<td>21.0</td>
</tr>
<tr>
<td>Existence of a champion of hip protectors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree (n=397, 75%)</td>
<td>40.0</td>
<td>p&lt;0.01*</td>
<td>21.0</td>
</tr>
<tr>
<td>Neutral or disagree (n=132, 25%)</td>
<td>35.0</td>
<td></td>
<td>19.0</td>
</tr>
</tbody>
</table>

† After removal of the cognitive item (COG06), “I doubt the effectiveness of hip protectors”
* p<0.01 in each multiply imputed dataset; Mann-Whitney U tests
Chapter 4. Determinants of Commitment to Hip Protectors in Long-Term Care Providers of a Regional Health Authority in British Columbia, Canada: A Cross-Sectional Survey

4.1. Introduction

About half (52%) of older adults residing in long-term care (LTC) facilitate experience frailty, and many have at least one morbidity, including dementia, incontinence, neuromuscular disorders (e.g., Parkinson’s disease), arthritis, osteoporosis, pain, sensory deficits, and/or depression [1-9]. Collectively, this places older adults in LTC at elevated risk for falls and fall-related injuries [10-14]. About one in two residents fall every year, with 11% of falls inflicting serious injury and 1% causing hip fracture [10, 15]. Residents in LTC are up to 10-times more likely to suffer a fall-related hip fracture than community-dwelling older adults [12-14], and hip fracture incidence rates (IR) of 23-51 per 1000 resident years have been reported in the United States and Germany, respectively [16, 17]. Less than two-thirds of residents admitted to hospital because of a fractured hip will survive the next six months, with survival rates dropping to 53% one year later [18]. Even after adjustments are made for age and baseline health status (e.g., physical activity, diabetes mellitus), community-dwelling women over the age of 75 who experience a hip fracture have a risk of death more than two times higher than the mortality rate of women without hip fracture [19]. In Canada, the cost of hip fractures is estimated at $1.1 billion annually (direct treatment costs only), and given the anticipated aging of the population, is expected to exceed $2.4 billion by 2041 [20, 21].

Falls have a multifaceted etiology, resulting from the interplay of situational (e.g., polypharmacy), intrinsic (e.g., neuromuscular disorders) and extrinsic (e.g., environmental hazards) factors. Accordingly, falls represent a ‘wicked problem’ that has proved very difficult to solve, especially in LTC [22]. As a result, complementary efforts have been directed towards creating safer movement environments, with the goal of minimizing risk for injury in the event of a fall.
Hip protectors are an example of protective clothing, which consist of hard shields or soft shell pads sewn or inserted into pockets covering the skin over the lateral aspects of the proximal femur. Hip protectors minimize the magnitude of compressive force transmitted to the greater trochanter at impact, through energy-absorbing and/or energy-shunting mechanisms [23-28]. However, commercially available hip protectors vary substantially in their capacity to attenuate impact force, especially at moderate impact velocities (3 m/s) [23].

If worn at the time of a fall, specific hip protectors are effective at preventing hip fractures [29, 30]. For example, when hip fracture rates are contrasted in padded and unpadded falls, the use of hip protectors has been shown to reduce fracture risk by 69-80% [31, 29, 32]. However, many older adults who are provided with hip protectors refuse to wear them [33, 30]. Clinical trials have reported rates of adherence between 20–80% [34, 35], with most hip fractures occurring while participants are not wearing hip protectors [36]. As a result, intention-to-treat type analyses show comparatively smaller and sometimes non-significant (e.g., 0-40% [36, 29]) reductions in risk for hip fracture between participants assigned to intervention and control arms. Thus, poor user adherence makes hip protectors less effective.

A number of factors influence whether a resident in LTC will accept the initial offer of hip protectors, and then continue to wear them [37]. Commonly reported barriers of acceptance and/or adherence include cost [38, 39], discomfort [40-46], difficulty with use [43, 38, 44], unwanted side effects [43, 44, 47, 48], frequent incontinence [47, 49, 38], and fatalism or depression [38, 45, 49], while facilitators include a history of falls and fall-related injuries [50], a high risk for falling [46], a strong fear of falling [51, 52], osteoporosis [53, 49, 47], and peer and family advocacy [53, 38]. Compliance is also mediated by distal factors, beyond the immediate control of residents and family. Here, barriers include poor availability of hip protectors when laundering (especially over the weekends) [42], and frequent turnover of managerial staff [54], while facilitators include the provision of hip protectors at no cost [41, 55], physician referral [56], and staff commitment [49, 57, 58, 43].
As acknowledged in several studies (e.g., [49, 57, 58, 43]), staff commitment is probably the least understood factor linked to adherence in LTC. Care providers play an important role in the delivery and utilization of hip protectors; for example, they are responsible for identifying residents at risk for falls who are likely to benefit from and tolerate hip protectors, providing service users (residents, family) with knowledge of hip protectors, monitoring adherence, checking for indications of discomfort or unwanted side effects, and identifying/implementing solutions to problems that might prevent continued coverage [43]. Yet, we know very little about the nature of commitment to hip protectors in LTC, including how it develops. Therefore, our objective was to identify factors associated with commitment to hip protectors amongst paid care providers in LTC.

4.2. Diffusion of Innovation Theory

The longstanding theory of diffusion of innovation (DOI) underpinned our framework of potential antecedents of commitment to hip protectors. DOI theory states that an individual’s decision to adopt or reject innovation into daily practice occurs over a five-stage iterative process, spanning knowledge acquisition, persuasion, decision, implementation and confirmation, whereby adoption will occur only if an individual forms a favourable attitude towards the innovation [59].

Commitment is a distinct, but related attitudinal phenomenon to the one conceptualized in DOI theory. According to Eagly and Chaiken (1993), commitment refers only to an individual’s attitude towards a target, and not their attitude towards changing or modifying behaviour [60, 61]. The attitude conceptualized in DOI theory reflects a broader construct, one that is likely the by-product of these two attitudinal phenomena. Consequently, even when an individual is committed to an innovation, they may not intend to modify their behaviour.

Many factors are theorized to influence attitudes towards innovations. According to DOI theory [59], the likelihood that a favourable attitude will form depends on: (i) personal traits, such as gender, specialty, professional tenure, and their general attitude towards change; (ii) aspects of the innovation, including its relative advantage, perceived compatibility, complexity, trialability, and observability; (iii) communication channels,
including face-to-face exchange, research publications, and mass media; and (iv) the social context, including bureaucracy, organizational culture, and leadership. Accordingly, we hypothesized commitment to hip protectors is associated with personal traits, aspects of the technology, and organizational characteristics.

4.3. Material and Methods

4.3.1. Setting and Experimental Protocol

We conducted a cross-sectional survey in thirteen publically subsidized LTC homes, all owned and operated by the Fraser Health Authority (BC, Canada). We convenience-sampled paid care providers who worked: (i) most of their time (greater than 50% of their work hours) at a participating LTC home; (ii) for at least one full month on their unit; (iii) for at least 8 hours per week on their unit. According to DOI theory, an individual must first become aware of an innovation before they can form an attitude (either favourable or unfavourable) towards that innovation [59]. Thus, we excluded respondents who had never heard of hip protectors; however, this was rare (1.1%, n=6).

A more detailed accounting of the research setting and experimental protocol is available elsewhere (Chapter 2). The experimental protocol was reviewed and approved by the Simon Fraser University Office of Research Ethics (ORE) and the Fraser Health Authority Research Ethics Board (FHREB).

4.3.2. Sample

Five-hundred and twenty-nine (n=529) paid care providers were included in the sample, mainly Caucasian (49%) females (90%) in their fifties (35%), who worked full-time (53%) as health care assistants/resident care aides (55%). Although we actively recruited participants from thirteen LTC homes owned and operated by the Fraser Health Authority, n=4 (0.8%) respondents indicated they worked most of their time at a LTC home owned and operated by Fraser Health Authority that elected not to participate in the launch of surveys. However, as these respondents otherwise met our criteria for inclusion, they were retained in the study sample. With respect to education, less than 1% of respondents did
not finish high school, 8% completed a high school diploma or equivalency certificate, 59% completed a college or non-university diploma, 23% completed a Bachelor’s degree, 7% completed a Master’s degree, and the remainder was unknown. Most respondents worked day shifts only (49%), or a combination of day, evening, and/or night shifts (39%). Just less than a third (28%) of respondents had between 10-20 years of clinical experience, and 30% had between 1-5 years of organizational tenure (years worked at the same LTC home).

4.3.3. Variable Measurement

4.3.3.1 Commitment to Hip Protectors

We measured commitment to hip protectors using the C-HiP Index, which assessed three dimensions of commitment: four items to assess affective commitment (e.g., ‘I believe in the value of hip protectors’), five items to assess behavioural commitment (e.g., ‘I am willing to adjust the way I do my job, as required to use hip protectors’), and five items to assess cognitive commitment (e.g., ‘I am convinced that, when worn, hip protectors reduce risk for injury from falls’). Responses were made on 5-point Likert scales ranging from 1 (‘Strongly disagree’) to 5 (‘Strongly agree’). We averaged responses across all fourteen items to derive a single value of commitment for each respondent. Internal consistency of the scale was high (Cronbach’s alpha=0.96).

4.3.3.2 Explanatory Variables

We measured ten personal traits, including age, gender, race/ethnicity, positive and negative affect [62], education, occupation, employment status, shift, clinical experience and organizational tenure. We assessed three aspects of the technology, including awareness of a padded fall resulting in hip fracture, familiarity with the use of hip protectors as a strategy to prevent injuries from falls, and familiarity with protocols concerning the use of hip protectors. Lastly, we assessed staff perceptions of twelve organizational characteristics, including the existence of a champion of hip protectors, communication [63], transformational and passive leadership of their direct supervisor [64, 65], intimacy among coworkers, workplace incivility [66], resident/family autonomy, quality
of resident-provider relationships, whether the respondent worked primarily on a dementia unit/ward, frequency of consistent assignment (assignment of providers to the same residents), family interference with work [67-70], and emotional exhaustion [71] (Table 4.1). Responses to clinical experience and organizational tenure were dichotomized into two categories (≤20 years=0; >20 years=1). We also constructed a dichotomous variable representing frequency of consistent consignment (<80% of shifts=0; ≥80% shifts=1).

4.3.4. Missing Data

Of the 529 respondents, 338 (64%) answered all questions completely, and thus had no missing data. For the remainder, missing data was handled using the multiple imputation (MI) procedures implemented in the mice [72] package of R [73]. MI is reputed to yield realistic parameter estimates and precise estimates of uncertainty, whilst also maintaining maximal statistical power, especially when compared to simpler techniques, such as list-wise deletion and mean substitution [74-76]. We imputed m=5 datasets, and included all variables in the MI imputation model.

4.3.5. Statistical Analysis

The goal of our analysis was to identify variables that have an apparent relationship with the primary response variable, which was the average of 14 Likert scales. Such a measurement has statistical properties that contraindicate the use of models based on a normal distribution. In particular, averages near the two boundary values – 1 and 5 – have considerably less variability than averages near the middle of the scale [77]. Because this variance structure more closely resembles that of binomial proportions, we rescaled each item of the C-HiP Index to take values 0, ¼, ½, ¾, or 1. We then averaged these responses, which resulted in an outcome variable that had properties very much like a binomial proportion. As such, we used logistic regression methods to model commitment to hip protectors as a function of personal traits, aspects of the technology, and organizational characteristics.

To identify which explanatory variables maintained an important relationship with commitment, we used Bayesian Model Averaging (BMA, [78]). Specifically, we fit separate
logistic regression models using each possible combination of explanatory variables and evaluated each model using the Bayesian Information Criterion (BIC). These BIC values were in turn converted to approximate “posterior probabilities” that each model is the correct one, given the data. The importance of each variable was measured as the sum of the posterior probabilities from all models that contained a given variable. The result was a posterior probability that each variable belongs in the model.

Interpretation of variables’ posterior probabilities is somewhat subjective, but generally variables with “high” probability (>95%) of being in the model are considered important; variables with “low” probability (<50%) are unimportant; and variables with intermediate probability (50-95%) are potentially important [79]. More specifically, it has been suggested that a posterior probability>99% constitutes very strong evidence of a relationship, a posterior probability=95-99% constitutes strong evidence, a posterior probability=75-94% constitutes positive evidence, and a posterior probability=50-74% constitutes weak evidence [79].

BMA represents a superior approach to variable selection over standard models (e.g., stepwise regression), as it considers each variable within the context of many possible models, where presence of other variables may change its apparent importance. By representing variable importance as a posterior probability rather than an in-or-out dichotomous indicator, BMA enables us to express the uncertainty involved in the model selection process when identifying antecedents of commitment to hip protectors.

We performed BMA using the bicglm function from the BMA package in R [73]. The process was performed separately on each of the five imputations of the data and average posterior probabilities, parameter estimates, standard errors, and confidence intervals were computed using established formulas accounting for both (i) the unconditional variability associated with the parameter estimation by BMA within each imputation and (ii) the variability imparted on the estimates by the imputation scheme [78].

For each explanatory variable, we report its posterior probability, estimated logistic regression coefficient, and corresponding 95% confidence interval. Posterior probabilities provide insight into the relative importance of each explanatory variable, while estimated logistic regression coefficients offer an indication of the direction of the effect (positive,
negative) each explanatory variable has on commitment. We also report the top ten models selected by BMA; for each model, we provide the estimated probability that the chosen model is the best one, as well as $R^2$ measures of predictive power (uncorrected and corrected Cox-Snell $R^2$ coefficients).

4.4. Results

4.4.1. Commitment to Hip Protectors

Mean (SD) commitment was 4.15 (0.71). Of the 529 respondents: $n=2$ (0.4%) had a mean commitment score equal to 1; $n=5$ (0.9%) had a mean score greater than or equal to 1, but less than 2; $n=25$ (4.7%) had a mean score greater than or equal to 2, but less than 3; $n=151$ (28.5%) had a mean score greater than or equal to 3, but less than 4; $n=280$ (52.9%) had a mean score greater than or equal to 4, but less than 5; $n=67$ (12.7%) had a mean score equal to 5.

4.4.2. Bayesian Model Averaging (BMA)

Eleven explanatory variables, including five personal traits, two aspects of the technology, and four organizational characteristics, had posterior probabilities above 50% (Table 4.2).

There was very strong evidence that belief in the existence of a champion of hip protectors (posterior probability=100.0%), ratings of the quality of communication (posterior probability=100.0%), perceived quality of relationships between residents and care providers (posterior probability=99.8%), and the extent of transformational leadership (posterior probability=99.8%) within the LTC home were positively associated with commitment to hip protectors. In addition, there was very strong evidence that respondents who were aware of at least one resident suffering a hip fracture during a fall while wearing hip protectors were, on average, less committed to hip protectors than respondents who were unaware (posterior probability=100.0%).
We observed strong evidence that respondents with more than 20 years of organizational tenure were, on average, less committed to hip protectors than respondents with 20 or fewer years (posterior probability=97.4%). There was positive evidence that Latin American respondents were, on average, more committed to hip protectors than respondents who did not identify as Latin American (posterior probability=83.3%), while there was weak evidence that Caucasian respondents were, on average, less committed to hip protectors than respondents who did not identify as Caucasian (posterior probability=64.9%). Furthermore, there was weak evidence that rehabilitation assistants were, on average, less committed to hip protectors than respondents who did not identify as rehabilitation assistants (posterior probability=72.1%), whilst resident care coordinators were, on average, more committed to hip protectors than respondents who did not identify as resident care coordinators (posterior probability=52.2%).

