An Examination of Fragility Fractures that Occur in Ontario Workplaces

by

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Institute of Health Policy, Management & Evaluation University of Toronto

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Abstract

Due to the aging population and increasing labour participation of older individuals, many workers are at risk for fragility fractures. Evidence is required to determine where prevention efforts should be targeted. The objective of this thesis was to examine fragility fractures (or fractures resulting from same-level falls) that occur in the workplace with respect to the characteristics of the workers who sustain these fractures, and the circumstances leading to fracture.

Methods included descriptive quantitative analyses and open card sorting with stakeholders to develop prevention recommendations. Phase I examined workers' compensation data on same-level falls to compare fracture and non-fracture injuries among workers 20-80 years (Study-1). Subsequently, same-level fall fractures among workers 50-80 years were categorized as potential fragility fractures and other fractures, and compared (Study-2). Phase II used survey data on working fragility fracture patients 50 years and older to compare fragility fractures occurring at work and elsewhere (Study-3). Lastly, workplace fragility fractures were examined to develop prevention recommendations (Study-4).

Many occupational sectors appear suitable targets for prevention, and tailoring may increase the appropriateness of an intervention. Based on fracture volumes, it may be prudent to focus on forearm fractures and workers aged 50-64 years for secondary fracture prevention initiatives. The workplace setting may provide opportunities to reach men. However, there is an overall lack of awareness among fragility fracture patients regarding their risk for fractures. Stakeholders recommended improving worker-environment interactions to limit exposure to potential fracture hazards, and increasing awareness of hazards, osteoporosis and fracture risk. These recommendations could be addressed by leveraging existing workplace slip, trip and fall prevention programs and employing a workplace-based chronic disease management program to prevent osteoporosis and fragility fractures.

These findings could inform a future knowledge translation intervention to prevent workplace fragility fractures which may enhance the health and productivity of older workers.

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Chapter 1: Background, Conceptual Framework and Research Objectives

1.1 Background

1.1.1 Osteoporosis and Fragility Fractures

Osteoporosis is a condition in which bones become fragile and susceptible to breaking (National Institutes of Health (NIH) 2000). This disease affects almost two million people in Canada and more than half a million people in Ontario (Government of Ontario 2005, Osteoporosis Canada 2010). Among Canadians 50 years and older, the overall annual cost of osteoporosis is estimated to be more than \$2.3 billion (Tarride et al. 2012). A fragility fracture is the clinical manifestation of osteoporosis (Bessette et al. 2008, Papaioannou et al. 2010). The World Health Organization (WHO) defines fragility fracture as "a fracture caused by injury that would be insufficient to fracture normal bone: the result of reduced compressive and/or torsional strength of bone" (WHO 1998). Clinically, a fragility fracture may be defined as a fracture that is caused by minimal trauma, such as a fall from standing height or less, or no identifiable trauma (Brown et al. 2002). These fractures result in excess mortality, morbidity and chronic pain compared to individuals without fractures, and significant economic costs (Wiktorowicz et al. 2001, Ioannidis et al. 2009, Papaioannou et al. 2009). Fragility fractures account for more than 80% of all fractures among people over 50 years, and evidence indicates that older individuals are at greater risk for fragility fractures (Brown et al. 2002, Papaioannou et al. 2010, Osteoporosis Canada 2011). In addition, falls, which are a precursor for fractures, and fractures themselves, increase with age (Brown et al. 2002, WHO 2007). Furthermore, people who have sustained a fragility fracture are at greatly increased risk for recurrent fractures (Osteoporosis Canada 2008, Papaioannou et al. 2010). People who have had a fragility fracture at any site are at twice the risk for subsequent fractures regardless of sex or bone quality, measured by level of bone mineral density (Ross et al. 1991, Klotzbuecher et al. 2000).

1.1.2 Fragility Fractures in the Workplace

An emerging patient sub-group of interest is individuals who have sustained a fragility fracture in the workplace. This is a population for which there is limited research. Older people are more likely to have osteoporosis (i.e. highest risk among those older than 65 years) and many studies and interventions have focused on this age group (Brown et al. 2002). However, the disease process begins years, if not decades, earlier (Osteoporosis Action Plan Committee 2003, Osteoporosis Canada 2011). As such, working-age adults are at risk for fragility fractures. It is estimated that the annual direct costs of treating fragility fractures among older people who are in the workforce in Europe, Canada and the United States is approximately \$48 billion per year (International Osteoporosis Foundation (IOF) 2002). Further, due to the aging population, the proportion of older people in the workforce is growing (Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008, Statistics Canada 2016a). Also, these older individuals are choosing to stay in the workforce longer rather than retire (Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008). In addition, the labour market participation rate of older women has been increasing (Toossi 2004, Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008, Statistics Canada 2016a) and they are particularly at risk for fragility fractures (Hanley & Josse 1996, IOF 2012). It is interesting to note that the sex distribution in the workforce typically involves a higher proportion of males. The Ontario workforce is approximately 53% male and 47% female, and the Ontario workers' compensation claimant population is approximately 62% male and 38% female (WSIB 2012a, WSIB 2012b, Statistics Canada 2016b).

Overall, older workers possess a great deal of knowledge, experience and skills, and as such, are an asset to the workforce (Peterson & Spiker 2005, Rogers et al. 2011). Therefore, it is important that fragility fractures be prevented to ensure older people are able to maintain healthy working lives and continue to contribute in the workplace.

1.1.3 Fractures from Same-Level Falls that Occur in the Workplace

In the workplace setting, an injury that closely matches the definition of fragility fracture is a fracture that results from a same-level fall, or a fall from standing height or less (e.g. slip, trip, and fall – i.e. forces that would not normally fracture healthy bone) (Association of Workers' Compensation Boards of Canada (AWCBC 2012)). At present, it is not possible to definitively conclude that fractures resulting from same-level falls at work are in fact fragility fractures (i.e.

low trauma fractures). However, based on close similarity to the fragility fracture definition, fractures from same-level falls are likely to provide the best source of existing information on fragility fractures that occur in the workplace setting, and were considered the most suitable surrogate in the absence of data on workplace fragility fractures.

Same-level falls, resulting from incidents such as slips and trips, account for a significant portion of workplace injuries. In 2010-2011, falls on the same level accounted for about 26% of injuries reported by employees in Great Britain (Health and Safety Executive 2012) and 14% of serious workers' compensation claims in Australia (Safe Work Australia 2014). Within Canada, occupational same-level falls accounted for 13% of serious claims in British Columbia in 2013 (WorkSafeBC 2013) and 13% of all lost-time injuries and illnesses in Manitoba over the period 2000 to 2014 (Safe Work Manitoba 2015). In the United States in 2013, same-level falls accounted for 16% of all non-fatal lost-time injuries and illnesses (Bureau of Labour Statistics (BLS) 2014).