Finally, we found weak evidence that extent of familiarity with hip protectors was positively associated with commitment to hip protectors (posterior probability=67.9%).

We provide the top ten models selected by BMA in Table 4.3. Of these, none stood out as a better model than the others; estimated model probabilities (the probability that the chosen model was the best model) ranged from 0.014 to 0.027, uncorrected Cox-Snell $R^2$ coefficients ranged from 0.557 to 0.583, and corrected Cox-Snell $R^2$ coefficients ranged from 0.592 to 0.617 (Table 4.4).

4.5. Discussion

To our knowledge, we are the first to design and test an empirical framework of potential antecedents of commitment to hip protectors amongst paid care providers in LTC. Guided by DOI theory [59], we modeled commitment to hip protectors as a function of three distinct taxonomies: (i) personal traits, (ii) aspects of the technology, and (iii) organizational characteristics.

We saw that commitment varied by race/ethnicity. On average, commitment was higher in Latin American compared to non-Latin American respondents, and lower in Caucasian compared to non-Caucasian respondents. Cultural norms and values vary by
race/ethnicity, so it is possible that race/ethnicity has an influence on commitment to hip protectors. Alternatively, the accuracy (validity and reliability) of survey responses is known to be affected by race/ethnicity [80, 81]. It has been theorized that individuals belonging to certain racial/ethnic groups may distort their responses to conform to socially desirable expectations ("mainstream conformity model"), to preserve their privacy ("cultural conflict model," e.g., [82]), and/or because of perceived discrimination or distrust of researchers ("cultural distrust model," e.g., [83]). An additional explanation offered by Johnson and Bowman [80] was that certain racial/ethnic groups may be more likely to respond erroneously due to misunderstanding and/or low literacy ("cultural deficit model," e.g., [84]). However, the association between race/ethnicity and accuracy (validity and reliability) of survey responses has mainly been studied in the context of self-reported drug use within the United States, and thus, may not be generalizable to the attitudes of care providers towards hip protectors within Canadian LTC homes.

On average, rehabilitation assistants and health care assistants were less committed to hip protectors, while resident care coordinators were more committed. Although the reasons for these findings are unclear, researchers have posited that attitudes towards hip protectors differ by occupation [48]. Forsen et al. (2004), for example, observed that adherence was greater in homes that employed a physiotherapist, rather than a nurse, to oversee the implementation of hip protectors, and perceived this might have been explained by more favourable attitudes towards hip protectors amongst physiotherapists, given that their role more specifically involved prevention of musculoskeletal injuries [48].

Organizational tenure was the last personal trait associated with commitment. Respondents with more than 20 years of organizational tenure were less committed to hip protectors than those with 20 or fewer years. Previous research indicates that resistance to change is greatest among older employees with long organizational tenure [85]. Thus, it is possible that respondents with more than 20 years of organizational tenure were more resistant to change, and consequently, less willing to adopt hip protectors into daily practice. If so, it follows that resistance to change might be the true deterrent to commitment, but this warrants further investigation.
Awareness of a resident sustaining a hip fracture while wearing a hip protector was an important barrier to commitment. We observed lower commitment among respondents who were aware of a resident suffering a fractured hip during a padded fall, compared to those who were unaware. Similar findings have been reported previously [48]. At first glance, this finding seems logical, but is not easily understood. The most likely possibility is that respondents formed a false sense of the benefits of hip protectors, and did not fully comprehend the limitations of the technology when appraising its relative advantage (i.e., they ‘set the bar too high’). Dissatisfaction is known to arise when performance expectations, albeit unrealistic, are unfulfilled (e.g., “expectation-disconfirmation theory” [86]), which could have led to a devaluation of hip protectors. Alternatively, this finding might stem, at least in part, from an actual underperformance of certain models of hip protectors. As we alluded to earlier, hip protectors are not equal in their biomechanical performance [23]. If we assume the probability that a padded fall will result in hip fracture increases with decreased biomechanical performance, it follows that a portion of the hip fractures in question might have occurred while residents were wearing inferior quality hip protectors. So, it is conceivable that some respondents who were aware of a padded hip fracture might have included products of inferior quality in their appraisal of the overall effectiveness of hip protectors. However, as policy makers within Fraser Health Authority have made concerted efforts to only promote hip protectors with documented protective effect (e.g., HipSaver, SAFEHIP®), we are more inclined towards the former of the two explanations. Whatever the cause, awareness of a resident suffering a fractured hip during a padded fall was clearly a barrier to commitment.

The second aspect of the technology that related to commitment was overall familiarity with hip protectors. Here, we observed strong evidence of a positive relationship between self-reported familiarity and commitment. Perhaps the use of hip protectors had become habitual among respondents who were very familiar with hip protectors. Habits are learned sequences of behaviours that have become relatively automatic [87, 88]. Once formed, habits are resilient, and are insensitive to devaluation of expected outcomes associated with these sequences of behaviours [87]. Habits are believed to influence commitment to other workplace foci, including organizational commitment [61]. On the topic, Solinger et al. (2008) wrote: “I am going to work every day, so I must like this organization” (p.72) [61]. As such, we argue the relationship between familiarity and
commitment could have been mediated by likelihood the use of hip protectors had become a habitual behaviour among respondents.

As hypothesized, commitment was also influenced by organizational characteristics. We observed strong evidence of an association between communication and commitment. Specifically, respondents were more committed to hip protectors when they perceived open, timely, accurate, and clear communication. Similar findings have been reported previously [56, 41]. Davies et al. (2004), for example, reported that staff awareness of the benefits of hip protectors was limited when information about hip protectors was not communicated to frontline staff [56]. Furthermore, Cameron et al. (2011) noted that nurses who possessed limited English language skills often seemed less interested in hip protectors [41].

Belief in the existence of a champion of hip protectors was also positively associated with commitment. A champion will go above and beyond what is required to adopt hip protectors into daily practice, often by exhibiting great personal sacrifice [89]. Champions are competent, persuasive, persistent, innovative, enthusiastic, charismatic, assertive, and/or willing to take risks to achieve their goals [90]. Originally framed by Bandura and Walters (1973), social learning theory states that people learn (at least in part) by observing, imitating and modeling the behaviour of others [91, 92]. Thus, we were not surprised to observe that the mere presence of a champion had a positive impact on commitment.

Commitment was also related to the quality of resident-provider relationships, such that respondents were more committed to hip protectors when they perceived mutually respectful relationships between residents and staff. Greater respect might have fostered a heightened sense of duty amongst respondents to contribute to the quality of life of the residents they serve. There is a substantial body of evidence that suggests commitment to a workplace foci can develop in attempts to avoid feelings of guilt or shame that might arise by letting down significant-others (e.g., colleague, friend, client) and/or to promote feelings of pride in one’s self for doing the right thing (e.g., [89, 93-96, 60]). These types of imagined consequences, previously referred to as normative outcomes, are considered an important antecedent of commitment [60, 61]. As such, it is possible respondents who
reported better quality relationships with residents perceived stronger normative outcomes associated with the use hip protectors, and this led to increased commitment.

Finally, we observed a positive relationship between transformational leadership and commitment. Transformational leaders create and share a vision of the future, support the personal development of followers, treat followers as autonomous agents who are capable of decision making, use unconventional, yet innovative strategies to achieve their goals, lead by example, and are competent and trustworthy [65]. Several authors have noted the importance of effective leadership in motivating staff to use hip protectors [56, 54, 52]. Davies et al. (2004), for example, employed a nurse specialist to facilitate and support the introduction of hip protectors. Staff characterized the nurse specialist as enthusiastic, competent, approachable, understandable, and accountable. After implementation, the authors conducted a survey to evaluate the impact of the nurse specialist. Almost all (95%) respondents indicated the nurse specialist had motivated them to use hip protectors, and a majority (79%) indicated the nurse specialist had made them aware of gaps in their knowledge [56].

As personal traits (i.e., organizational tenure, race/ethnicity, and occupation) cannot be modified, our findings suggest that programs to enhance commitment should be tailored to meet the needs of individual care providers. However, if we can further understand the mechanisms of why these traits are associated with commitment, we may be able to identify appropriate targets of change (e.g., overcoming resistance to change in tenured employees). Additionally, improved awareness among care providers of the limitations of hip protectors, including the scenarios in which they are unlikely to benefit residents, should enhance commitment. For example, hip protectors are not effective in cases of spontaneous fracture (which are rare) [97], when impact occurs to the posterior buttocks or to the knees [98, 99], or when the hip protector is not worn properly [100, 101]. This awareness should abate, but probably not eliminate, skepticism that surfaces after each time a hip fracture occurs during a padded fall. Furthermore, hip protector programs should periodically evaluate the effectiveness of hip protectors, and convey this information to care providers to minimize reliance on anecdotal evidence. Our findings suggest that interventions should also target the quality of resident-provider relationships, communication, and transformational leadership. Efforts should be made to foster
champions of hip protectors, and to market them as opinion leaders within and outside the home.

We acknowledge three important limitations. We did not randomly sample participants. Rather, our sample was one of convenience. Thus, it is possible that our sample was biased in favour of greater commitment to hip protectors. We also sampled from a regional district in BC, Canada, which could limit the generalizability of our findings. Finally, the cross-sectional nature of our study permits the inference of correlation, but not causation, thereby limiting the interpretability of findings.

4.6. Conclusions

Despite these limitations, we offer novel insight into the factors governing commitment to hip protectors amongst paid care providers in LTC. Race/ethnicity, occupation, organizational tenure, awareness of a padded hip fracture, familiarity of hip protectors, resident-provider relationship quality, communication, transformational leadership and the existence of a champion of hip protectors emerged as possible determinants of commitment. Although we were liberal in our inclusion of explanatory variables, we suggest this research serves as a foundation, from which future studies should build and expand. A related, but relevant research priority should be to identify determinants of commitment to hip protectors amongst service users in LTC, including residents and family members. We speculate adherence is optimized only when all members of an ecological system are harmonious in their commitment to hip protectors.
4.7. References


### 4.8. Tables

#### Table 4.1  Characteristics of the instruments and items used to measure personal traits, aspects of the technology, and organizational characteristics.

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Instrument</th>
<th>No. Items</th>
<th>Response categories/scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal traits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Investigator-developed</td>
<td>1</td>
<td>Male, Female</td>
</tr>
<tr>
<td>Age</td>
<td>Investigator-developed</td>
<td>1</td>
<td>Single response</td>
</tr>
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<td>Race/ethnicity</td>
<td>Investigator-developed</td>
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<td>Multiple responses</td>
</tr>
<tr>
<td>Highest level of education</td>
<td>Investigator-developed</td>
<td>1</td>
<td>Single response</td>
</tr>
<tr>
<td>Occupation</td>
<td>Investigator-developed</td>
<td>1</td>
<td>Multiple responses</td>
</tr>
<tr>
<td>Employment status</td>
<td>Investigator-developed</td>
<td>1</td>
<td>Single response</td>
</tr>
<tr>
<td>Shift</td>
<td>Investigator-developed</td>
<td>1</td>
<td>Single response</td>
</tr>
<tr>
<td>Clinical experience</td>
<td>Investigator-developed</td>
<td>1</td>
<td>Single response</td>
</tr>
<tr>
<td>Organizational tenure</td>
<td>Investigator-developed</td>
<td>1</td>
<td>Single response</td>
</tr>
<tr>
<td>Positive/negative affect</td>
<td>Positive and Negative Affect Schedule (PANAS)(^1)</td>
<td>20</td>
<td>1 ('Very slightly or not at all') – 5 ('Extremely')</td>
</tr>
<tr>
<td><strong>Aspects of the technology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aware of padded hip fracture</td>
<td>Investigator-developed</td>
<td>1</td>
<td>No, Yes</td>
</tr>
<tr>
<td>Familiarity with hip protectors</td>
<td>Investigator-developed</td>
<td>1</td>
<td>1 ('Not at all familiar') – 5 ('Very familiar')</td>
</tr>
<tr>
<td>Familiarity with hip protector protocols</td>
<td>Investigator-developed</td>
<td>1</td>
<td>1 ('Not at all familiar') – 5 ('Very familiar')</td>
</tr>
<tr>
<td><strong>Organizational characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existence of a champion of hip protectors</td>
<td>Investigator-developed</td>
<td>1</td>
<td>1 ('Strongly disagree') – 5 ('Strongly agree')</td>
</tr>
<tr>
<td>Communication</td>
<td>ICU Nurse-Physician Questionnaire(^2)</td>
<td>7</td>
<td>1 ('Strongly disagree') – 5 ('Strongly agree')</td>
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<tr>
<td>Transformational leadership</td>
<td>Global Transformational Leadership (GTL)(^3)</td>
<td>9</td>
<td>1 ('Rarely, or not at all') – 5 ('Most of the time')</td>
</tr>
<tr>
<td>Passive leadership</td>
<td>Multifactor Leadership Questionnaire (MLQ)(^4)</td>
<td>3</td>
<td>1 ('Rarely, or not at all') – 5 ('Most of the time')</td>
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<tr>
<td>Intimacy with coworkers</td>
<td>Unpublished (Care and Construction Study)(^5)</td>
<td>8</td>
<td>1 ('Strongly disagree') – 5 ('Strongly agree')</td>
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<tr>
<td>Workplace incivility</td>
<td>Workplace Incivility Scale (WIS)(^6)</td>
<td>7</td>
<td>1 ('Rarely, or not at all') – 4 ('Most of the time')</td>
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<tr>
<td>Resident/family autonomy</td>
<td>Unpublished (Care and Construction Study)(^5)</td>
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<td>1 ('Strongly disagree') – 5 ('Strongly agree')</td>
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<td>Resident-provider relationships</td>
<td>Unpublished (Care and Construction Study)(^5)</td>
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<td>Dementia unit/ward</td>
<td>Investigator-developed</td>
<td>1</td>
<td>No, Yes</td>
</tr>
<tr>
<td>Consistent assignment</td>
<td>Investigator-developed</td>
<td>1</td>
<td>1 ('No, never') – 5 ('Yes, at least 80% of shifts')</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------</td>
<td>---</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Family interference with work</td>
<td>Various(^7)</td>
<td>8</td>
<td>1 ('Rarely, or not at all') – 4 ('Most of the time')</td>
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<td>Emotional exhaustion</td>
<td>Maslach Burnout Inventory (MBI)(^8)</td>
<td>5</td>
<td>0 ('Never') – 6 ('Every day')</td>
</tr>
</tbody>
</table>


\(^2\)Excerpted from The Organization and Management of Intensive Care Units. Copyright © 1989 Shortell and Rousseau. Modified with permission.