Fractures are one of the most concerning and detrimental consequences of workplace same-level falls. Of the ten most costly occupational same-level fall injuries, fractures accounted for more than half (Courtney et al. 2001). For instance, upper arm, lower leg and hip fractures resulting from same-level falls cost two to five times more than the average same-level fall workers' compensation claim. In addition, the Ontario Workplace Safety and Insurance Board (WSIB) indicated that among fractures as a category of injury claims, "fall on same level" was the most frequently cited event code (WSIB 2015a, WSIB 2015b). Similarly in the United States, same-level falls were the foremost cause of work-related fractures (32%), with the next leading cause being struck by an object or equipment (21%) (BLS 2014). Fractures are thought to be one of the most disabling occupational injuries that arise from same-level falls based on days the injured employee is away from work (Courtney & Webster 2001). Fractures from same-level falls resulted in a median of 36 lost work days versus 21 days for fractures caused by being struck by an object or equipment (BLS 2014). One might expect that fractures caused by being struck would be more debilitating than those from a same-level fall, but the data do not support this supposition.

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1.1.4 Characteristics of People Experiencing Fractures from Same-Level Falls in the Workplace

1.1.4.1 Age and Sex

Workplace studies have examined fractures resulting from same-level falls but overall, there are few studies available describing the characteristics of these fractures in the workplace. One investigation by McNamee et al. (1997) used data from UK and Swedish national occupational injury reporting systems to characterize falls on the same level resulting in fractures among women by age. In particular, risk (relative risk (RR)) was examined by comparing fracture rates among workers aged 45 years of age and older (considered in this study as older workers) to those under 45 years (i.e. younger workers). The study reported a statistically significant, greatly increased risk of fracture among older women after standardizing for occupation in the UK (RR = 3.43) and Sweden (RR = 4.87). In the UK, a more detailed analysis of fracture data by age was performed (prior to standardizing by occupation). Compared to younger women, the risk of fracture was more than double among women aged 45 to 54 years old (RR = 2.58). In addition, the risk of fracture was elevated even further when women aged 55 to 64 years were compared to younger women (RR = 4.98). The investigation also reported that the risk of fracture among older men relative to younger men (not standardized by occupation) was significantly increased, though not as great as for older women compared to younger women (UK: RR = 1.27, Sweden: RR = 1.84). From this study, it is clear that older women are at increased risk of fracture from a same-level fall (which rises with age). This is consistent with literature that indicates that older women in general are at increased risk of fragility fracture, and that this risk increases with age (Hanley & Josse 1996, Brown et al. 2002).

1.1.4.2 Occupation

McNamee et al. (1997) also examined the risk of fracture from same-level fall among women stratified by occupational group based on national injury reporting classification schemes. In the UK, the risk of fracture appeared to be particularly elevated among women employed in management and administrative work; clerical or secretarial work; associated professional and technical work; and personal and protective services. Additionally, the study's investigators noted that cleaners contributed 15% of all fractures due to same-level falls. In Sweden, the risk of fracture appeared to be greatest among women employed in sales work; health, nursing and

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social work; and service work. This information provides an overview of the occupational groups at risk.

1.1.4.3 Falls and Fracture Risk

In a subsequent study by Cherry et al. (2005), some of the same authors examined whether the excess of fractures from falls on the level (i.e. slip, trip and fall) sustained by older women at work was due to a greater likelihood of falling, or a greater risk of fracture as a result of the fall. This UK study comprised two parts. In part one, surveys and health measures were conducted among women who had fallen at work (n = 130) and matched referents (n = 130). In part two, surveys were conducted among women who had fallen at work and sustained a fracture (n =120), and matched referents who had fallen at work but did not sustain a fracture (n = 314). The investigation reported that women who fell were older than referents who had been matched on job and workplace. However, age did not continue to be a significant factor after controlling for body weight and the use of glasses. With regard to the second part of the investigation, fractures were more common among older women who fell, especially those individuals who were postmenopausal and had a low body mass. In addition, the risk of fracture appeared to continue to increase with age beyond the age of menopause. The study concluded that the increased risk of fractures in older women appeared to be due to their greater risk of fracture rather than a greater likelihood of falling. The conclusions, and especially the findings of the second part of the study, are consistent with the literature on fragility fractures (Hanley & Josse 1996, Brown et al. 2002).

1.1.4.4 Physical Demands of Occupation

The previous two studies only characterized workplace fractures from same-level falls by age and sex; factors which are known from the literature to be related to fragility fractures (i.e. older women are at increased risk of fragility fractures) (Hanley & Josse 1996, Brown et al. 2002). Two recent studies provided further insight about other characteristics of fractures from samelevel falls. One investigation based on US workers' compensation data by Verma et al. (2007) examined the association between occupational physical demands and the risk of fracture from a same-level fall. Females in three age groups (18-49 years, 50-59 years and 60-69 years) who had sustained a fall were randomly selected and examined on the basis of fracture occurrence and levels of physical activity, standing and sitting. As with the previous studies, age was found to be significantly associated with an increased risk of fracture when comparing the older groups to the younger group (18-49 years) (50-59 years: RR = 2.0, 60-69 years: RR = 2.8). In addition, when age was considered as a continuous exposure, fracture risk was significantly increased by 19% for every 5-year increase in age. Among the older groups, an increasing duration of standing and a decreasing duration of sitting were associated with a decreased risk of fracture. This trend was statistically significant for both groups. Furthermore, among female workers 50 years and older, moderate occupational physical demands were associated with the lowest risks of fracture. This finding is consistent with weight-bearing exercise aiding in the prevention of osteoporosis and fragility fractures (Brown et al. 2002, Papaioannou et al. 2010). However, individuals involved in heavy occupational physical activity appeared to be at greater risk of fracture than those in the moderate category. This finding is interesting as it may suggest that particular workplace exposures may increase fracture risk (Verma et al. 2007). Furthermore, the authors of this investigation indicated that more research is needed to identify work-related exposures that influence fracture risk in occupations that are sedentary and those involving heavy physical activity.

1.1.4.5 Type of Fracture

Another investigation by Verma et al. (2008) examined the association between particular circumstances of same-level falls and the risk of wrist, ankle and hip fracture. This US study was based on workers' compensation claims data of women over age 45 years. Fracture cases (n = 3,062) were compared with controls (n = 113,388) who had sustained non-fracture injuries from same-level falls and were matched on age, season of fall, industry and state. Data pertaining to circumstances of the fall included: manual material handling tasks, hazards, the initiating event and fall location. The study found that falls during pushing and pulling were associated with a significantly increased risk of wrist fracture (odds ratio (OR) = 1.73). Falling as a result of an uneven surface was associated with a significantly increased risk of wrist fracture (OR = 1.42). Falls due to tripping were associated with a significantly increased risk of wrist (OR = 1.66) and ankle fracture (OR = 3.34). This was the first study to examine a number of characteristics of workplace same-level fall fractures. However, the study's results might be even more informative if it were possible to stratify the data by industrial sector or

occupation so as to better direct prevention efforts (i.e. rather than controlling for industry at the outset).

Finally, Islam et al. (2001) analyzed work-related fractures resulting from numerous causes based on West Virginia (United States) workers' compensation claims. This was an exploratory study reporting on incidence and potential risk factors for fractures. As such, little information was available specific to fractures resulting from same-level falls (n = 753). However, the investigation noted that wrist fractures, mostly resulting from falls on surfaces, were disproportionately high among teachers (other than university and college) compared to other occupations. As such, the authors suggested that prevention efforts should target schools and teachers in order to reduce fractures in this group. The investigation did not report this finding stratified by sex. It is possible that the elevated risk among teachers may have resulted because more teachers were women. Finally, although this study provides preliminary data, further research is needed to confirm the finding regarding teachers. Furthermore, it would be useful to repeat this study stratified for fractures from same-level falls.

1.1.4.6 Strengths and Limitations of the Literature

Of the available studies that examined characteristics of workplace fractures from same-level falls, many of them shared strengths as well as had common limitations. First, on the positive side, though still sparse, there are a few studies on individuals on the lower end of the older worker spectrum (e.g. 45-65 years old) (Cherry et al. 2005, Verma et al. 2007) as many investigations have focused on fractures in seniors (i.e. greater than 65 years old). As such, the reviewed studies provide the foundation for further work.

Second, a common conclusion among the five studies is that there is a need to prevent fractures from same-level falls that occur in the workplace. Cherry et al. (2005) indicate prevention strategies should be applied to the whole working population. Similarly, McNamee et al. (1997) concluded that efforts should be made to minimize hazards in all occupational sectors, especially those with high proportions of female workers. Verma et al. (2007) were more specific in their recommendation. The authors indicated that employers may wish to implement workplace fall prevention initiatives and educational programs designed to decrease falls and fractures in older women, especially those employed in sedentary occupations. The final two studies reviewed only indicate that prevention initiatives for fractures that occur at work are needed among

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teachers (Islam et al. 2001) and in general (Verma et al. 2008). Much of the prevention which is advocated appears to be related to hazard identification and removal. Some of these investigations mentioned osteoporosis as potentially related to these fractures. However, all of these workplace studies failed to recognize the importance of the connection between osteoporosis and fractures, and the need for initiatives to improve bone health.

Third, the studies are missing some important aspects. A number of the investigations were based solely on administrative data (i.e. data from occupational injury reporting systems or workers' compensation claims databases presented in summarized form) (McNamee et al. 1997, Islam et al. 2001, Verma et al. 2007, 2008). Such data lack details of workers' circumstances and contextual factors specific to particular workplaces. Additionally, there is a lack of investigations involving males. The risk of fragility fractures is lower in males than females. It is estimated that one in two women and one in five men over age 50 will suffer a fragility fracture (IOF 2012). However, males are nonetheless affected and should be included in studies. As well, the existing studies are based in Europe and the US, with research lacking in Canada. Such examinations are necessary to determine if Canadian workers' experiences are the same as those in other jurisdictions. Finally, while the reviewed studies concluded that fracture prevention efforts were needed, none examined workers' perceptions or beliefs regarding fractures or bone health, such as individuals' perceived susceptibility or risk for fractures.

1.1.5 The Health Belief Model

In order to improve on previous studies and provide due consideration for workers' perceptions about fractures and bone health, the Health Belief Model (HBM) was selected as the conceptual framework to guide components of this thesis.

1.1.5.1 Beliefs in Relation to Knowledge and Behaviours

Before outlining the HBM, it is important to consider beliefs in relation to knowledge and behaviours. A knowledge translation (KT) intervention may be considered as efforts to modify thoughts and behaviours through information transfer (i.e. consistent with current scientific evidence) (Contandriopoulos 2012). Within the context of a KT intervention (e.g. delivery of tailored education), acquiring knowledge is a positive first step in becoming aware of an issue (Bellamy 2004). Knowledge informs beliefs, and the changing of beliefs indicates a transition in

thinking (Bellamy 2004). Finally, a beneficial action or a behaviour change may provide the best indication that learning has occurred and that interventions to prevent disease may be working (Bellamy 2004). In the context of the current conceptual framework and research, the focus will be placed on health beliefs. It is necessary to first understand workers' current beliefs in order to discern the type of knowledge to impart and the method of delivery needed so as to positively change beliefs. Furthermore, it is hoped that such changes in beliefs will lead to positive behaviours to prevent or address osteoporosis and fragility fractures.

1.1.5.2 Key Concepts of the Health Belief Model

The HBM is based on the theory that an individual's beliefs about the threat posed by a health problem, and their perceptions about the benefits of trying to avoid it, influence their decision about whether to take action (Rosenstock et al. 1994, NIH 2005). As such, the HBM may help to explain, predict, and influence behaviours relevant to prevention and management of osteoporosis and fragility fractures (e.g. weight-bearing exercise, calcium and vitamin D intake, engaging in fall prevention strategies, bone mineral density testing, taking appropriate medication) (Papaioannou et al. 2010). The model is comprised of seven components that are related to whether an individual will decide to take action to prevent and/or control a condition, disease or injury (Rosenstock et al. 1994, Bellamy 2004, NIH 2005):

- Perceived susceptibility: beliefs about the risk of getting a condition
- Perceived severity: beliefs about the seriousness of a condition and its consequences

• Perceived benefits: beliefs about the effectiveness of taking action to reduce the risk or seriousness of a condition

- Perceived barriers: beliefs about the costs of taking action (e.g. physical, financial)
- Self-efficacy: confidence in one's ability to take action to produce a desired outcome
- Cues to action: factors that motivate people to take action

• Modifying factors: include social influences, demographic and other variables that may affect an individual's perceptions (e.g. age, sex, ethnicity, educational background).

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The first five items can be considered to form the core components of the model as they deal with an individual's beliefs which is the fundamental premise for the model. Cues to action are factors that activate readiness for change, such as physical symptoms of the condition, knowledge of the health condition or event in others, advice from others, media reporting, or availability of a KT or educational intervention (through which individuals may gain knowledge of their increased risk) (Bellamy 2004, NIH 2005). Modifying factors form an important component as they take into consideration elements relevant to context. For example, the context of the workplace may be significant in terms of how individuals perceive their risk of osteoporosis.

1.1.5.3 Hypothesized Relationships between Key Concepts

The HBM hypothesizes that there are relationships between an individual's perceptions (i.e. health beliefs and self-efficacy) and behaviours, as depicted in Figure 1.1. The grey box in the centre of the figure represents internal processes within an individual (i.e. thinking). It is posited that an individual is likely to take action to prevent and/or control a condition if they perceive themselves to be susceptible to the condition (perceived susceptibility) and consider it to have serious consequences (perceived severity) (Rosenstock et al. 1994). Individuals are also likely to take action if they feel that the action will be beneficial in reducing their susceptibility to, and/or the severity of, the condition (perceived benefits) and believe that the benefits to taking action outweigh the barriers (perceived barriers) (Rosenstock et al. 1994). In addition, individuals are likely to take action if they are confident that they are capable of executing the behaviours needed to achieve the desired outcomes (self-efficacy) (Rosenstock et al. 1994). Together, the components of perceived susceptibility and perceived severity represent 'perceived threat'. Whereas perceived benefits, perceived barriers, and self-efficacy represent an individual's 'expectations'. Threat and expectations together form an individual's perceptions. Cues to action (e.g. KT intervention) and modifying factors (e.g. workplace context) may influence an individual's perceptions and as a result, contribute to the decision about whether or not to take action (Rosenstock et al. 1994). Overall, if the threat is great, expectations are high (i.e. high self-efficacy, benefits outweigh barriers), and cues to action and modifying factors favour action, positive behaviours will result (i.e. behaviours to prevent and address osteoporosis and fragility fractures).