\(^4\)Excerpted from the Multifactor Leadership Questionnaire™. Copyright © 1995 Bruce Avolio and Bernard Bass. Published by Mind Garden, Inc. Reproduced with permission.

\(^5\)Excerpted from the Staff Survey on Nursing Home Quality of Life: A Component of the Care and Construction Study. Reproduced with permission.


\(^8\)Excerpted from the Maslach Burnout Inventory General Survey™. Copyright © 1996, 2016 Wilmar B. Schaufeli, Michael P. Leiter, Christina Maslach & Susan E. Jackson. Published by Mind Garden, Inc. Reproduced with permission.
Table 4.2 The posterior probability, estimated logistic regression coefficient, and 95% confidence interval (CI) for each explanatory variable.

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Posterior probability† (%)</th>
<th>Logistic regression coefficient</th>
<th>95% CI (Lower, Upper)</th>
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<tr>
<td>20-29</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>30-39</td>
<td>0.00</td>
<td>0.000</td>
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<td>40-49</td>
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<td>-0.040, 0.035</td>
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<td>50-59</td>
<td>8.30</td>
<td>0.010</td>
<td>-0.068, 0.089</td>
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<tr>
<td>60-69</td>
<td>0.04</td>
<td>0.000</td>
<td>-0.005, 0.005</td>
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<td>Latin American</td>
<td>83.32</td>
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<td>Caucasian</td>
<td>64.94</td>
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<td>12.76</td>
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<td>-0.032, 0.034</td>
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<td>0.38</td>
<td>0.000</td>
<td>-0.030, 0.029</td>
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<td>West Asian</td>
<td>0.32</td>
<td>0.001</td>
<td>-0.038, 0.040</td>
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<td>Korean</td>
<td>0.00</td>
<td>0.000</td>
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</tr>
<tr>
<td><strong>Highest level of education</strong></td>
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<tr>
<td>High-school (equivalent) or less</td>
<td>--</td>
<td>--</td>
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</tr>
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<td>College or Bachelor’s degree</td>
<td>0.26</td>
<td>0.000</td>
<td>-0.012, 0.012</td>
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<tr>
<td>Graduate studies (e.g., Master’s)</td>
<td>0.04</td>
<td>0.000</td>
<td>-0.006, 0.006</td>
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<tr>
<td>Rehabilitation assistant</td>
<td>72.06</td>
<td>-0.393</td>
<td>-1.065, 0.279</td>
</tr>
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<td>Resident care coordinator</td>
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<td>-0.721, 0.619</td>
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<td>-0.034</td>
<td>-0.330, 0.262</td>
</tr>
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<td>2.76</td>
<td>-0.013</td>
<td>-0.193, 0.167</td>
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<td>Licensed practical nurse</td>
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<td>0.000</td>
<td>-0.023, 0.022</td>
</tr>
<tr>
<td>Recreational therapist</td>
<td>0.28</td>
<td>0.001</td>
<td>-0.030, 0.032</td>
</tr>
<tr>
<td>Role</td>
<td>p</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----</td>
<td>------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Registered psychiatric nurse</td>
<td>0.26</td>
<td>0.000</td>
<td>-0.038, 0.038</td>
</tr>
<tr>
<td>Other¶</td>
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<td>0.000</td>
<td>-0.009, 0.009</td>
</tr>
<tr>
<td>Manager of care</td>
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<td>0.000</td>
<td>-0.008, 0.008</td>
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**Employment status**

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<th>Shift</th>
<th>Full-time</th>
<th>Part-time</th>
<th>Casual</th>
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<tbody>
<tr>
<td></td>
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<td>0.00</td>
<td>5.62</td>
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**Shift**

<table>
<thead>
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<th>Shift</th>
<th>Combination</th>
<th>Day</th>
<th>Evening</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>--</td>
<td>4.22</td>
<td>0.16</td>
<td>1.46</td>
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**Aspects of the technology**

<table>
<thead>
<tr>
<th>Awareness</th>
<th>Aware of a padded hip fracture</th>
<th>Familiarity with hip protectors</th>
<th>Familiarity with hip protector protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100.00</td>
<td>67.94</td>
<td>0.20</td>
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**Organizational characteristics**

<table>
<thead>
<tr>
<th>Existence of a champion of hip protectors</th>
<th>100.00</th>
<th>0.238</th>
<th>0.168, 0.308</th>
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</thead>
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<td>Communication</td>
<td>100.00</td>
<td>0.038</td>
<td>0.023, 0.054</td>
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<tr>
<td>Resident-provider relationships</td>
<td>99.84</td>
<td>0.100</td>
<td>0.046, 0.153</td>
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<td>Transformational leadership</td>
<td>99.76</td>
<td>0.013</td>
<td>0.005, 0.020</td>
</tr>
<tr>
<td>Emotional exhaustion</td>
<td>4.28</td>
<td>0.000</td>
<td>-0.004, 0.003</td>
</tr>
<tr>
<td>Workplace incivility</td>
<td>3.84</td>
<td>0.001</td>
<td>-0.005, 0.007</td>
</tr>
<tr>
<td>Dementia unit/ward</td>
<td>2.72</td>
<td>0.003</td>
<td>-0.034, 0.040</td>
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<td>Passive leadership</td>
<td>2.24</td>
<td>0.000</td>
<td>-0.005, 0.006</td>
</tr>
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<td>Consistent assignment ≥80% shifts</td>
<td>0.42</td>
<td>-0.000</td>
<td>-0.012, 0.012</td>
</tr>
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<td>Family interference with work</td>
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<td>0.000</td>
<td>-0.001, 0.001</td>
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<td>Resident/family autonomy</td>
<td>0.00</td>
<td>0.000</td>
<td>0.000, 0.000</td>
</tr>
<tr>
<td>Intimacy with coworkers</td>
<td>0.00</td>
<td>0.000</td>
<td>0.000, 0.000</td>
</tr>
</tbody>
</table>

† Posterior probabilities expressed as a percentage from 0-100%
§ Multiracial, Pacific Islander, Taiwanese, and unspecified
¶ Physiotherapists, activity aides, registered dieticians, housekeeping, musical therapists, therapeutic assistants, nursing students, and administrators (program/unit clerks)
Table 4.3  Presence (x) and absence (--) of explanatory variables in the top ten models identified by Bayesian Model Averaging.

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M7</th>
<th>M8</th>
<th>M9</th>
<th>M10</th>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;20 years organizational tenure</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td><strong>Race/ethnicity</strong></td>
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</tr>
<tr>
<td>Latin American</td>
<td>--</td>
<td>--</td>
<td>x</td>
<td>--</td>
<td>--</td>
<td>x</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>x</td>
</tr>
<tr>
<td>Caucasian</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>--</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>South Asian</td>
<td>--</td>
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<td>--</td>
<td>x</td>
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<td>--</td>
<td>--</td>
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<tr>
<td><strong>Occupation</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rehabilitation assistant</td>
<td>--</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>--</td>
</tr>
<tr>
<td>Resident care coordinator</td>
<td>--</td>
<td>--</td>
<td>x</td>
<td>--</td>
<td>--</td>
<td>x</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Health care assistant</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>x</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Registered nurse</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>x</td>
<td>--</td>
<td>--</td>
<td>x</td>
</tr>
<tr>
<td>Clinical nurse educator</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>x</td>
<td>--</td>
<td>--</td>
<td>x</td>
</tr>
<tr>
<td>Social worker</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>x</td>
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<td><strong>Aspects of the technology</strong></td>
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<td></td>
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<tr>
<td>Aware of padded hip fracture</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>Familiarity with hip protectors</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>--</td>
<td>x</td>
<td>x</td>
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<td><strong>Organizational characteristics</strong></td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Existence of a champion of hip protectors</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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</tr>
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<td>Communication</td>
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<td>x</td>
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</tr>
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<td>Resident-provider relationships</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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</tr>
<tr>
<td>Transformational leadership</td>
<td>x</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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</tbody>
</table>
Table 4.4  For each of the top ten models identified in Bayesian Model Averaging, the estimated probability the chosen model is the best model (model probability), the uncorrected Cox-Snell $R^2$ coefficient, and the corrected Cox-Snell $R^2$ coefficient.

<table>
<thead>
<tr>
<th>Model</th>
<th>Model probability</th>
<th>Uncorrected Cox-Snell $R^2$ coefficient</th>
<th>Corrected Cox-Snell $R^2$ coefficient</th>
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<tbody>
<tr>
<td>$M_1$</td>
<td>0.027</td>
<td>0.557</td>
<td>0.592</td>
</tr>
<tr>
<td>$M_2$</td>
<td>0.026</td>
<td>0.563</td>
<td>0.598</td>
</tr>
<tr>
<td>$M_3$</td>
<td>0.021</td>
<td>0.581</td>
<td>0.617</td>
</tr>
<tr>
<td>$M_4$</td>
<td>0.020</td>
<td>0.557</td>
<td>0.592</td>
</tr>
<tr>
<td>$M_5$</td>
<td>0.019</td>
<td>0.567</td>
<td>0.603</td>
</tr>
<tr>
<td>$M_6$</td>
<td>0.019</td>
<td>0.576</td>
<td>0.612</td>
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<td>$M_7$</td>
<td>0.019</td>
<td>0.583</td>
<td>0.620</td>
</tr>
<tr>
<td>$M_8$</td>
<td>0.015</td>
<td>0.567</td>
<td>0.602</td>
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<tr>
<td>$M_9$</td>
<td>0.015</td>
<td>0.562</td>
<td>0.597</td>
</tr>
<tr>
<td>$M_{10}$</td>
<td>0.014</td>
<td>0.577</td>
<td>0.614</td>
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Chapter 5.  A Social Ecological Model as a Framework of Determinants of Adherence with Hip Protectors in Long-Term Care Homes from the Fraser Valley of British Columbia, Canada: A 12-Month Retrospective Cohort Study

5.1. Introduction

Approximately 60% of older people (over age 65) residing in long-term care (LTC) fall once or more per year [1-3]. About 11% of falls cause serious injury, and 1% result in hip fracture [3, 2]. In Canada, over 28,000 people aged 65 or older are hospitalized for hip fractures each year, including about 4500 seniors living in LTC [4]. Hip fractures are debilitating and costly, especially in institutionalized older people. Compared to community-dwelling older adults, residents in LTC are between 2 to 11 times more likely to fracture their hip, and experience worse outcomes after a hip fracture [5-7]. For example, 47% of older persons residing in LTC who experience a hip fracture die within one year, while another 37% never fully recover the ability to walk [8]. In Canada, the one-year direct costs to treat a single hip fracture are approaching $40,000, and the total economic burden of hip fractures is estimated at over $1.1 billion [9, 10].

About 95% of hip fractures in older people are caused by falls [4]. As such, the prevention of hip fractures in LTC requires a multifactorial approach targeting reductions in the frequency and severity of falling, as well as improvements in the fracture strength of bone [11]. Hip protectors are specialized garments with soft pads or hard domes secured adjacent to the greater trochanter of the femur. Hip protectors minimize the severity of sideways landed falls by absorbing the energy of falls and/or by shunting impact forces away from the proximal femur to surrounding soft tissues [12-14]. Laboratory-based studies have demonstrated the capacity of specific types of commercially available hip protectors to substantially reduce the magnitude of force applied to the proximal femur during sideways falls [15, 16].

Wearing hip protectors at the time of falling reduces an older adult’s risk of hip fracture between 69–80% [17-19]. However, users must be willing and able to wear hip
protectors on a regular basis to achieve optimal protection, and this has proved challenging [20]. From a cluster randomized clinical trial examining the effectiveness of hip protectors to prevent hip fractures in older people from Australian LTC homes, Cameron et al. (2001) reported that just over half (53%) of falls experienced by participants in the intervention group occurred while hip protectors were properly applied, including none of the falls that resulted in hip fracture. Consequently, the risk of hip fracture did not differ between intervention and control groups (hazard ratio=1.46; 95% CI 0.51–4.20) [21]. Subsequent clinical trials have reported rates of adherence below 50%, which has added to the uncertainty surrounding the clinical value of hip protectors (e.g., [22, 23]).

In efforts to optimize the clinical efficacy of hip protectors, many studies have examined and addressed the complex factors influencing user adherence [24, 25]. However, studies have mostly been conducted in artificial scenarios where hip protectors were supplied to residents at no expense [26]. In Canada, a single pair of hip protectors cost between $70 and $120 CAD, and only a few private insurance companies offer reimbursement for the cost of hip protectors. Accordingly, there is a pressing need to identify factors governing acceptance of and adherence to hip protectors in real-life situations.

The social ecological model (SEM) of health explains that an individual’s behaviour is shaped by factors at various social ecological levels [27]. Consistent with the SEM, adherence to the use of hip protectors in LTC has been shown to be affected by factors at multiple social ecological levels, ranging from aspects of the technology to public policy [25]. For example, aspects of the technology that affect acceptance and/or adherence include comfort [28-32], style [33, 32, 34, 35], ease of use (especially among residents with arthritis) [29, 36, 32, 37], and expense [36, 38]. Personal factors that facilitate acceptance and/or adherence include a high risk for falling [39, 34], a history of falls and fall-related injuries [40], a strong fear of falling [41, 42], and a diagnosis of osteoporosis [43, 44, 39]. On the contrary, personal factors that contribute to rejection and/or disuse of hip protectors include a fatalistic view of end of life or depressive symptoms [36, 44, 45], frequent incontinence [44, 39] (but not the wearing of incontinence materials [46]), and acute illness or deterioration of health [28].
In LTC, care providers appear to play a central role in shaping whether a resident will wear hip protectors. Adherence is facilitated when care providers are committed to encourage and support the use of hip protectors [44, 36, 24]. Zimmerman et al. (2010), for example, observed a positive association between the commitment of registered nurses (as scored by research personnel) to hip protectors and levels of adherence aggregated to the home level (β=3.15, SE=1.11) [44]. However, neither was a definition of commitment provided, nor was the criteria in which research personnel evaluated commitment described, which limits the credibility of this observation. The effect of commitment on adherence is likely mediated by the extent of resident and family involvement in decision-making. For example, in homes where care providers are dedicated to upholding the autonomy of residents (right to live at risk), staff commitment may have a smaller effect on adherence than in homes where care providers prioritize safety over autonomy [47].

At the most distal level, individual socioeconomic status (SES) appears to be an important predictor of acceptance of hip protectors [26, 44]. For example, Klenk et al. (2011) reported that elderly residents in German LTC homes were 40% (95% CI 19–56%) less likely to be offered hip protectors if they were receiving welfare [26]. Likewise, Zimmerman et al. (2010) observed a negative association between the percentage of residents on Medicaid and levels of adherence (β=-0.17, SE=0.02) [44]. Although the importance of individual SES has been established, it is unclear whether regional SES affects levels of reported adherence in the wearing of hip protectors. Comparing differences in barriers to acceptance of hip protectors between geographic regions of high and low SES may provide insights on the mechanisms by which regional SES affects acceptance, to inform strategies to enhance acceptance.