Figure 1.1: Hypothesized relationships between key concepts



1.1.5.4 Hypothesized Relationships and Workplace Context

It appears there are no studies that have examined the health beliefs of individuals who have sustained fragility fractures in the workplace. Available studies have investigated the perceptions or health beliefs of general populations of fragility fracture patients. These studies indicate that many fragility fracture patients do not perceive a link between their fracture and osteoporosis (Bogoch et al. 2006, Giangregorio et al. 2008, Sujic et al. 2013). A study examining fragility fracture patients reported that even though 44% of participants recognized that they had osteoporosis, only 17% of them believed that their fracture was associated with osteoporosis (Giangregorio et al. 2008). Furthermore, less than 45% of these patients thought they were at risk for a fracture in the future. These findings indicate that the general population of fragility fracture patients do not perceive the link between osteoporosis and fragility fractures; i.e. low perceived susceptibility.

The context of the workplace may play an important role in shaping individuals' beliefs about their risks for osteoporosis and fragility fractures (i.e. perceived susceptibility). Based on the HBM, it may be hypothesized that a person who sustains a fragility fracture at work may be less likely to believe that osteoporosis or poor bone health contributed to their fracture, compared to someone who sustains a fragility fracture outside of work. For instance, workers may be more likely to attribute the fracture to workplace exposures (e.g. cluttered or slippery work area) as the primary cause rather than underlying bone health issues like osteoporosis. This could act as a barrier to workers accepting the need to attend to bone health and treatment to reduce risk of recurrent fractures. Additionally, for individuals who receive workers' compensation for their fracture, claims and processes are oriented around the "accident" event and environmental causes, emphasizing an external cause rather than that external cause in the context of an individual with osteoporosis. Therefore, among those who sustain a fracture at work, workplace context (i.e. modifying factor) may pose an additional barrier to these individuals making the connection between osteoporosis and their fragility fracture, thus hindering perception of susceptibility.

1.1.6 Summary and Implications

Considering the risk of fragility fractures among a growing population of older workers and the burden of these fractures in terms of disability and costs, there is a need to increase efforts to prevent fragility fractures in the workplace. Currently, the information and evidence required to construct and undertake appropriate fragility fracture prevention initiatives in the workplace are limited.

There are few studies that have examined the characteristics of workplace fractures resulting from same-level falls (i.e. surrogate for workplace fragility fractures). The available studies lack details of workers' circumstances and workplace contextual factors, data on males and Canadian workers. Most importantly, though the need for prevention of workplace fractures from same-level falls has been recognized, there has been failure to go beyond removal of workplace hazards to make efforts to improve bone health among workers. In addition, on the basis of the HBM, the workplace may be an important modifying factor in a worker's perception of their risk for fracture (i.e. perceived susceptibility). Studying the working population at this time may provide the opportunity to prevent recurrent fragility fractures and more serious consequences of osteoporosis in the future life of these workers. On this basis, there is a need to examine fragility fractures that occur in Ontario workplaces to provide the foundation for a future KT intervention to prevent fragility fractures in the workplace (further details on undertaking this foundational work are provided in Section 2.1).

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1.2 Research Goal and Objectives

1.2.1 Research Goal

The overall goal of this research was to conduct preliminary work necessary to develop a KT intervention to prevent fragility fractures in the workplace. This foundational work involved gathering data about the current situation and conditions underlying the need for an intervention. Development of an intervention was outside the scope of this thesis.

1.2.2 Overall Objective

The overall objective of this thesis was to examine fragility fractures (or surrogate: fractures resulting from same-level falls) that occur in the workplace with respect to the characteristics of the workers who sustain these fractures, and the circumstances leading to fracture, to inform the development of a KT intervention to prevent fragility fractures in the workplace.

1.2.3 Specific Objectives

This thesis has two Phases, with each phase informed by a different data source. Phase I examined administrative workers' compensation claims data on fractures from same-level falls from the Ontario Workplace Safety & Insurance Board (WSIB). This phase addressed Specific Objectives 1 and 2 which correspond to Studies 1 and 2, respectively. Phase II examined data from working fragility fracture patients obtained through a survey conducted via the Fracture Clinic Screening Program (FCSP) of the Ontario Osteoporosis Strategy. Phase II addressed Specific Objectives 3 and 4 which correspond to Studies 3 and 4, respectively.

The Specific Objectives of the thesis were as follows:

Phase I: To use Ontario workers' compensation claims data:

Objective 1) to describe fractures from same-level falls at work in terms of

- i) burden (proportion of total claims)
- ii) characteristics of workers (age and sex), industry and circumstances (when and how fractures occurred) and
- iii) age and sex subgroups by industry;

Objective 2)

- i) to estimate the proportion of fractures from same-level falls that may be considered osteoporosis-related (i.e. potential fragility fractures (PFFs)) and
- to describe (in terms of age, sex and industry of the workers) how PFFs differ from other fractures resulting from same-level falls, and how types of PFFs (i.e. vertebrae, forearm, humerus, pelvis, hip) differ from each other.

Phase II: To use survey data from working fragility fracture patients participating in a postfracture care program:

Objective 3) to examine whether differences existed in patient characteristics (i.e. demographic and occupational traits), the circumstances leading to fracture (e.g. hazards, activity involved, place and time of fracture) and beliefs about risk for osteoporosis and fractures, between workers who fractured at work compared to other settings.

Objective 4) to conduct a series of consensus groups (CGs) with stakeholders using an open card sorting methodology to facilitate development of recommendations for fragility fracture prevention in the workplace.

Chapter 2: Overview of Research Design and Thesis

2.1 Overview of Research Design

2.1.1 Medical Research Council Process for Developing and Evaluating Complex Interventions

The methodology for this thesis was guided by the UK Medical Research Council (MRC) process for developing and evaluating complex interventions (Craig et al. 2008a, 2008b). The MRC defines complex interventions as interventions consisting of many interacting components. The MRC advocates developing interventions systematically by applying the best available evidence and appropriate theory, followed by testing via pilot studies, then evaluation, and implementation (please see Figure 2.1) (Craig et al. 2008a, 2008b). This thesis only focused on two of the three activities concerned with the first stage, Development. Specifically, this research involved undertaking foundational work to develop the evidence base while considering relevant theory (i.e. the HBM). Emphasis was placed solely on the first two activities of Development because research in this particular area is absent. Future research will involve developing the KT intervention to prevent fragility fractures in the workplace (i.e. Modeling process and outcomes) and address the other stages of the MRC process (i.e. Feasibility and piloting, Evaluation, and Implementation).

Figure 2.1: Key elements of the UK Medical Research Council process for developing and evaluating complex interventions (Craig et al. 2008b)



2.1.2 Research Design and Sources

There is a lack of evidence on the specific population of interest – individuals who have sustained a fragility fracture in the workplace. This foundational work sought to understand workplace fragility fractures in terms of the burden of this issue (as a proportion of particular populations) and characteristics of this type of injury. This thesis was structured in two phases that took a step-wise approach to explore the Overall Objective (Section 1.2.2) by progressively narrowing down the focus to the population of interest. Phase I involved population-based worker's compensation administrative data (Figure 2.2). First, among adult-aged workers (i.e. 20-80 years), same-level falls resulting in fractures were compared to those resulting in non-fracture injuries (Specific Objective 1/Study 1). The subset, same-level fall fractures among older workers (i.e. 50-80 years), were categorized as potential fragility fractures and other fractures, and compared (Specific Objective 2/Study 2). These potential fragility fractures were further examined by fracture type (i.e. vertebrae, forearm, humerus, pelvis and hip).





Phase II continued to narrow the focus to the population of interest by using survey data on fragility fracture patients (i.e. 50 years and older) who were in the workforce at the time of fracture (Figure 2.3). Furthermore, this patient survey data was important as it provided the opportunity to understand fracture patients' health beliefs, which the administrative data could

not provide. First, individuals who sustained fragility fractures at work and elsewhere (e.g. home, community) were compared (Specific Objective 3/Study 3). Next, patients from Study 3 who had sustained their fragility fractures in the workplace were examined in greater depth with consensus groups (CGs) in order to develop recommendations for preventing fragility fractures in the workplace (Specific Objective 4/Study 4).





2.2 Overview of Thesis

The results of this thesis are presented in the form of four separate but connected study manuscripts (Chapter 3-6), as summarized below. The final chapter (Chapter 7) summarizes the four studies comprising this thesis, synthesizes the findings and indicates implications for prevention, discusses the strengths and limitations of the research, highlights other relevant research, describes recommendations for future research, and outlines next steps with regard to knowledge translation and a future intervention to prevent fragility fractures in the workplace.

2.2.1 Chapter 3 (Study 1)

Title: Fractures from Same-Level Falls in the Workplace: A Descriptive Study of Workers' Compensation Claims in Ontario, Canada

The purpose of this manuscript was to examine fractures in a large population of working-aged adults who had sustained same-level falls. This paper sought to understand the size and scope of this issue in the workplace, in particular how these fractures compared to non-fracture injuries.

The objectives of this manuscript were to use Ontario workers' compensation claims data to describe fractures from same-level falls at work in terms of i) burden (proportion of total claims) ii) characteristics of workers (age and sex), industry and circumstances (when and how fractures occurred) and iii) age and sex subgroups by industry.

Manuscript submitted:

Adhihetty C, Hogg-Johnson S, Beaton DE, Jaglal SB. Fractures from Same-Level Falls in the Workplace: A Descriptive Study of Workers' Compensation Claims in Ontario, Canada. Ergonomics (Submitted October 2016).

2.2.2 Chapter 4 (Study 2)

Title: Does the Workplace Have a Role in the Prevention of Fragility Fractures?

The purpose of this manuscript was to refine the scope of the research by using Ontario workers' compensation claims data to examine the characteristics and patterns of fractures from same-level falls among older workers with fracture types considered to be related to osteoporosis. The objectives of this manuscript were to: i) to estimate the proportion of fractures from same-level falls that may be considered osteoporosis-related (i.e. potential fragility fractures (PFFs)) and ii) to describe (in terms of age, sex and industry of the workers) how PFFs differ from other fractures resulting from same-level falls, and how types of PFFs (i.e. vertebrae, forearm, humerus, pelvis, hip) differ from each other.

2.2.3 Chapter 5 (Study 3)

Title: Are Fragility Fractures that Occur in the Workplace Different from Those that Happen Elsewhere?

The purpose of this manuscript was to use survey data from working fragility fracture patients participating in a post-fracture care program to further refine the scope of the research in understanding the population of interest. The objective of this manuscript was to examine whether differences exist in patient characteristics (i.e. demographic and occupational traits), the circumstances leading to fracture (e.g. hazards, activity involved, place and time of fracture) and beliefs about risk for osteoporosis and fractures, between workers who fractured at work compared to other settings.

2.2.4 Chapter 6 (Study 4)

Title: Fragility Fractures at Work: Let's Sort It Out - Consensus Group Recommendations

The purpose of this manuscript was to use the survey data on the population of interest – fragility fracture patients who had sustained their fractures at work – to understand these individuals in greater depth and consider opportunities to prevent these fractures. The objective of this manuscript was to conduct a series of consensus groups with stakeholders using an open card sorting methodology to facilitate development of an intervention for fragility fracture prevention in the workplace.

Chapter 3: Manuscript 1 – Fractures from Same-Level Falls in the Workplace: A Descriptive Study of Workers' Compensation Claims in Ontario, Canada

3.1 Introduction

Same-level falls (i.e. falls from standing height or less), resulting from incidents such as slips and trips, account for a significant portion of workplace injuries. In Australia, the United States and Canada, same-level falls account for approximately 13% to 16% of workers' compensation claims or lost-time injuries and illnesses (WorkSafeBC 2013, Bureau of Labor Statistics (BLS) 2014, Safe Work Australia 2014, Safe Work Manitoba 2015). Fractures are one of the most concerning injuries resulting from workplace same-level falls. Of the ten most costly occupational same-level fall injuries, fractures accounted for more than half (Courtney et al. 2001). For example, same-level falls resulting in upper arm, lower leg and hip fractures cost between two to five times more than the average same-level fall workers' compensation claim. Additionally, the Ontario Workplace Safety and Insurance Board (WSIB) indicated that among fractures as a category of injury claims, "fall on same level" was the most common event code (WSIB 2015a, WSIB 2015b). Similarly in the US, same-level falls were the leading cause of work-related fractures (32%), with the next leading cause being struck by an object or equipment (21%) (BLS 2014). Fractures are also considered one of the most disabling occupational injuries that arise from same-level falls in terms of days the injured person is away from work (Courtney & Webster 2001). Same-level fall fractures resulted in a median of 36 lost work days versus 21 days for fractures resulting from being struck by an object or equipment (BLS 2014).

Fractures from same-level falls are a workplace problem due to their costs and disability, yet these injuries are often preventable, such as through fall prevention strategies (Layne & Pollack 2004, Verma et al. 2007, Bell et al. 2008). Therefore, it is vital to better understand workers who sustain fractures from same-level falls and the circumstances leading to these fractures. This will help to identify potentially modifiable workplace factors (i.e. hazards) and/or interventions for the individual (e.g. preventive health behaviours, health screening) that may assist in preventing these fractures and the associated human and financial costs. The objectives of this study were

to use Ontario workers' compensation claims data to describe fractures from same-level falls at work in terms of i) burden (proportion of total claims) ii) characteristics of workers (age and sex), industry and circumstances (when and how fractures occurred) and iii) age and sex subgroups by industry.