Accordingly, the objectives of this study were three-fold: (i) to identify social ecological factors associated with levels of reported adherence in the wearing of hip protectors in LTC; (ii) to compare levels of reported adherence and barriers to acceptance of hip protectors (as perceived by care providers) between the least and most deprived regions in the Fraser Valley of British Columbia (BC); (iii) to contribute knowledge on the clinical value of hip protectors for residents in LTC by comparing the risk of hip, pelvic and other fractures between falls with and without hip protectors. Based on the existing
literature, we hypothesized adherence would be correlated with SES, the commitment of care providers to support and encourage the use of hip protectors, the involvement of residents and family in decision making, and demographic characteristics of residents. We also hypothesized: (i) median levels of adherence aggregated to the level of the home would be lower in the most deprived compared to the least deprived regions of the Fraser Valley; and (ii) cost would be identified more frequently by care providers as a barrier of acceptance to hip protectors in the most deprived compared to the least deprived regions of the Fraser Valley. Thirdly, we hypothesized the risk of hip fracture would be lower in falls with hip protectors compared to falls without hip protectors, while risk of pelvic and other fractures would be similar between the two categories of falls.

5.2. Methods

5.2.1. Experimental Design and Setting

We performed a 12-month retrospective cohort study in fourteen publically subsidized LTC homes situated in the Fraser Valley of BC, Canada. The Fraser Valley is a regional district in Southwestern BC, with a land area exceeding 13,000 km² and a population of roughly 276,000 inhabitants. All participating LTC homes (n=14) were owned and operated by the same regional health authority (Fraser Health). Hip protectors are considered a best practice for fall-related injury prevention by Fraser Health (CPG, 2013); however, residents in owned and operated LTC homes are required to purchase their own supply of hip protectors. We enrolled homes in the study between June 2015 and December 2015. The study protocol was approved by the Simon Fraser University Office of Research Ethics (ORE) and the Fraser Health Research Ethics Board (FHREB).

5.2.2. Adherence and Fall-Related Hip, Pelvic and Other Fractures

Our primary outcome variable of interest was levels of reported adherence in the wearing of hip protectors. Consistent with extant research (e.g., [48, 49, 21]), we defined adherence in two ways: (i) the number of residents who wore a hip protector during at least one fall as a percentage of the total number of residents who fell during the 12-month study (Adherence_{protected_residents}), and (ii) the number of falls that occurred with hip
protectors as a percentage of the total number of falls that occurred during the 12-month study (Adherence\textsubscript{protected\_falls}). Secondary outcome variables included the occurrence of fall-related hip (proximal femoral), pelvic, and other fractures.

We acquired data on outcome variables from fall incident report forms. In BC, provincial legislation mandates that details surrounding the circumstances of every fall involving a person in care must be recorded on incident report forms, regardless of the severity of the fall [50]. In each facility, we retrieved fall incident report forms recorded in the 12-months prior to baseline (date of enrollment in the study) from the BC Patient Safety & Learning System (BC PSLS), and extracted the following information for each fall: date and time of the fall; use of hip protectors at the time of the fall (yes, no, unknown); and the severity (degree of harm) of the fall, including the type and location (body part) of associated injuries.

5.2.2.1 Missing Data

A total of 3826 falls by 1076 residents were recorded in the BC PSLS during the 12-month study. For a small number (n=47, 1.2%) of recorded falls, it was unknown whether a hip protector was worn. All unknown cases were excluded from the dataset when calculating measures of adherence (Adherence\textsubscript{protected\_residents} and Adherence\textsubscript{protected\_falls}). Accordingly, for these analyses, our sample consisted of 3779 falls by 1066 residents.

The BC PSLS categorizes the severity of each fall per the following criteria: no harm=1, minor harm=2, moderate harm =3, severe harm=4, and death=5. No recorded falls were missing data on degree of harm. Of the 3779 recorded falls retained after excluding missing adherence data, 22.4% (n=857) were documented as harmful (degree of harm>1). Only recorded falls documented as harmful were presumed to have caused injury. Of the 857 falls that were documented as harmful, 30.5% (n=261) were missing data on the type of injury sustained in the fall. To identify unreported hip, pelvic and other fractures, we reviewed progress notes attached to the 261 fall incident report forms containing missing injury data. Two fractures (one hip, one other) were identified in these progress notes. The remainder (n=259, 6.8%) of falls containing missing injury data were
listwise deleted. Accordingly, when comparing the risk of hip, pelvic and other fractures between falls protected by a hip protector and unprotected falls, our sample comprised 3520 falls by 1,033 fallers.

5.2.3. **Socioeconomic Status (SES) of Geographic Regions**

LTC homes were sampled from twelve geographic regions within the Fraser Valley of BC. We extracted measures of SES for each region of interest from Vincent and Sutherland (2013) [51], where high and low SES scores were indicative of more and less deprived regions, respectively. Measures of SES were originally derived from data collected in the 2006 Canadian Census using the *two-stage index*, which comprised n=78 variables from the following six domains: education, employment, income, housing and social position.

5.2.4. **Cross-Sectional Survey of Care Providers from Participating Long-Term Care (LTC) Homes**

We administered a paper survey to paid care providers from each LTC home at baseline (date of enrollment to the study). To be eligible for participation, care providers must have worked: (i) most of their time (greater than 50% of their working hours) at a participating LTC home; (ii) for at least one full month on their unit; (iii) for at least 8 hours per week on their unit. Respondents were excluded if they had never heard of hip protectors (n=6, 1.1%). Overall, we convenience sampled n=529 paid care providers. The return of completed paper surveys was interpreted as implied consent. Respondents were mainly females (89.6%), between 50–59 years of age (35.3%), who were employed as health care assistants (54.8%). With regards to employment status, 53.3% were full-time, 28.2% were part-time, 16.2% were casual, and the remainder was unknown.

The survey contained fourteen items to measure respondents’ commitment to hip protectors (C-HiP Index), as well as two items to assess the extent of resident and family involvement in decision-making. The C-HiP Index contains four items assessing affective commitment (e.g., “I believe in the value of hip protectors”), five items assessing behavioural commitment (e.g., “I am willing to put in a great deal of effort, above and beyond what is normally expected, to work with hip protectors”), and five items assessing
cognitive commitment (e.g., “I think that hip protectors work”). Construct development and psychometric testing of the C-HiP Index has been described previously (Chapter 3). Scales used 5-point Likert responses, ranging from 1 (strongly disagree) to 5 (strongly agree). We also included a single open-ended question, which asked respondents to recant the most common reasons provided by residents and/or their family members for refusing to purchase hip protectors.

5.2.4.1 Aggregation of Care Provider Ratings to the Level of Homes

We aggregated individual ratings of commitment to hip protectors and resident/family involvement in decision-making to the level of homes by calculating home-specific means. We convenience sampled n=4 to n=85 care providers across participating LTC homes (mean±SD=37.8±22.2).

We also calculated home-specific means for only those respondents who identified as health care assistants. Commitment to hip protectors is known to vary by occupation, with health care assistants and rehabilitation assistants reporting lower commitment than other occupations, and resident care coordinators reporting higher commitment than other occupations (Chapter 4). As we did not sample an equal proportion of occupations in each home, simply averaging ratings across all respondents from a given home could result in biased estimates. We convenience sampled n=2 to n=55 health care assistants across participating LTC homes (mean±SD=21.0±13.7).

5.2.4.2 Missing Data

8.5% (n=45) of respondents were missing data for at least one item of the C-HiP index, and 0.9% (n=5) were missing data for at least one item on the extent of resident and family involvement in decision-making. We handled missing data using the multiple imputation (MI) procedures implemented in the mice package [52] of R [53]. Imputation was based on responses to age, gender, race/ethnicity, personality (positive and negative affect), education, job type, employment status, shift (day, evening, night or combination), clinical experience, organizational tenure, familiarity with hip protectors, as well as perceptions of organizational climate (e.g., leadership, communication, teamwork,
resident-provider relationships, emotional exhaustion, frequency of consistent assignment, work-life balance, and emotional exhaustion). We imputed \( m = 5 \) datasets. Home specific-means were first calculated separately in each of the five imputed datasets, and then averaged across the datasets to derive single estimates of mean commitment to hip protectors and mean perceptions of resident/family involvement in decision-making for each LTC home. The protocol used to impute missing data has been described previously (Chapter 4).

Another 5% (\( n = 27 \)) of survey respondents did not offer at least one barrier to acceptance of hip protectors. As this question was open-ended, we could not impute missing data. Thus, when calculating the frequency of reporting of barriers to acceptance, we listwise deleted the few respondents who refused to provide at least one barrier to acceptance of hip protectors, leaving a sample of \( n = 502 \) care providers from across the Fraser Valley.

### 5.2.5. Minimum Data Set (MDS) Health Records

In each LTC home, we collected information on the number, demographics and health status of residents at baseline (date of enrollment in the study) from the Minimum Data Set (MDS 2.0, interRAI Corporation 1999). Upon admission, residents undergo an initial background admission assessment. Subsequently, follow-up MDS assessments are administered quarterly. For each facility, we acquired the following information from background admission forms: the number (%) of residents who spoke English as their primary language, the number (%) of residents who completed post-secondary education, and the number (%) of residents paying (at least partly) for their care privately. We also acquired the following information from follow-up MDS assessments: the mean (SD) age of residents, the number (%) under 65 years of age, the number (%) over 85 years of age, the number (%) of females, the number (%) with osteoporosis, the number (%) with dementia other than Alzheimer’s disease, the number (%) with Alzheimer’s disease, the number (%) with depression, the number (%) who experienced bowel and/or urinary incontinence in the past 14 days, the number (%) who fell in the past 180 days, the number (%) who experienced a fracture (hip or other) in the past 180 days, the number (%) with Cognitive Performance Scale (CPS) scores above 3 (severe cognitive impairment), and
the number (%) with Activities of Daily Living (ADL) Self-Performance Hierarchy scores above 2 (extensive assistance or more required). Some data (e.g., diagnosis of Alzheimer’s disease) was only available on annual MDS assessments. For each variable, we extracted data from the relevant assessment (quarterly or annual) that occurred nearest to, but not after, baseline. We also calculated occupancy rates by dividing the number of residents (with or without MDS assessments) by the total number of beds per home.

5.2.5.1 Missing Data

At baseline, 1817 residents occupied participating LTC homes. On average, LTC homes were missing admission background assessments for 0.5% (range:0–1.1%) of residents, and at least one follow-up (quarterly or annual) MDS assessment for 3.3% (range:0–6.6%) of residents. When describing the demographic characteristics and health status of residents in each participating LTC home, we excluded residents with missing MDS data.

5.2.6. Statistical Analysis

Unless otherwise specified, data was analyzed using SPSS for Windows, version 22.0 (SPSS Inc., Chicago, IL, USA), and significance was defined as p<0.05.

5.2.6.1 Falls and Adherence to Hip Protectors

Data was analyzed using JMP® for Mac, version 13.0 (SAS Institute Inc., Cary, NC, USA). For each LTC home, we recorded the number of beds, and calculated the incidence of falls by dividing the total number of falls recorded in the 12-month study by the total number of beds (falls per bed per year). Rates of Adherence\textsubscript{protected\_falls} and Adherence\textsubscript{protected\_residents} were also calculated for each home. We calculated the average number of falls per faller, and performed a Student’s t-test to compare the mean frequency of falling between residents who fell at least once during the 12-month study while wearing hip protectors and residents who always fell without hip protectors.
5.2.6.2 Social Ecological Determinants of Adherence to Hip Protectors

We performed univariate, non-parametric Spearman’s rank correlations on 10,000 bootstrap samples to examine associations between individual social ecological variables and our two definitions of adherence aggregated to the level of homes (Adherence\textsubscript{protected\_falls} and Adherence\textsubscript{protected\_residents}). We used bootstrapping techniques to estimate 95% CI.

5.2.6.3 Differences between the Least and Most Deprived Regions of the Fraser Valley

Data was analyzed using JMP for Mac, version 13.0 (SAS Institute Inc., Cary, NC, USA). First, we categorized geographic regions into lowest quartile (Q1<966.70), middle quartiles (Q2=966.70–997.25, Q3=997.26–1041.87), and upper quartile (Q4>1041.87) of SES (socioeconomic deprivation). We performed Fisher’s exact tests and Wilcoxon tests to compare characteristics of LTC homes and median levels of adherence, respectively, between regions in the lowest (Q1) and highest (Q4) quartiles of SES (socioeconomic deprivation). We then performed Fisher’s exact tests to compare characteristics of respondents and the frequency of reporting of barriers to acceptance (as perceived by care providers) between Q1 and Q4.

5.2.6.4 Hip, Pelvic and Other Fractures

We expressed rates of hip, pelvic and other fracture as the number of fractures per 100 falls. We used information on the date and time of each fall to create an ordinal variable representing the order in which falls were experienced by each faller (‘order of falls’). We used Poisson regression generalized estimating equation (GEE) models to compare the relative risk of hip, pelvic and other fractures between protected and unprotected falls. To account for multiple falls within a given resident, ‘order of falls’ was entered in GEE models as a within-subject variable.
5.3. Results

5.3.1. Falls and Adherence to Hip Protectors

The mean (SD) incidence of falls in participating LTC homes was 2.02 (0.54) falls per bed per year. After excluding the few (n=47, 1.2%) falls with missing adherence data, the majority (n=2260, 59.8%) of remaining falls were protected with a hip protector. Across the fourteen LTC homes, Adherence$_{protected\_residents}$ ranged from 28.6% to 76.7% (median=63.0%), and Adherence$_{protected\_falls}$ ranged from 22.4% to 79.5% (median=66.9%) (Figure 5.1). Mean (SD) number of falls per faller was 3.55 (4.48). On average, residents who wore a hip protector during at least one fall experienced more falls during the 12-month study than residents who always fell without a hip protector (mean difference=2.65, 95% CI 2.21–3.09, p<0.001).

5.3.2. Characteristics of Participating Long-Term Care (LTC) Homes

Participating LTC homes had between 57 and 234 beds (mean±SD=137±61, total=1923). At baseline (date of enrollment in the study), occupancy rates ranged from 70.1% to 101.3% (mean=95.2%) across homes, and SES deprivation scores of associated geographic regions ranged from 976 to 1107 (mean±SD=1003±4). See Table 5.1 for more details about homes.

5.3.3. Social Ecological Determinants of Adherence to Hip Protectors

Adherence$_{protected\_residents}$ was negatively correlated with SES (socioeconomic deprivation) of the region ($p$=-0.630, $p$=0.016), positively correlated with the percentage of residents who were self-pay ($p$=0.539, $p$=0.047), negatively correlated with the percentage of residents with a diagnosis of depression ($p$=-0.538, $p$=0.047), and positively correlated with the percentage of residents with a history of hip fracture ($p$=0.677, $p$=0.008) (Table 5.2). Adherence$_{protected\_falls}$ was negatively correlated with mean scores of resident and family involvement in decision-making as reported by health care assistants ($p$=-0.585, $p$=0.028), negatively correlated with the percentage of residents who were
under 65 years of age ($\rho=-0.550$, $p=0.042$), and positively correlated with the percentage of residents with a history of hip fracture ($\rho=0.745$, $p=0.002$).

### 5.3.4. Differences between the Least and Most Socioeconomically Deprived Regions

Of the fourteen participating LTC homes, three each were situated in the least (Q1) and most (Q4) socioeconomically deprived regions. Compared to Q1, a greater percentage of residents in LTC homes from Q4 spoke English as their primary language (median difference=6.5%, $\chi^2=3.86$, $p=0.050$) and were diagnosed with depression (median difference=17.9%, $\chi^2=3.86$, $p=0.050$), while fewer residents attained a post-secondary education (median difference=12.4%, $\chi^2=3.86$, $p=0.050$). The estimated difference in median Adherence$_{protected\_residents}$ between Q1 and Q4 was 13.1% ($\chi^2=3.86$, $p=0.050$), while the difference in Adherence$_{protected\_falls}$ was not statistically significant (median difference=1.5%, $\chi^2=0.43$, $p=0.513$) (Figure 5.2).

Care providers most often cited discomfort (70.9%), cost (68.3%), concerns about appearance (21.2%), and a lack of recognition of the need for hip protectors (17.0%) as barriers of acceptance (Table 5.3). Of the 502 care providers who responded with at least one barrier of acceptance, 126 (25.1%) and 46 (9.2%) worked in Q1 and Q4, respectively. No differences in demographic characteristics were observed between respondents (care providers) from Q1 and Q4, with two exceptions. More respondents in Q4 were Caucasian (83.5% vs. 47.8%, $p<0.001$), and fewer were South Asian (0.0% vs. 21.6%, $p<0.001$). Compared to Q1, respondents in Q4 more frequently identified cost and lack of recognition of the need for hip protectors, and less frequently identified concerns about their appearance and heat as barriers of acceptance to hip protectors (Table 5.3).

### 5.3.5. Hip, Pelvic and Other Fractures

Of the 3520 recorded falls, 0.57% (n=20) resulted in hip fracture. Among falls protected by hip protectors, the rate of hip fracture was 0.33 per 100 falls (7 hip fractures/2108 falls). Comparatively, in falls without hip protectors, the rate of hip fracture was 0.92 per 100 falls (13 hip fractures/1412 falls). The relative risk of hip fracture was
0.36 (95% CI 0.14–0.90, p=0.029) during falls protected by a hip protector compared to unprotected falls (Table 5.4).

Of the 3520 recorded falls, 0.26% (n=9) resulted in pelvic fracture, and 0.63% (n=22) resulted in at least one other fracture (n=3 resulted in multiple fractures to body parts other than the hip or pelvis). There were no significant differences between falls with hip protectors and falls without hip protectors in the relative risk of pelvic fracture (relative risk=1.34, 95% CI 0.34–5.36, p=0.68), or the relative risk of fractures other than hip or pelvis (relative risk=1.00, 95% CI 0.35–1.86, p=0.61) (Table 5.4).

5.4. Discussion

Our objectives were three-fold: (i) to identify social ecological factors associated with levels of reported adherence in the wearing of hip protectors in LTC; (ii) to compare levels of reported adherence and barriers to acceptance of hip protectors (as perceived by care providers) between the least and most deprived regions in the Fraser Valley of BC; and (iii) to compare risk of hip, pelvic and other fractures between protected and unprotected falls.

The incidence of falls (falls per bed per year) ranged from 0.84 to 3.25 (mean=2.02) across participating LTC homes. In the only LTC home with an incidence of falls less than 1.0 falls per bed per year, about one in five (22%) residents were under the age of 65 years. The home in question also contains a specialized unit for ventilator-dependent residents. This could explain the lower than expected rate of falling. Nevertheless, the mean incidence of falls across all LTC homes was consistent with rates reported previously [2, 54]. Rubenstein, Josephson and Robbins (1994), for example, reported a mean incidence of falls in LTC equivalent to 1.5 falls per bed per year [2].

Between LTC homes, the median percentage of residents who fell at least once while wearing a hip protector (Adherence_{protected_residents}) was 63.0% (range=28.6–76.7%), and the median percentage of falls protected by a hip protector (Adherence_{protected_falls}) was 66.9% (range=22.4–79.5%). Rates of adherence were relatively high, especially considering hip protectors were not supplied freely to residents as part of an intervention.
As we understand it, only three other studies have reported rates of adherence in comparable situations where residents were required to purchase their own supply of hip protectors [26, 48, 31]. In an observational study, Klenk et al. (2011) observed that availability of hip protectors ranged from 0–38% across 48 German nursing homes, with a quarter of homes not making hip protectors available to residents at all [26]. The other two studies were clustered randomized control trials examining the effectiveness of structured education combined with the provision of free hip protectors to improve adherence [31, 48]. Among participants in the control groups who were provided with a brochure about hip protectors, Adherence$_{protected\_residents}$ and Adherence$_{protected\_falls}$ ranged from 0–15% and 0–8%, respectively [31, 48].

The percentage of residents in each home who experienced a hip fracture in the past 180 days was positively correlated with Adherence$_{protected\_residents}$ and Adherence$_{protected\_falls}$. It seems that a history of hip fractures in the home is an important determinant of both acceptance and adherence with hip protectors. Similar findings have been reported previously [46]. Cryer, Knox and Stevenson (2008) observed a positive association between the number of fractured femurs recorded in homes over the past four years and levels of reported daytime adherence with hip protectors ($\beta$=6.5%, 95% CI - 0.8–13.9%) [46]. Although this finding might seem paradoxical, we argue that more frequent exposure to hip fractures might have resulted in a more favourable response of residents and/or family members to accept and apply hip protectors, via improved understanding of the need for hip protectors. However, future research is needed to clarify the casual relationships between a history of hip fractures in the home and levels of adherence in the wearing of hip protectors.

The percentage of residents with a diagnosis of depression at baseline was negatively correlated with the percentage of residents who fell at least once while wearing hip protectors (Adherence$_{protected\_residents}$), but not the percentage of falls that occurred with hip protectors (Adherence$_{protected\_falls}$). Others have demonstrated a negative association between depressive symptomology and adherence [44, 43]. Zimmerman et al. (2010), for example, reported that the consistent display of sad, anxious or resistive behaviours related to a 6.90% (SE=2.17%) decrease in levels of reported adherence with hip protectors [44].
Contrary to expectation, the commitment of care providers to support and encourage the use of hip protectors was not correlated with either measure of adherence. Findings are consistent with those reported by Milisen et al. (2010), who also found no evidence of a relationship between the attitudes of care providers towards hip protectors and adherence [29]. However, this is not to say that commitment is unimportant. Mean commitment to hip protectors amongst care providers was high across participating LTC homes, ranging from 3.70 to 4.52 (mean=4.20) out of 5.00 possible points. Milisen et al. (2010) also reported generally positive attitudes towards hip protectors amongst caregivers. For example, in their cross-sectional survey of n=37 caregivers, 81% agreed or completely agreed that wearing hip protectors is important, and 89% agreed or completely agreed that wearing hip protectors is meaningful [29]. The high levels of commitment reported by care providers in participating LTC homes might explain (at least partially) why we observed relatively high rates of adherence. To more accurately examine the relationship between care provider commitment and adherence, future research should actively sample LTC homes with a broader range of commitment to hip protectors.

In a similar vein, mean ratings of resident and family involvement in decision-making reported by health care assistants was unrelated to Adherence protected_residents, but was negatively related to Adherence protected_falls. Based on existing literature [47], one possible explanation for these findings is that in homes with lower ratings of resident and family involvement in decision-making, care providers prioritized safety over respect for autonomy, and made the decision to apply hip protectors without gaining the clear consent of residents and/or family. If so, it follows they probably wouldn’t have done so if they hadn’t been committed to hip protectors. Thus, the relationship between autonomy and adherence is probably mediated by staff commitment to hip protectors. This could be an interesting avenue of future research.

Regional SES (socioeconomic deprivation) was negatively correlated with Adherence protected_residents, but was not correlated with Adherence protected_falls. Aligned with this finding, we observed a 13% difference in median Adherence protected_residents between LTC homes from the least and most deprived regions of the Fraser Valley, but no difference in median Adherence protected_falls. Regional SES appears to be an important
determinant of initial acceptance of hip protectors, but probably does not affect continued adherence.

We uncovered some insight into the mechanisms by which regional SES might affect levels of adherence in the wearing of hip protectors. Care providers employed in the most deprived regions of the Fraser Valley more often cited cost and lack of recognition of the need for hip protectors as barriers to acceptance of hip protectors, compared to respondents employed in the least deprived regions. We also observed that LTC homes from the most deprived regions of the Fraser Valley had a greater proportion of residents with depression (median difference=18%), and fewer residents with post-secondary education (median difference=12%) compared to homes from the least deprived regions. Consequently, differences in economic hardship, prevalence of depression and education probably explain the differences observed in adherence between geographic regions of high and low SES.

Our final objective was to build on existing knowledge of the clinical value of hip protectors in LTC, by contrasting hip, pelvic and other fractures between falls with hip protectors and falls without hip protectors. Among falls with hip protectors, rates of hip, pelvic and other fracture were 0.33, 0.28 and 0.71 per 100 falls, respectively. Among falls without hip protectors, rates of hip, pelvic and other fractures were 0.92, 0.21 and 0.71 per 100 falls, respectively. Rates are generally lower than reported by Kannus et al. (2000) [19]. Given that a portion of participants in Kannus et al. (2000) were recruited from outpatient care units, if anything, we expected to observe slightly higher rates of fractures in our sample of LTC residents. Rates are also lower than those described by Rubenstein, Josephson and Robbins (1994), who observed that 4% of falls in LTC cause fracture. The relatively low rates of fractures documented in participating LTC homes might be due to a combination of co-intervention (e.g., vitamin D₃ supplementation, use of antiresorptive agents) in participating LTC homes, the relatively high use of hip protectors (60% of falls were protected by a hip protector), underreporting of fractures in the BC Patient Safety and Learning System (PSLS) – the database we accessed to retrieve information on the type and location of injuries sustained in falls – and/or underreporting of non-injurious falls in previous research due to detection bias.
Like others before us, we have shown that hip protectors are an efficacious strategy to prevent hip fractures for those residents who are willing and able to wear them at the time of falling. The relative risk of hip fracture was 64% (95% CI 10–86%) lower during falls with hip protectors compared to falls without hip protectors, and the use of hip protectors prevented about 12 (95% CI 0–28) hip fractures (0.92%-0.33%=0.59% of 2108 in Table 5.4). Similar findings have been reported previously [19, 17, 18]. Kannus et al. (2000), for example, observed an 80% (95% CI 50–95%) reduction in the unadjusted risk of hip fracture in falls with hip protectors compared to falls without hip protectors [19].

There are several limitations to our study. In our examination of social ecological determinants of adherence, we used regional SES scores derived from 2006 national census data, which might not reflect the current SES of regions. However, regional SES scores correlated with the percentage of residents who attained a post-secondary education ($\rho=-753, p=0.002$), a traditional marker of SES level. We measured commitment to hip protectors and perceptions of resident/family autonomy in convenience samples of care providers from participating LTC homes. Our ratings might not represent the entire population of care providers in the homes we studied (e.g., response bias). However, we did not appear to over or under sample obvious groups of respondents in terms of age, gender and occupation (Chapter 3). We conducted statistical analyses at the level of homes (n=14), rather than at the level of individual residents or care providers, which restricted our statistical power. In comparing fracture rates between protected and unprotected falls, we did not have access to medical records, and were unable to account for potential confounders (e.g., age, sex, bone mineral density) in our statistical analyses. However, we found no significant differences in the rates of non-hip fractures between protected and unprotected falls. This suggests that factors other than the use of hip protectors were probably not responsible for the observed between-group difference in hip fracture rates.

Despite these limitations, we offer new insight into the factors governing adherence to hip protectors. We observed inequalities in the utilization of hip protectors between LTC homes from the least and most deprived regions of a regional district in BC, Canada. Disparities were likely due to differences in economic hardship, prevalence of depression and education. We also offer evidence of the clinical value of hip protectors. The risk of
hip fracture was 64% lower during falls with hip protectors compared to falls without hip protectors, and as sixty percent of falls occurred with hip protectors, the use of hip protectors prevented about 12 hip fractures in one year.
5.5. References


5.6. Figures and Tables

Figure 5.1 (A) The percentage of residents who fell at least once while wearing hip protectors (Adherence$_{\text{protected_residents}}$) and (B) the percentage of falls that occurred while hip protectors were worn (Adherence$_{\text{protected_falls}}$) measured in each of the fourteen participating long-term care (LTC) homes during the 12 months prior to baseline (date of enrollment to the study).
Figure 5.2 Median percentage of residents who fell at least once while wearing hip protectors (Adherence_{protected_residents}) and the median percentage of falls that occurred while hip protectors were worn (Adherence_{protected_falls}) during the 12-months prior to baseline (date of enrolment to the study) in long-term care (LTC) homes from regions in the lowest (Q1; n=3) and highest (Q4; n=3) quartiles of socioeconomic deprivation.

* Non-parametric Wilcoxon Test, p<0.05
Table 5.1  Characteristics of the fourteen participating long-term care (LTC) homes at baseline (date of enrollment to the study).