3.2 Methods

The WSIB administers Ontario's no-fault workplace insurance system which is funded by employer premiums (WSIB 2015a, WSIB 2015b). Legislated by the Workplace Safety and Insurance Act, the WSIB provides medical coverage and wage loss benefits, and assists in early and safe return to work for people injured in the course of employment or who contract an occupational disease (WSIB 2015a, WSIB 2015b). This study examined administrative workers' compensation claims data from the WSIB which covers approximately 75% of the workforce in Ontario (WSIB 2015a, WSIB 2015b).

The analyses used allowed lost-time (LTA) claims in the WSIB Information Management Catalogue with dates of accident from January 1, 2002 to December 31, 2011 (10 year period). The data were extracted on May 14, 2013. Claims had to be at least one year past the date of registration so that all of the required information was likely present in the claim. Claims included were for workers 20 to 80 years of age at the time of accident in order to capture a broad spectrum of working adults. In particular, the upper end of 80 years was selected as greater numbers of older individuals are choosing to remain in the workforce rather than retire (Walsh 1999, Marshall & Ferrao 2007). Specifically, the proportion of working seniors who are age 70 years or older has been growing (Duchesne 2004). Of particular interest were cases defined as LTA claims coded as "fracture" [nature of injury code: 01200, i.e. fractures of the bones and teeth] resulting from "fall on same level" [event codes: 13000 ("fall on same level, unspecified"), 13100 ("fall to floor, walkway, or other surface"), 13200 ("fall onto or against objects"), 13900 ("fall on same level, not elsewhere classified")] (as per the Canadian Standards Association (CSA) Standard Z795 applied by the Association of Workers' Compensation Boards of Canada (AWCBC 2012)).

The total number of LTA claims was ascertained and the proportions of LTA claims for the events, "falls" [event code: 1*] and "fall on same level" [event codes: 13000, 13100, 13200, 13900], were calculated for the 10 year period. Also, the proportion of "falls" that occurred on

the same level, as opposed to other means (e.g. "fall to lower level") was determined. The proportion of LTA claims for "fractures" was calculated for the 10 year period. Finally, the proportion of claims for "fall on same level" that result in "fractures", and the proportion of claims for "fractures" that result from "fall on same level" were assessed. These last two proportions provide the burden of fractures from same-level falls, first within the context of possible injuries and second in terms of potential injury events.

For the second objective, fractures from same-level falls were analyzed in terms of worker, industry and circumstance characteristics. Worker characteristics considered were age, sex and part of body injured. Age was examined as a continuous variable, as well as by two age groups (younger workers: 20-49 years, older workers: 50-80 years). Part of body data was coded according to CSA Standard Z795 (AWCBC 2012) and the region of body arose from aggregation of part of body data at the highest level possible.

Industry was based on the rate group of the injured worker's employer. The WSIB classifies all business activities into 155 rate groups which can be categorized into one of 17 different industries (WSIB 2015c). The industries include Schedule 1 sectors of Agriculture, Automotive, Chemical/Process, Construction, Education, Electrical, Food, Forestry, Health Care, Manufacturing, Mining, Municipal, Primary Metals, Pulp and Paper, Services and Transportation (WSIB 2015a); and Schedule 2 which comprise firms funded by public funds, legislated by the province but self-funded, or privately owned but involved in federally regulated industries (Schedule 2 Employers Group 2014, WSIB 2008).

Circumstance characteristics describe when and how the fracture occurred in terms of season, time of day and hazards. Seasons were defined as winter (December to February), spring (March to May), summer (June to August), and autumn (September to November). The time of day was defined as morning (6:00am to 11:59am), afternoon (12:00pm to 5:59pm), evening (6:00pm to 11:59pm), and night/early morning (12:00am to 5:59am). Hazards were assessed by examining source of injury and secondary source of injury data which were coded according to the CSA Standard Z795 (AWCBC 2012). Source of injury describes the surface fallen on to or against. Secondary source of injury describes the object, substance, person, or condition that initiated the fall, if there is some indication that it contributed to the fall (AWCBC 2012).

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Descriptive statistics were performed with the mean and standard deviation calculated for continuous data and proportions calculated for discrete data. In addition among claims due to "fall on same level", analyses were performed to compare individuals who had sustained fractures [nature of injury code: 01200] with those who had not (non-fracture injury) [nature of injury code: all, except 01200]. Chi-squared tests and t-tests were applied when making comparisons among fracture and non-fracture claimants for age, sex and part of body. Additionally, fractures within an industry were calculated as a proportion of same-level fall claims within that industry. Hazards were examined among industries with 1000 or more cases.

For the third objective, fractures from same-level falls were examined in terms of age and sex within each industry by calculating proportions for four subgroups: females 20-49 years, males 20-49 years, females 50-80 years and males 50-80 years. SAS version 9.3 was used for the data analyses. The Research Ethics Board at the University of Toronto approved this study (reference #28543).

3.3 Results

3.3.1 Proportion of Total Claims

There were 828,704 LTA claims to the WSIB with accident dates from January 1, 2002 to December 31, 2011. Over this 10 year period, 18.2% of all LTA claims (n = 150,701) were for the event, "falls", and 12.4% of LTA claims (n = 103,167) were specifically for the event, "fall on same level", among workers 20 to 80 years old. Same-level falls made up 68.5% of "falls" LTA claims. During this period, 6.8% of all LTA claims (n = 56,634) were for nature of injury, "fractures", among individuals 20 to 80 years of age. Combining these attributes, 15.3% of LTA claims for "fall on same level" resulted in "fractures" (15,800/103,167) and among fracture claims, "fall on same level" represented 27.9% (15,800/56,634) of events (Figure 3.1).

The 103,167 LTA claims for "fall on same level" constitute the study population with 15,800 being fractures from same-level falls and 87,367 non-fracture same-level fall injuries.

3.3.2 Worker, Industry and Circumstance Characteristics

3.3.2.1 Worker Characteristics

3.3.2.1.1 Age and Sex

Among workers who had experienced same-level falls, individuals who sustained fractures (n = 15,800) had a mean age of 52.8 ± 12.3 years and those who sustained non-fracture injuries (e.g. sprains, strains, bruises) had a mean age of 49.8 ± 12.2 years (p < 0.0001). The majority of fractures from same-level falls occurred among workers 50-80 years (Table 3.1). Those sustaining a fracture (64.7%) were more likely to be in the older age group (50-80 years) compared to those sustaining a non-fracture injury (54.6%, p < 0.0001). Nearly fifty-two percent of fracture claims were from female workers while 48.1% were from male workers (Figure 3.2). However, fracture claims were not evenly distributed across sex in the two age groups with 57.7% of the younger age group (20-49 years) being males while 57.2% of the older age group (50-80 years) are females.