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<th>SD</th>
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<td>% Female</td>
<td>52.2</td>
<td>76.1</td>
<td>65.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% English primary language</td>
<td>74.5</td>
<td>100</td>
<td>89.1</td>
<td>7.9</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Post-secondary education</td>
<td>14.3</td>
<td>35.6</td>
<td>21.6</td>
<td>6.1</td>
</tr>
<tr>
<td>Responsibility for payment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Canadian resident, self-pay</td>
<td>4.2</td>
<td>48.7</td>
<td>21.7</td>
<td>12.9</td>
</tr>
<tr>
<td>Disease diagnoses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Osteoporosis</td>
<td>0.0</td>
<td>28.8</td>
<td>15.5</td>
<td>7.3</td>
</tr>
<tr>
<td>% Depression</td>
<td>3.0</td>
<td>32.6</td>
<td>16.2</td>
<td>8.2</td>
</tr>
<tr>
<td>% Dementia</td>
<td>17.9</td>
<td>60.2</td>
<td>38.3</td>
<td>11.8</td>
</tr>
<tr>
<td>% Bowel incontinence in past 14 days</td>
<td>26.9</td>
<td>53.9</td>
<td>40.3</td>
<td>8.0</td>
</tr>
<tr>
<td>% Urinary incontinence in past 14 days</td>
<td>45.7</td>
<td>76.3</td>
<td>57.1</td>
<td>7.9</td>
</tr>
</tbody>
</table>
### Functional outcomes

<table>
<thead>
<tr>
<th>% Cognitive Performance Scale &gt; 3§</th>
<th>21.2</th>
<th>74.6</th>
<th>32.8</th>
<th>12.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>% ADL Self-Performance Hierarchy &gt; 2¶</td>
<td>55.1</td>
<td>87.6</td>
<td>69.1</td>
<td>10.6</td>
</tr>
</tbody>
</table>

### History of falls and fractures

<table>
<thead>
<tr>
<th>% Fell within past 180 days</th>
<th>11.1</th>
<th>37.3</th>
<th>23.3</th>
<th>8.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Hip fracture in past 180 days</td>
<td>0.0</td>
<td>1.5</td>
<td>0.66</td>
<td>0.57</td>
</tr>
<tr>
<td>% Other fracture (not hip) in past 180 days</td>
<td>0.0</td>
<td>3.0</td>
<td>0.86</td>
<td>1.0</td>
</tr>
</tbody>
</table>

† Average response to fourteen items from the C-HiP Index, scored on a five-point Likert scale (1–5)
‡ Average response to two items, scored on a five-point Likert scale (1–5)
§ Severe cognitive performance
¶ Extensive assistance or more required
Table 5.2  Correlation of social ecological factors with the percentage of residents who fell at least once while wearing hip protectors (Adherence\textsubscript{protected\_residents}) and the overall percentage of falls protected by a hip protector (Adherence\textsubscript{protected\_falls}).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adherence\textsubscript{protected_residents}</th>
<th>Adherence\textsubscript{protected_falls}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \rho )</td>
<td>95% CI (Lower,Upper)</td>
</tr>
<tr>
<td>Socioeconomic status (SES) of geographic regions</td>
<td>-0.630</td>
<td>-0.879,-0.169</td>
</tr>
<tr>
<td>Ratings of heterogeneous care providers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean commitment to hip protectors†</td>
<td>0.033</td>
<td>-0.534, 0.573</td>
</tr>
<tr>
<td>Mean resident and family autonomy‡</td>
<td>-0.037</td>
<td>-0.657, 0.554</td>
</tr>
<tr>
<td>Ratings of health care assistants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean commitment to hip protectors†</td>
<td>0.037</td>
<td>-0.540, 0.559</td>
</tr>
<tr>
<td>Mean resident and family autonomy‡</td>
<td>-0.200</td>
<td>-0.701, 0.526</td>
</tr>
<tr>
<td>Resident demographics/health status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (years)</td>
<td>0.046</td>
<td>-0.598, 0.661</td>
</tr>
<tr>
<td>% Under 65 years</td>
<td>-0.416</td>
<td>-0.829, 0.196</td>
</tr>
<tr>
<td>% Over 85 years</td>
<td>0.059</td>
<td>-0.473, 0.637</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Female</td>
<td>-0.116</td>
<td>-0.617, 0.418</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% English primary language</td>
<td>-0.178</td>
<td>-0.734, 0.458</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Post-secondary education</td>
<td>0.464</td>
<td>-0.162, 0.865</td>
</tr>
<tr>
<td>Responsibility for payment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Canadian resident, self-pay</td>
<td>0.539</td>
<td>-0.098, 0.919</td>
</tr>
<tr>
<td>Disease diagnoses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Osteoporosis</td>
<td>-0.015</td>
<td>-0.611, 0.588</td>
</tr>
<tr>
<td>% Depression</td>
<td>-0.538</td>
<td>-0.823, -0.031</td>
</tr>
<tr>
<td>% Dementia</td>
<td>-0.349</td>
<td>-0.754, 0.308</td>
</tr>
</tbody>
</table>
### Functional outcomes

<table>
<thead>
<tr>
<th>% Bowel incontinence in past 14 days</th>
<th>0.007</th>
<th>-0.691, 0.624</th>
<th>0.982</th>
<th>0.112</th>
<th>-0.510, 0.702</th>
<th>0.703</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Urinary incontinence in past 14 days</td>
<td>-0.086</td>
<td>-0.728, 0.527</td>
<td>0.771</td>
<td>-0.204</td>
<td>-0.756, 0.376</td>
<td>0.483</td>
</tr>
</tbody>
</table>

#### Falls and fractures

<table>
<thead>
<tr>
<th>% Fell within past 180 days</th>
<th>0.455</th>
<th>-0.188, 0.852</th>
<th>0.102</th>
<th>0.477</th>
<th>-0.089, 0.811</th>
<th>0.085</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Hip fracture in past 180 days</td>
<td>0.677</td>
<td>0.278, 0.882</td>
<td>0.008**</td>
<td>0.745</td>
<td>0.372, 0.917</td>
<td>0.002**</td>
</tr>
<tr>
<td>% Other fracture (not hip) in past 180 days</td>
<td>0.355</td>
<td>-0.299, 0.796</td>
<td>0.213</td>
<td>0.270</td>
<td>-0.353, 0.724</td>
<td>0.350</td>
</tr>
</tbody>
</table>

† Average response to fourteen items from the C-HiP Index, scored on a five-point Likert scale (1–5)
‡ Average response to two items, scored on a five-point Likert scale (1–5)
§ Severe cognitive performance
¶ Extensive assistance or more required
a Univariate non-parametric Spearman’s rank correlation coefficients from 10,000 bootstrap samples;
* p<0.05; ** p<0.01
ρ = Spearman’s Rho coefficient; CI = confidence interval
Table 5.3  Barriers to acceptance of hip protectors reported by care providers in long-term care (LTC) homes from all geographic regions, regions in the lowest quartile (Q1) of socioeconomic deprivation, and regions in the highest quartile (Q4) of socioeconomic deprivation.

<table>
<thead>
<tr>
<th>Barriers, n (%)</th>
<th>All regions†</th>
<th>Q1 regions‡</th>
<th>Q4 regions§</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expense</td>
<td>342 (68.3)</td>
<td>80 (63.5)</td>
<td>38 (82.6)</td>
<td>0.017*</td>
</tr>
<tr>
<td>Lack of recognition of the need for hip protectors</td>
<td>85 (17.0)</td>
<td>14 (11.1)</td>
<td>12 (26.1)</td>
<td>0.028*</td>
</tr>
<tr>
<td>Disbelief in the efficacy of hip protectors</td>
<td>14 (2.8)</td>
<td>6 (4.7)</td>
<td>1 (2.2)</td>
<td>0.676</td>
</tr>
<tr>
<td>Lack of family advocacy</td>
<td>19 (3.8)</td>
<td>7 (5.6)</td>
<td>2 (4.4)</td>
<td>1.000</td>
</tr>
<tr>
<td>Self-conscious about appearance</td>
<td>106 (21.2)</td>
<td>33 (26.2)</td>
<td>4 (8.7)</td>
<td>0.012*</td>
</tr>
<tr>
<td>Loss of dignity</td>
<td>6 (1.2)</td>
<td>0 (0.0)</td>
<td>1 (2.2)</td>
<td>0.267</td>
</tr>
<tr>
<td>Too bulky to fit under clothing</td>
<td>61 (12.2)</td>
<td>15 (11.9)</td>
<td>5 (10.9)</td>
<td>1.000</td>
</tr>
<tr>
<td>Cannot apply or remove independently</td>
<td>60 (12.0)</td>
<td>14 (11.1)</td>
<td>7 (15.2)</td>
<td>0.443</td>
</tr>
<tr>
<td>Discomfort</td>
<td>355 (70.9)</td>
<td>96 (76.2)</td>
<td>28 (60.9)</td>
<td>0.056</td>
</tr>
<tr>
<td>Heat</td>
<td>42 (8.4)</td>
<td>17 (13.5)</td>
<td>0 (0.0)</td>
<td>0.007**</td>
</tr>
<tr>
<td>Skin irritation</td>
<td>5 (1.0)</td>
<td>3 (2.4)</td>
<td>0 (0.0)</td>
<td>0.565</td>
</tr>
<tr>
<td>Restriction of movement</td>
<td>5 (1.0)</td>
<td>0 (0.0)</td>
<td>2 (4.4)</td>
<td>0.070</td>
</tr>
<tr>
<td>Cognitive impairment or behavioural symptoms</td>
<td>25 (5.0)</td>
<td>3 (2.4)</td>
<td>2 (4.2)</td>
<td>0.611</td>
</tr>
</tbody>
</table>

† n=502 respondents from all geographic regions
‡ n=126 respondents from Q1
§ n=46 respondents from Q4

* Fisher’s Exact Tests; * p<0.05; ** p<0.01
Table 5.4  The relative risk of hip, pelvic and other fractures in falls protected by a hip protector compared to falls without a hip protector.

<table>
<thead>
<tr>
<th>Type of fracture</th>
<th>Falls with a hip protector</th>
<th>Falls without a hip protector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incidence† (No. per 100 falls)</td>
<td>Incidence‡ (No. per 100 falls)</td>
</tr>
<tr>
<td>Hip</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Pelvic</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Other§</td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

† n=2,108 falls occurred with hip protectors
‡ n=1,412 falls occurred without hip protectors
§ Includes fractures of the skull (n=1), shoulders (n=3), arms (n=2), olecranon (n=1), wrists (n=3), fingers (n=2), ribs (n=2), vertebrae (n=2), legs (n=2), patella (n=2), malleolus (n=3), and feet (n=2)
* Poisson regression generalized estimating equation (GEE) models; * p<0.05
Chapter 6. Conclusions

6.1. Aims and Objectives

In Canada, more than 28,000 seniors are hospitalized for hip fractures each year [1]. With the anticipated aging of the Canadian population [2], the annual incidence of hip fracture is expected to triple in the next 25 years, even though age-adjusted incidence rates are declining [3]. Residents in long-term care (LTC) experience about 16% of all age-related hip fractures in Canada, yet they comprise no more than 7% of the population over age 65 [1]. Compared to community-dwelling older adults, residents in LTC are at greater risk for hip fracture [4-6], and experience worse functional outcomes following a hip fracture [7]. As such, the prevention of hip fractures in LTC is a public health priority.

Hip fracture prevention requires a multifactorial approach, especially in the particularly frail cohort of older adults that live in LTC. A pillar of fracture prevention in LTC is the treatment of osteoporosis through administration of antiresorptive agents (e.g., bisphosphonates), vitamin D$_3$ and calcium [8]. But, as over 95% of age-related hip fractures result from falls [1], interventions should also address the frequency and severity of falling. Hip protectors represent one component of the fracture prevention toolkit [8]. They often consist of pants, shorts or undergarments with soft pads or hard shields embedded in pockets covering the lateral aspect of the pelvis, which aim to decrease the magnitude of stress applied to the proximal femur during sideways landed falls [9-11]. Laboratory-based studies [12, 13] and clinical trials [14-16] have demonstrated the capacity of hip protectors to prevent fall-related hip fractures. However, considerable doubt persists regarding their clinical value, primarily due to poor user adherence in the wearing of these devices [17]. Therefore, the overall aims of this thesis are to provide updated knowledge of perceived barriers and facilitators to initial acceptance of and continued adherence with hip protectors in LTC, and to provide evidence-based strategies to improve these outcomes.
6.2. Summary

To achieve these aims, we conducted four distinct studies, originally presented in chapters 2–5. In the present chapter, the objectives, methods, results and conclusions from each study are revisited and summarized.

6.2.1. Chapter 2

In Chapter 2, a systematic review was performed to synthesize existing knowledge of perceived barriers and facilitators to acceptance and adherence with hip protectors in LTC, and to identify gaps in existing knowledge. Findings from this chapter served as the impetus for the remaining chapters of the thesis. To achieve these objectives, we conducted a key word search for studies published in English between 2000 and 2013. We also performed supplemental searches by cross-referencing selected studies and contacting experts in the field for additional references. Studies were included if they presented findings related to adherence with hip protectors among residents, family caregivers, and/or health care providers in LTC, regardless of the overarching aim of the study, i.e., to examine the clinical effectiveness of hip protectors. All research designs were accepted (e.g., qualitative, quantitative, mixed methods). As the primary goal of this chapter was to describe, classify and explore relationships of facilitators and barriers to acceptance and adherence between studies, rather than to conduct meta-analyses of effects, we elected to perform a narrative synthesis.

A total of 1086 potentially relevant articles were identified from database searching. A team of falls prevention researchers and LTC clinicians screened all abstracts for inclusion. 112 appeared potentially relevant, and proceeded to full-text review. After full-text review, 28 articles were retained for data extraction, including 22 articles employing a purely quantitative design, two articles employing a purely qualitative design, and four articles employing mixed methods.

Of the 28 articles, 24 measured and reported rates of acceptance and/or adherence. Specifically, 12 articles reported rates of acceptance and adherence, one article reported rates of acceptance only, and 11 articles reported rates of adherence only. Between articles, acceptance ranged from 32–85% (median=48%), and adherence
ranged from 3–93%. However, articles defined, measured and reported adherence in vastly different ways, which limited our ability to compare findings across articles.

Facilitators and barriers to acceptance and adherence emerged at various social ecological levels, ranging from aspects of the design of hip protectors to public policy. Accordingly, we sorted barriers and facilitators into four thematic groups: (i) system-related, (ii) caregiver-related, (iii) resident-related, and (iv) hip protector-related. System-related factors that were cited as facilitators of acceptance and/or adherence included organizational commitment to hip protector programs, structured education and the provision of hip protectors at no cost, and advocacy from external sources, such as physicians and accreditation bodies. System-related factors that acted as barriers of acceptance and/or adherence included issues surrounding the laundering of hip protectors (contributing to temporary non-adherence), high turnover of nursing and managerial staff, and poor communication amongst staff. Caregiver-related factors that facilitated acceptance and/or adherence included staff commitment to encourage and support the use of hip protectors and positive attitudes regarding the effectiveness of hip protectors, while factors that acted as barriers of acceptance and/or adherence included negative opinions of hip protectors, and concerns about upholding residents’ rights to individual choice and autonomy. Resident-related facilitators and barriers were numerous. Commonly cited facilitators of acceptance and/or adherence included clinical risk factors for falls and fragility fractures, a history of falls and fragility fractures, recognition of the need for hip protectors, positive attitudes regarding the effectiveness of hip protectors, peer and family advocacy, the wearing of incontinence materials, and physical and cognitive impairment, while barriers included economic hardship (welfare recipients), non-white race/ethnicity, migration backgrounds, depressive symptoms, frequent incontinence, and acute illness or deteriorated health. Aspects of the design of hip protectors that were positively associated with acceptance and/or adherence included soft-shell models and colour steadfastness, while discomfort, unwanted side effects, concerns about appearance, and difficulty with use were important barriers.

We also identified noteworthy gaps in our current understanding of barriers and facilitators to adherence with hip protectors in LTC. First, staff commitment to encourage and support the use of hip protectors was identified as a facilitator of acceptance and/or
adherence in 46% (n=13) of included articles. Yet, the quality of available evidence was low, being mostly anecdotal in nature. Robust research with minimal bias is needed to inform clinical decision-making. Prior to undertaking future research, it is important to establish a definition of commitment, and a valid and reliable way of assessing commitment to hip protectors amongst paid care providers. Second, there was no knowledge of the factors that influence staff commitment to hip protectors. This knowledge may illuminate strategies to enhance commitment and ultimately facilitate adherence with hip protectors in LTC. And finally, all but three articles described factors governing acceptance and adherence in unrealistic scenarios where hip protectors were provided freely to residents. In many countries, hip protectors are not supplied to residents at no cost, and health care insurance companies (public or private) rarely reimburse the expense of hip protectors. There is a need for natural experiments in real world settings, where targeting of findings has strong fidelity to improve safety, efficiency and quality of care. Chapters 3–5 were designed to address (at least in part) these knowledge gaps.

6.2.2. Chapter 3

Care providers appear to play a central role in shaping whether a resident will accept and wear hip protectors on a regular basis. The commitment of care providers to encourage and support the use of hip protectors has been identified as facilitator of both acceptance and adherence (e.g., [18-20]). However, our understanding of the nature of commitment, along with its associated antecedents and outcomes, is constrained by the absence of a psychometrically valid assessment tool. Accordingly, in Chapter 3, a cross-sectional survey was conducted in thirteen publically subsidized LTC homes to evaluate the psychometric properties of a scale developed to assess commitment to hip protectors. Findings from this chapter also laid the foundation for Chapter 4 of this thesis.

Consistent with extant definitions of organizational commitment [21], commitment to hip protectors was defined as a care provider’s attachment to and behavioural intentions regarding hip protectors, reflected by: (i) a belief in the value of hip protectors (affective commitment), (ii) acceptance of the clinical efficacy of hip protectors (cognitive commitment), and (iii) a willingness to act or modify their behaviour to generally encourage and support the use of hip protectors (behavioural commitment). We adapted three
existing metrics – Mowday, Steer and Porter’s (1979) Organizational Commitment Questionnaire (OCQ) [22] and two scales written by Herscovitch and Meyer (2002) [23] – to develop the 15 item Commitment to Hip Protectors (C-HiP) Index, containing four items to measure affective commitment, five items to measure behavioural commitment, and six items to measure cognitive commitment.

To test construct validity, n=529 responses to the C-HiP Index were subjected to a series of hierarchical exploratory factor analyses (EFA). We hypothesized hierarchal EFA would yield three lower-order factors, representing the affective, behavioural and cognitive components of commitment, and a single higher-order factor, representing the overarching concept of commitment to hip protectors. Contrary to expectation, only two lower-order factors were present. Individual items from the affective and cognitive subscales loaded highest on the first lower-order factor, and items from the behavioural subscale loaded highest on the second. As expected, both lower-order factors subsequently loaded onto a single higher-order factor.

To test content validity, we recruited a sample of falls prevention researchers and LTC clinicians (n=11) to complete a completely anonymous survey. Experts were invited to rate the clarity and relevance of each item contained in the C-HiP Index on Likert scales ranging from 1 (e.g., ‘Not at all relevant’) to 4 (e.g., ‘Extremely relevant’). A content validity index (CVI) of clarity and a CVI of relevance were calculated for each item, expressed as the proportion of experts giving ratings of 3 or 4. Twelve items had a CVI of clarity and a CVI of relevance above 0.79 (>79% agreement), a threshold used previously to indicate adequate content validity. One item (BEH04) had questionable clarity (CVI=0.70-0.79), but adequate relevance (CVI>0.79), while another item (BEH03) had unacceptable clarity (CVI<0.70), and questionable relevance (CVI=0.70-0.79). Only one item (COG06) had unacceptable (CVI<0.70) clarity and relevance.

After construct and content validity testing were underway, we made the decision to remove one item from the C-HiP Index. The item originally written to assess cognitive commitment, “I doubt the effectiveness of hip protectors” was removed as it did not meet our criteria for retention in EFA, and it had unacceptable ratings of clarity (CVI=0.36) and relevance (CVI=0.36) by experts. Thus, subsequent psychometric evaluations were
performed on the remaining 14 items of the C-HiP Index, now consisting of four items to measure affective commitment, five items to assess behavioural commitment, and five items to measure cognitive commitment.

Another way to test the validity of metrics is to determine whether variables that ought to be related to the outcome measure of interest are indeed related. We hypothesized responses to the C-HiP Index would be positively related to their willingness to champion hip protectors, by behaving in ways that go above and beyond what is explicitly required to encourage and support the use of hip protectors. To test this hypothesis, we had respondents rate their agreement to the following question on a Likert scale ranging from 1 (‘Strongly disagree’) to 5 (‘Strongly agree’): “Do you think of yourself as a champion of hip protectors?” We observed a positive associated between responses to this question and the C-HiP Index, whereby a one-unit increase in agreement corresponded to a 5.2-point (95% CI 4.4–6.1, p<0.01) increase in commitment.

We also examined the ability of the C-HiP Index to distinguish between subgroups of respondents it should theoretically be able to distinguish between. Based on existing literature, we hypothesized responses to the C-HiP Index would be lower in respondents who were aware of at least one resident breaking their hip in a fall while wearing hip protectors compared to those who had not heard of any such cases, and higher in respondents who believed in the existence of a champion of hip protectors within the home compared to those who did not. As expected, median C-HiP Index scores were 4.3-points lower in care providers who were aware of at least one padded hip fracture (p<0.01), and 7.0-points higher in respondents who agreed that there is at least one other person in their LTC home that is a champion of hip protectors (p<0.01).

To complete our psychometric evaluation, we examined the internal consistency of items contained in the C-HiP Index. Cronbach’s alpha coefficients for the combined affective/cognitive subscale, the behavioural subscale and the entire C-HiP Index were 0.97, 0.87 and 0.96, respectively. All coefficients were above 0.70, a threshold used previously to indicate acceptance internal consistency.
6.2.3. Chapter 4

After establishing the validity and reliability of the C-HiP Index, we proceeded to investigate potential determinants of commitment to hip protectors amongst paid care providers in Chapter 4. We collected data simultaneously for Chapter 3 and Chapter 4, by means of a cross-sectional survey in thirteen publically subsidized LTC homes from a single regional district in BC, Canada. Amongst the n=529 respondents, mean (SD) commitment was 4.15 (0.71) out of 5.00 possible points. In this chapter, diffusion of innovation (DOI) theory underpinned our efforts [24, 25]. As such, we used Bayesian Model Averaging (BMA) logistic regression to model commitment to hip protectors as a function of personal traits, aspects of the technology, and organizational characteristics.

We found that commitment to hip protectors was affected by race/ethnicity, occupation and organizational tenure. Commitment was higher in Latin American compared to non-Latin American respondents, and lower in Caucasian compared to non-Caucasian respondents. Furthermore, health care assistants and rehabilitation assistants were less committed to hip protectors, while resident care coordinators were more committed to hip protectors. Finally, respondents with more than 20 years of organizational tenure reported lower commitment to hip protectors than respondents with 20 or fewer years.

We also investigated whether an individual’s experiences with hip protectors might affect their level of commitment. We observed that awareness of a resident suffering a hip fracture during a fall while wearing hip protectors associated negatively with commitment, while greater familiarity of hip protectors as a strategy to prevent injuries from falls associated positively with commitment.

Finally, we found that commitment was influenced by perceptions of the timeliness, openness, and accuracy of communication within the LTC home, perceptions of transformational leadership behaviours of a respondent’s primary supervisor, perceptions of the quality of resident-provider relationships (extent of mutual respect between staff and residents), and belief in the existence of a champion of hip protectors within the LTC home.
In Chapter 5, a 12-month retrospective cohort study was conducted in fourteen publically subsidized LTC homes owned and operated by the Fraser Health Authority. Our objectives were threefold: (i) to identify social ecological factors associated with levels of reported adherence; (ii) to compare levels of adherence and barriers to acceptance of hip protectors (as perceived by care providers) between LTC homes from the least and most deprived regions of a regional district in BC, Canada; and (iii) to contribute evidence of the clinical value of hip protectors, by comparing risk of hip, pelvic and other fractures between falls that occurred with hip protectors and falls that occurred without hip protectors. Unlike most previous research, we did not supply residents with hip protectors.

We reviewed all fall-related incident report forms completed during the 12-months prior to baseline (date of enrollment to the study). For each fall, we determined whether a hip protector was worn, and whether a fracture was sustained (hip, pelvic or other). A total of 3826 falls by 1076 residents were documented in participating LTC homes during the 12-months prior to baseline. The mean (SD) incidence of falls was 2.02 (0.54) falls per bed per year. Sixty percent of falls occurred while hip protectors were worn. For each facility, we calculated two measures of adherence: (i) the percentage of residents who fell at least once while wearing hip protectors (Adherence$_{protected\_residents}$), and (ii) the percentage of falls that occurred while hip protectors were worn (Adherence$_{protected\_falls}$). Across participating LTC homes, Adherence$_{protected\_residents}$ ranged from 28.6% to 76.7% (median=63.0%), and Adherence$_{protected\_falls}$ ranged from 22.4% to 79.5% (median=66.9%).

When defined as the percentage of residents who wore hip protectors during at least one fall (Adherence$_{protected\_residents}$), adherence was negatively correlated with regional socioeconomic deprivation ($\rho=-0.630$) and the percentage of residents with depression ($\rho=-0.538$), and was positively correlated with the percentage of residents paying for care privately ($\rho=0.539$) and who fractured their hip in the past 180 days ($\rho=0.677$). When defined as the percentage of falls that occurred while hip protectors were worn (Adherence$_{protected\_falls}$), adherence was negatively correlated with mean ratings of resident and family autonomy as reported by health care assistants ($\rho=-0.585$) and the percentage of residents under age 65 ($\rho=-0.550$), and was positively correlated with the percentage of residents who fractured their hip in the past 180 days ($\rho=0.745$).
Median Adherence \(_{\text{protected\_residents}}\) was 13.1% lower in LTC homes from the most compared to the least socioeconomically deprived regions, while there was no difference in median Adherence \(_{\text{protected\_falls}}\). More residents had depression (median difference=17.9%) and fewer residents had completed a postsecondary education (median difference=-12.4%) in LTC homes from the most compared to the least socioeconomically deprived regions. Care providers more often cited cost and lack of recognition of the need for hip protectors, and less frequently identified concerns about appearance and heat as barriers of acceptance of hip protectors in homes from the most compared to the least socioeconomically deprived regions.

The last objective was to contribute evidence of the clinical value of hip protectors, by comparing the risk of hip, pelvic and other fractures between falls with and without hip protectors. 54 fractures were documented in 51 falls during the 12-months prior to baseline (date of enrollment to the study), including 20 hip fractures, 9 pelvic fractures and 25 other fractures. Among falls with hip protectors, rates of hip fracture were 0.33 per 100 falls. Among falls without hip protectors, rates of hip fracture were 0.92 per 100 falls. The relative risk of hip fracture was 0.36 (95% CI 0.14–0.90) in falls with hip protectors compared to falls without hip protectors. There was no difference in the risk of pelvic (relative risk=1.34, 95% CI 0.34–5.36) or other (relative risk=1.00, 95% CI 0.42–2.38) fractures between protected and unprotected falls.

6.3. General Discussion

6.3.1. Epidemiology of Falls and Fall-Related Fractures in LTC

This thesis offers additional knowledge of the epidemiology of falls in LTC. The mean incidence of falls in participating LTC homes was 2.02 (range:0.84–3.25) falls per bed per year. Similar findings have been reported previously [26, 27]. For example, Rubenstein, Josephson and Robbins (1994) reported a mean incidence of falls of 1.45 (range:0.22–3.60) falls per bed per year. Furthermore, Rapp et al. (2012) observed fall rates of 2.18 and 1.49 falls per person-year in men and women living in German nursing homes. At baseline, mean occupancy was 95.2% (range:70.1–101.3%) in participating LTC homes. We can estimate person-years of exposure by multiplying the bed capacities.
of participating homes by degree of occupancy at baseline. This results in a mean fall rate of 2.14 (range:0.84–3.45) falls per person-year in participating LTC homes.

It is noteworthy that one LTC home had a fall rate of 0.84 falls per bed per year (and 0.84 falls per person-year). This is contrary to extant literature, which suggests that fall rates below one fall per person-year are implausible in LTC [27]. However, 22% of residents in this LTC home were under the age of 65. In BC, LTC is not only for older adults. Risk of falling is known to increase with advancing age [28, 26]. This home also housed a specialized unit for ventilator-dependent residents. Residents living in this unit likely received a high level of care. Low fall rates have been reported previously in residents with high care needs, probably because they are often bedridden and less exposed to activities (e.g., walking, transferring) that lead to falls [27]. These observations could explain the low number of falls documented in this LTC home during the 12-month study.

With respect to the epidemiology of fall-related injuries in LTC, we observed that about 22% of documented falls were injurious, and 1.4% resulted in fractures. A recent study reported a similar rate of injurious falls, with injuries occurring in approximately 25% of falls [29]. However, fracture rates are lower than reported previously [26, 14, 16, 29]. Rubenstein, Josephson and Robbins (1994), for example, reported that fractures occurred in about 4% (range:1–10%) of falls in LTC [26], while Buchele et al. (2014) observed suspected fractures in 2.4% of falls in men and 4.2% of falls in women living in LTC [29]. The lower than expected rate of fractures might be due to a combination of co-intervention (e.g., vitamin D₃ supplementation, use of antiresorptive agents) in participating LTC homes, the relatively high use of hip protectors (60% of falls were protected by a hip protector), underreporting of fractures in the BC Patient Safety and Learning System (PSLS) – the database we accessed to retrieve information on the type and location of injuries sustained in falls – and/or underreporting of non-injurious falls in previous research due to detection bias [27].
6.3.2. Clinical Value of Hip Protectors to Prevent Hip Fractures in LTC

Another important contribution of this thesis is evidence of the clinical value of hip protectors to prevent hip fractures in LTC. The clinical value of hip protectors depends on the biomechanical capacity of hip protectors to minimize stress applied to the proximal femur during sideways landing impact configurations, ultimately leading to reduced risk of hip fracture, in addition to the overall willingness and ability of residents to wear hip protectors on a continued basis. We provide evidence of both. In falls with documented use of hip protectors, the risk of hip fracture was reduced by 64% (95% CI 10–86%) compared to falls without hip protectors. As there was no difference in the incidence of pelvic and other fractures between falls with and without hip protectors, factors other than the use of hip protectors were probably not responsible for the observed between-group difference in hip fracture rates. Furthermore, as 60% of the 3779 documented falls occurred with hip protectors, the use of hip protectors prevented about 12 hip fractures in one year (95% CI 0–28). Similar findings have been reported previously [14, 6, 4]. Kannus et al. (2000), for example, observed an 80% (95% CI 50–95%) reduction in the unadjusted risk of hip fracture between falls with hip protectors compared to falls without hip protectors, and hip protectors were worn in 74% of documented falls [14].

6.4. Clinical Implications

6.4.1. Strategies to Enhance Adherence with Hip Protectors in LTC

As the clinical value of hip protectors is linked to user adherence in the wearing of these devices, deeper insight (and targeting) of the factors governing adherence should lead to improvements in the efficacy of hip protectors to prevent hip fractures in LTC. Accordingly, the overall aims of this thesis were to apply the social ecological model (SEM) of health [30] as a framework of determinants of adherence with hip protectors in LTC, and to identify evidence-based strategies to improve adherence.