3.3.2.1.2 Part of Body

Fracture and non-fracture claims appeared to occur at different regions of the body. The most commonly injured areas due to fractures were the upper extremities (45.5% of fractures), followed by the lower extremities (32.7%) and trunk (17.5%). In contrast, non-fracture claims from same-level falls most frequently occurred to the trunk (35.5%), lower extremities (24.0%) and multiple body parts (22.6%), with less than 10% to the upper extremities.

3.3.2.2 Industry Characteristics

Same-level falls that resulted in fracture and non-fracture LTA claims were distributed similarly across industries (table not shown). Within the fracture and non-fracture groups, approximately 50% of claims originated from the Services and Schedule 2 industries (fractures: 25.6% Services, 21.4% Schedule 2; non-fracture injuries: 25.8% Services, 25.3% Schedule 2). The Services industry is comprised of organizations involved in sales (e.g. food, clothing) and services (e.g. restaurants, hotels, personal services (e.g. cleaning, grooming), legal services, vehicle repair) (WSIB 2015d). Schedule 2 includes government entities, as well as telephone, airline, shipping and railway industries (WSIB 2008). The distribution of fracture and non-fracture same-level
fall LTA claims by industry is not unique, but reflects the industry distribution for all LTA claims from 2002 to 2011 (WSIB 2012a, WSIB 2012b).

In contrast, the proportion of same-level fall claims that are fractures varies across industry (Table 3.2) with a high of almost a quarter of claims in Mining and Construction and a low of 12.9% in Automotive. Mining includes gold, nickel and other types of mines and Construction is comprised of subsectors such as homebuilding, road building, electrical and metal work, roofing and masonry (WSIB 2015d).

3.3.2.3 Circumstance Characteristics

3.3.2.3.1 Season

Reporting similar proportions, fracture and non-fracture injuries from same-level falls occurred with the greatest frequency in the winter (37.2% of fractures, 35.8% of non-fracture injuries) and were least frequent in the summer (18.6% of fractures, 19.5% of non-fracture injuries) (table not shown).

3.3.2.3.2 Time of Day

Fractures and non-fracture injuries from same-level falls occurred most often in the morning followed by afternoon (39.9% and 33.6% of fractures, 39.7% and 31.9% of non-fracture injuries, respectively) and were least likely to occur during the evening and night/early morning (11.6% and 4.8% of fractures, 12.3% and 5.1% of non-fracture injuries, respectively). This is consistent with more occupational activities occurring during regular business hours.

3.3.2.3.3 Hazards

Source of injury data indicated that the surfaces fallen onto or against in the majority of cases were: Floor of building [source code: 62210]; Floors, walkways, ground surfaces, unspecified [62000]; Ground [62300]; and Parking lots [62800]. Table 3.3 presents hazards (i.e. secondary sources of injury) which constituted 5.0% or more of the hazards identified with claims in each selected industry. The most common hazards among the six largest industries were: Bodily motion or position of injured, ill worker [56200]; Ice, sleet, snow [93730]; Liquids, unspecified [96200]; and Unknown [99990]. "Bodily motion or position of injured, ill worker" includes stress or strains induced by a free movement of the body or its parts with no impact involved

(AWCBC 2012). A random loss of balance (if not involving other objects, substances, people or conditions) may fit this description. However, for same-level falls this classification is also used for miscellaneous circumstances and thus these data may be less useful. The finding that "ice, sleet, snow" was involved in 19.5% to 37.1% of fractures from same-level falls among the selected industries is consistent with exposures in winter, the season reporting the highest proportions of same-level fall injuries. Overall, more than half (51.5%) of same-level fall fractures in winter were due to "ice, sleet, snow".

3.3.3 Age and Sex Subgroups by Industry

Table 3.4 provides the combined age and sex distribution of fractures from same-level falls by industry. Overall, the greatest proportion of fractures was sustained by older females (37.0%), followed by older males (27.7%), younger males (20.3%) and younger females (14.9%). Among the six largest industries with more than 1000 fractures, Services, Schedule 2 and Health Care had the highest proportion of fractures from same-level falls for older women (Services (39.0% of same-level fall fractures were among older women), Schedule 2 (46.1%) and Health Care (70.5%)). The Health Care industry includes organizations such as health professionals' clinics, hospitals, laboratories, nursing homes and residential care facilities (WSIB 2015d). In contrast, older men represented the highest proportion of fractures in Manufacturing (38.6%) and Transportation (46.7%). Only Construction had the highest proportion of fractures in a younger age group (51.1% among younger men). The Manufacturing industry makes products such as rubber, wood, metal, paper, glass and textile items, furniture, electronics, machinery and equipment (WSIB 2015d). The Transportation industry is comprised of subsectors such as air transport, trucking, warehouse operations and courier services. Similar patterns were found among some of the industries with fewer total fractures (i.e. less than 1000 claims). Like Construction, Mining had high proportions of fractures among older and younger males (59.5% and 31.6%, respectively). Similar to Health Care, Education which includes elementary and secondary schools, universities and other educational facilities (WSIB 2015d), also had one of the highest proportions of fractures among older women (65.3%).

3.4 Discussion

The results of this study showed differences in fracture proportions across age and sex groups and these differed by industry. When the data were separated into two age groups, there was a

higher proportion of women among claims for fractures from same-level falls in the older group (i.e. 50-80 years). Studies suggest that older women appear as likely as younger women to be exposed to workplace hazards, but intrinsic factors like age-related changes (e.g. declining bone health) may increase their vulnerability for fractures (McNamee et al. 1997, Cherry et al. 2005). One study on workplace same-level falls examined whether the excess of fractures from samelevel falls sustained by older women was due to a greater likelihood of falling, or a greater risk of fracture as a result of the fall (Cherry et al. 2005). This UK study comprised two parts. In part one, surveys and health measures were conducted among women who had fallen at work (n = 130) and matched referents (n = 130). In part two, surveys were conducted among women who had fallen at work and sustained a fracture (n = 120), and matched referents who had fallen at work but did not sustain a fracture (n = 314). The study reported that women who had fallen were older than referents matched on job and place of work. However, after controlling for weight and the use of glasses, age was not a significant factor with respect to the likelihood of falling. The second part of the study found that fractures were more frequent among older women who had fallen, especially those individuals who were post-menopausal and had a low body mass. In addition, the risk of fracture appeared to continue to increase with age beyond the age of menopause. This study concluded that the increased risk of fractures in older women may be due to their greater risk of fracture rather than a greater likelihood of falling. These findings by Cherry et al. (2005) along with the current results may be indicative of poor bone health among older women.

In contrast, among the younger age group (i.e. 20-49 years), men sustained the highest proportion of fractures from same-level falls. Fractures from same-level falls among males appear to be associated with heavier industries (characterized by large-scale complex processes to produce goods or extract raw materials and the involvement of heavy products or equipment) and those considered more hazardous (based on fatality rates (Marshall 1996)), such as Manufacturing, Transportation, Mining and Construction. This suggests that the high proportion of fractures among young men may be due to more dangerous occupational duties (McNamee et al. 1997, Toscano et al. 1998). It may be hypothesized that in these industries, injuries arising from same-level falls may receive little attention compared to injuries that may be caused by more dangerous exposures (e.g. chemicals, machinery-related physical hazards).