When defined as the percentage of residents who wore a hip protector during at least one fall (Adherence_{protected\_residents}), we observed that adherence was negatively
correlated with regional socioeconomic deprivation. Median adherence was 13.1% lower in LTC homes from the most compared to the least deprived regions of the Fraser Valley. From a public health perspective, this is a noteworthy finding, as it highlights socioeconomic inequalities in the delivery and utilization of health care in Canada. To decipher the effect of socioeconomic status (SES) on adherence, we compared characteristics of LTC homes and frequency of reporting of barriers to acceptance (as perceived by care providers) between LTC homes from the most and least deprived regions of the Fraser Valley. We found that a greater percentage of residents in LTC homes from the most deprived regions were diagnosed with depression, while fewer completed post-secondary education. Additionally, care providers employed in the most deprived regions of the Fraser Valley more often cited cost and lack of recognition of the need for hip protectors as barriers to acceptance of hip protectors, compared to respondents employed in the least deprived regions. Accordingly, differences in economic hardship, prevalence of depression and education probably explain the disparity observed in adherence between geographic regions of high and low socioeconomic status.

Aligned with this finding, we identified cost as an important barrier to acceptance of hip protectors. Currently, a single pair of hip protectors cost between $70–$120 CAD. In addition to this expense, residents are sometimes required to buy larger clothing to fit over the added bulk of hip protectors. In our cross-sectional study, 68% (n=342) of paid care providers cited cost as a barrier to acceptance of hip protectors, including 83% (n=38) of respondents in LTC homes from the most socioeconomically deprived regions, and 64% (n=80) of respondents in LTC homes from the least socioeconomically deprived regions. We are not the first to identify cost as an important barrier to acceptance of hip protectors. For example, a central theme of the qualitative study by Tavener-Smith and De Vet (2006) was that hip protectors are not affordable, particularly for pensioners [19]. Findings suggest that improvements in acceptance might be gained by implementing a policy to make hip protectors more affordable, especially for residents living in socioeconomically deprived regions. In further support of our argument, the provision of three pairs of hip protectors at no expense to residents at high risk of falling has been shown in clinical trials to improve adherence by 6–53% [31, 32].
We also observed a negative correlation between Adherence\textsubscript{protected\_residents} and the percentage of residents with a diagnosis of depression. Similar findings have been reported previously [19, 33, 18, 34]. For example, Tavener-Smith and De Vet (2006) reported that some residents made the decision to discontinue use of hip protectors because they were fatalistic about their life stage and would rather live at risk. These residents demonstrated a good understanding of their risk for hip fracture, as well as the life changing nature of a hip fracture. Yet, they simply felt too old to care [19]. In a similar vein, Zimmerman et al. (2010) observed that residents who consistently displayed depressed, sad or anxious mood indicators were, on average, 7% less than adherent than residents who did not [18]. Findings suggest that improvements in the prevention and treatment of depression among older adults living in LTC should facilitate acceptance and adherence with hip protectors.

Lack of understanding of the need for hip protectors amongst residents was another important barrier to acceptance of hip protectors. 17.0% (n=85) of paid care providers who responded to our survey cited lack of recognition of the need for hip protectors as a barrier to acceptance of hip protectors, including 26.1% (n=12) of respondents in LTC homes from the most socioeconomically deprived regions, and 11.1% (n=14) of respondents in LTC homes from the least socioeconomically deprived regions. Additionally, 2.8% (n=14) of respondents cited disbelief in the efficacy of hip protectors as a barrier to acceptance. Care providers felt that some residents declined the initial offer of hip protectors because they doubted their own fragility and/or the effectiveness of hip protectors. Similar findings were reported in Sims-Gould et al. (2014) [35] and Milisen et al. (2010) [36]. For example, in the qualitative study by Sims-Gould et al. (2014), many residents could not fathom the need for hip protectors, as they did not consider themselves to be frail or at risk for falling. To illustrate this theme, Sims-Gould et al. (2014) offered the following quote: “I’m very steady and I’m sturdy and I walk a lot and so I don’t think I’d ever need them” (pg. 698). The authors commented that residents persisted in their view that hip protectors were unnecessary, despite appearing frail and unsteady, and having had a recent fall [35]. Furthermore, Milisen et al. (2010) observed that 54% (n=20) of nursing staff who responded to a cross-sectional survey cited lack of insight in the usefulness of hip protectors as a barrier to adherence [36]. Based on these findings, interventions targeted at improved self-awareness among residents of their vulnerabilities for falls and
fall-related hip fractures, in addition to the potential benefits of hip protectors, should enhance levels of reported adherence in the wearing of hip protectors in LTC.

Like several researchers before us (e.g., [36-38, 35, 39, 40, 19]), we observed that concerns about discomfort, the aesthetic appeal and usability of hip protectors are important barriers to adherence with hip protectors in LTC. 70.9% (n=355) of paid care providers who responded to our survey cited discomfort, 8.4% (n=42) cited heat (especially in the summer months), 2.0% (n=10) cited skin irritation or restriction of movement, 21.2% (n=106) cited concerns about appearance, 1.2% (n=6) cited loss of dignity, 12.2% (n=61) cited bulkiness, and 12.0% (n=60) cited difficulty donning and doffing garments independently as barriers to acceptance of hip protectors. Again, findings are consistent with extant literature (e.g., [36-38, 35, 39, 40, 19]), and suggest that improvements in the design of hip protectors to make them more comfortable, breathable, conspicuous and user-friendly should improve utilization of hip protectors in LTC.

6.4.2. Respecting a Resident’s Right to Live at Risk

We found that mean ratings of resident and family involvement in decision-making reported by health care assistants in participating LTC homes was unrelated to the percentage of residents who wore a hip protector during at least one fall (Adherence\textsubscript{protected_residents}), but was negatively correlated with the percentage of falls that occurred while hip protectors were worn (Adherence\textsubscript{protected_falls}). Accordingly, greater respect for autonomy and individual choice was negatively correlated with levels of reported adherence in the wearing of hip protectors. This is aligned with findings by Sims-Gould et al. (2014) [35]. For example, in their qualitative study, some residents described conceding to the use of hip protectors after repeated pressure by staff, to avoid causing disruption or being perceived as a nuisance. Sims-Gould et al. (2014) offered the following quotes to illustrate this theme: “I just know it has to be worn whether I want to wear it or not” (pg.698) and “Like I say, I have no choice” (pg.699). Sims-Gould et al. (2014) also reported that staff were dedicated to keeping residents safe, and sometimes made the decision to apply hip protectors despite a resident’s explicit refusal. This theme was illustrated nicely by the following quote: “They have to. They have no choice. You wear it.” (pg.700). In Sims-Gould et al. (2014), care providers also felt they had more influence on
the wearing of hip protectors amongst residents with dementia or cognitive impairment [35], a finding that was echoed in earlier work by Milisen et al. (2010) [36].

Findings are worthy of further discussion for several reasons. First, they highlight the role care providers play in shaping whether a resident will wear hip protectors. In participating LTC homes, mean commitment to hip protectors amongst care providers was 4.15 out of 5.00. Accordingly, care providers had positive beliefs regarding the value and effectiveness of hip protectors, and were willing to act or modify their behaviour to encourage and support the use of hip protectors. Findings demonstrate that the relationship between care provider commitment and adherence is probably mediated by respect for autonomy and individual choice. In other words, the effect of commitment on adherence likely depends on the value care providers place on respecting a resident’s decision to refuse hip protectors. Second, findings reiterate the challenges faced by care providers in balancing a resident’s right to individual choice and autonomy against concerns about safety [35]. Although safety is a pillar of health care delivery, a key principle of person-centered care is maintenance of dignity and autonomy, even when a resident’s decision is contrary to safekeeping [41]. The involvement of residents in decisions about care has been shown to foster feelings of citizenship and engagement, improve wellbeing, and enhance interactions with peers and care providers [42]. Accordingly, even though the use of hip protectors might be negatively impacted, improvements in person-centered care might be gained through improved awareness amongst care providers of the importance of safeguarding autonomy.

6.4.3. Strategies to Enhance Care Provider Commitment to Hip Protectors in LTC

An important contribution of this thesis is novel insight into the factors governing the commitment of care providers to encourage and support the use of hip protectors in LTC. Consistent with diffusion of innovation (DOI) theory [24, 25], we found that commitment was affected by personal traits, aspects of the technology, and organizational characteristics.

Respondents with more than 20 years of organizational tenure (years worked at a given LTC home) were less committed to hip protectors than those with 20 or fewer years
of organizational tenure. Based on existing literature [43], it seems likely this was due to increased resistance to change amongst tenured employees. Consequently, strategies to overcome resistance to change amongst tenured employees might facilitate commitment to hip protectors.

We also found that commitment was lower among respondents who were aware of a resident suffering a fractured hip during a fall while wearing hip protectors, compared to respondents who were unaware. Although the reason for this finding is unclear, it is possible that respondents formed a false sense of the capabilities of hip protectors, and therefore, began to doubt the effectiveness of hip protectors after hearing of a hip fracture that occurred during a protected fall (expectation-disconfirmation theory [44]). Findings suggest that improved awareness amongst care providers of the limitations of hip protectors, including the scenarios in which they are unlikely to offer protection (e.g., spontaneous fracture [45], impacts to the posterior buttocks or knees [46], when hip protector is not worn properly [47]), might enhance commitment to hip protectors. Additionally, efforts by decision-makers should be made to communicate objective evidence of the clinical value of hip protectors to care providers, to minimize reliance on anecdotal evidence.

Finally, commitment was positively related to (i) perceptions of transformational leadership behaviours among supervisors, (ii) perceptions of communication, (iii) the quality of resident-provider relationships, and (iv) belief in the existence of a champion of hip protectors within the home. These observations are aligned with extant literature examining barriers and facilitators to adherence with hip protectors [48, 49]. It follows that interventions to promote transformational leadership behaviours in supervisors, to improve the openness, accuracy, timeliness and clarity of communication within the LTC home, to foster respectful relationships between residents and care providers, and to develop champions of hip protectors within the LTC home should positively affect commitment to hip protectors.

6.5. Limitations

In this section, we acknowledge two key limitations of the thesis.
6.5.1. Generalizability

Primary data collection was conducted only in LTC homes owned and operated by the Fraser Health Authority, which could limit the generalizability of findings beyond the Fraser Valley of BC, Canada. Within Fraser Health owned and operated LTC homes, the use of hip protectors has been established as a best practice for injury prevention. In 2013, policy-makers within Fraser Health published a clinical practice guideline endorsing the use of hip protectors amongst residents: (i) who had more than two falls in the previous six months, (ii) who were admitted to the LTC home in the past month, (iii) with impaired mobility, balance or gait, and/or (iv) who are agitated, restless or unable to follow directions. The CPG states that education about hip protectors should be provided to residents (or their substitute decision-maker) who meet these criteria, and refusal to adhere should be clearly documented in health records. Although not documented in the CPG, many (if not all) participating LTC homes keep a ‘communal’ store of hip protectors, often donated by family members of deceased residents. Newly admitted residents are given the opportunity to use ‘communal’ hip protectors, while they are waiting for their own supply of hip protectors to arrive. Additionally, when resident-owned hip protectors are temporarily misplaced or are otherwise unavailable (e.g., during laundering), hip protectors from the communal stock are often borrowed to ensure residents have continuous access to hip protection. Accordingly, utilization of hip protectors in study sites is probably higher than what would typically be found elsewhere. As a comparison, in a recent observational study in Germany, availability of hip protectors ranged from 0–38% across 48 LTC homes, with a quarter of homes not making hip protectors available to residents at all [50].

6.5.2. Definition and Measurement of Adherence with Hip Protectors

Consistent with extant literature (e.g., [51, 32]), we defined and measured adherence in two ways: (i) the percentage of residents who wore a hip protector during at least one fall (Adherence\textsubscript{protected\_residents}), and (ii) the percentage of falls that occurred while a hip protector was worn (Adherence\textsubscript{protected\_falls}). We acknowledge there are likely inherent differences between residents who do and don’t have falls. Consequently, determinants of adherence may also differ between fallers and non-fallers. However, as the clinical
value of hip protectors is directly linked to adherence at the time of falling (compared to all times), we argue \( \text{Adherence}_{\text{protected_residents}} \) and \( \text{Adherence}_{\text{protected_falls}} \) are valid measures of adherence.

### 6.6. Future Research Directions

As mentioned previously, one objective of this thesis was to provide evidence of the clinical value of hip protectors to prevent hip fractures in LTC. To achieve this, we conducted a 12-month retrospective cohort study in fourteen LTC homes, and compared risk for hip, pelvic and other fractures between falls with and without hip protectors. The relative risk of hip fracture was 0.36 (95% CI 0.14–0.90) during falls protected by a hip protector compared to unprotected falls. Furthermore, as 60% of falls were protected by a hip protector during the 12-month study, the use of hip protectors prevented about 12 hip fractures. As hip protectors are routinely used in participating LTC homes, it would not have been appropriate to conduct a clinical trial with randomization of participants to control and intervention arms. However, given the conflicting findings of randomized control trials on the efficacy of hip protectors, subsequent clinical trials on the effectiveness of hip protectors are needed to inform clinical decision-making. Recommendations for conducting future clinical trials have been established, and should be consulted prior to undertaking future studies [52].

Contrary to expectation, the commitment of care providers to support and encourage the use of hip protectors was not correlated with either measure of adherence. However, commitment was high in participating LTC homes, ranging from 3.70 to 4.52 (mean=4.20) out of 5.00 possible points. Accordingly, it is likely we did not sample LTC homes with adequate variability in commitment to hip protectors to understand the relationship between commitment and levels of reported adherence in the wearing of hip protectors. Subsequent research with adequate statistical power is needed to examine this relationship. Future research should take care to sample LTC homes with variable commitment to hip protectors. Prior to undertaking future research, however, efforts should be made to refine the C-HiP Index. Although the C-HiP Index demonstrated good content validity, convergent validity, concurrent validity and internal consistency, hierarchical exploratory factor analysis yielded an unexpected factor structure, with
affective and cognitive items loading onto the same lower-order factor. It is possible we failed to capture the affective component of commitment in the C-HiP Index, and instead wrote nine items to measure cognitive commitment. Suggestions to refine the C-HiP Index were provided in Chapter 3, and included the addition of the following items: “I love the idea of hip protectors”, “I hate the idea of hip protectors”, “I would consider wearing hip protectors if I was a senior residing in this long-term care home”, or perhaps, “I would put hip protectors on someone I love or care deeply for.”

6.7. Conclusion

In this thesis, we offer important knowledge of the clinical value of hip protectors to prevent hip fractures, determinants of adherence with hip protectors in LTC, and factors influencing the commitment of care providers to encourage and support the use of hip protectors in LTC. Findings should provide decision-makers, LTC clinicians, and biomedical engineers with greater awareness of strategies to enhance adherence with hip protectors in LTC. Because adherence is a significant factor in determining hip protector efficacy, targeting of these factors may ultimately lead to a reduction in both the frequency and burden of hip fractures amongst older persons living in LTC.
6.8. References