When both age groups and sexes were considered together, the second highest proportion of fractures from same-level falls overall after older women was for men aged 50-80 years. One may hypothesize that the high proportion of fractures among these older men may be due to similar age-related changes (i.e. declining bone health) as older women, which may increase their risk for fractures (Melton et al. 1998, Kaufman et al. 2013). Additionally, older men appear to be engaged in industries such as Manufacturing and Transportation which may involve exposure to dangerous occupational duties that pose additional fracture risk.

The industry-specific age and sex distributions appear to reflect patterns in terms of male and female dominated occupations. As in this and other studies, women represented a greater proportion of the Service industry than men (Wootton 1997, Gabriel & Schmitz 2007). Previous workplace studies on same-level falls have also indicated that fractures were common among women in service jobs. Verma et al. (2008) examined wrist, ankle and hip fractures among women over 45 years of age and found most of these fractures were in the service industry and retail trade (35.5% and 16.6%, respectively). In another study, women who sustained same-level fall fractures were more likely to be engaged in service or manual work than women who only fell (i.e. did not sustain a fracture) (OR = 1.53 (95% CI 0.92-2.56)) (Cherry et al. 2005). McNamee et al. (1997) reported an increased risk of fracture among older (45-64 years) compared to younger (16-44 years) women in service and sales work (RR = 3 and 4.5, respectively). Additionally, the current study reported a high proportion of older women with fractures from same-level falls in the Education sector which is consistent with teaching being a female dominated profession (Wootton 1997, Statistics Canada 2015). Similar to the current investigation, Islam et al. (2001) identified more than a two-fold increased risk of radius and ulna fractures among teachers (other than university and college) compared with all other occupations (OR = 2.32 (95% CI 1.15-5.60)). Men, in contrast, were concentrated in traditional blue-collar work related to craft, production, operator, and labourer jobs as would be found in the Manufacturing and Construction industries (Wootton 1997, Gabriel & Schmitz 2007). Thus, the proportions of fractures within industries in this study sample appears to align with whether or not the industry is male or female dominated.

This study has a number of strengths. It contributes evidence on fractures from same-level falls among a wide range of working-age individuals. In particular, the research describes same-level fall fractures among older workers (50-80 years). When it comes to fractures, the falls literature

tends to be more focused on seniors in non-work settings (e.g. at home, in long term care facilities) (Berry & Miller 2008). This also appears to be the first Canadian study in this area and it provides findings on males which are often lacking in the fracture literature. Additionally, use of WSIB data for this study is beneficial as the WSIB covers approximately 75% of Ontario's workforce (WSIB 2015a, 2015b), meaning the data represents the majority of the working-age population. Furthermore, coding of injuries at the WSIB is reliable and consistent according to coding rules and guidelines, with coders achieving 90% to 95% agreement in quality assessment checks (Van Eerd et al. 2006). This study also has limitations. First, administrative data may be limited by missing data (Van Eerd et al. 2006, Hulley et al. 2007). For example, time of day was missing for 11% of claims. Additional weaknesses of administrative data are the potential for misclassified data or errors within the data (Van Eerd et al. 2006, Hulley et al. 2007). For instance, the injury may be inaccurately described by the employer on the form used for reporting to the WSIB (i.e. Form 7), such as error in assignment of cause (e.g. same-level fall documented as a slip without fall). Second, studies such as this which use workers' compensation claims databases must rely on administrative classification schemes to provide occupational and injury related information. This may lead to inaccurate or generalized portrayals of fractures from same-level falls. For instance, the data for hazards and industries lacked specificity. Additionally, the focus was on fractures as an injury type, and while it is assumed that same-level falls are of low trauma, it is not possible to confirm whether they were high or low trauma fractures. Therefore, it is not possible to attribute the high proportion of fractures among older women and men to inadequate bone health specifically. The findings can only be used to generate hypotheses.

3.5 Conclusion

In summary, the findings of this study highlight a number of issues with respect to the prevention of fractures from same-level falls. First, the distribution of fractures was similar to non-fracture injuries on the basis of sex, industry, season and time of day; but differed in terms of age and part of body. This means that interventions to prevent fractures may only need to differ from same-level fall prevention initiatives on the basis of age (i.e. fractures were more likely in the older age group) and part of body (e.g. large proportion of fractures affected the upper extremities). Second, slippery conditions generated by ice, sleet, snow and liquids were common hazards involved with same-level fall fractures. These hazards can be prevented by improving

workplace housekeeping practices and educating workers to enhance awareness of hazards and detrimental outcomes such as fractures. Third, in the older age group (50-80 years), women represented the larger proportion. This may be indicative of poor bone health which suggests the need for screening among older women. Fourth, in the younger age group (20-49 years) a greater proportion of fractures was found among men. These fractures appear to be associated with more heavy and hazardous industries where little attention may be given to same-level fall injuries. If seeking to prevent fractures in younger men, further investigation is required to understand safety training for this group and whether adequate education is provided about same-level fall injuries and fractures as a potential outcome. Fifth, older men (50-80 years) represented the second highest proportion of fractures from same-level falls overall. Fractures in this group could be due to poor bone health as well as exposure to dangerous occupational hazards. Further research is needed to explore these potential causes for workplace same-level fall fractures among older men as literature is lacking. Finally, traditional male and female dominated occupations appeared to influence the proportions of men and women sustaining fractures from same-level falls in different industries. This may suggest the need to tailor prevention initiatives in particular workplaces by sex depending on whether they involve male or female dominated occupations.

Figure 3.1



Burden of fractures from same-level falls

	Same-level falls				
Charactoristic	Fracture	Non-fracture ¹			
Characteristic	N = 15,800	N = 87,367			
	%	%			
Age ²					
20 - 49 years	35.3	45.4			
50 - 80 years	64.7	54.6			
Sex ^{2,3}					
Females	51.9	53.9			
Males	48.1	46.1			
Region of body ²					
Upper Extremities	45.5	9.3			
Lower Extremities	32.7	24.0			
Trunk	17.5	35.5			
Head	2.6	6.8			
Multiple Body Parts	1.5	22.6			
Neck, including Throat	0.2	1.5			
Other Body Parts	*	0.1			
Body Systems	0.0	0.1			

Worker characteristics of lost-time allowed (LTA) claims for fracture and nonfracture injuries from same-level falls among individuals 20-80 years

¹ The most common non-fracture injuries were sprains, strains and bruises

 2 p-value < 0.0001 for chi-square tests comparing fractures and non-fracture injuries

³ Missing values for Sex: n = 13 (Fracture: n = 1, Non-fracture: n = 12)

* = less than 6 claims (i.e. suppressed cells)





Fractures as a proportion of same-level fall injuries by industry (lost-time allowed (LTA) claims among individuals 20-80 years)

In duction (Same-level	Fractures from	
(by decreasing fracture propertien)	fall injuries	same-level falls	
(by decreasing fracture proportion)	Ν	n (%)	
Mining	326	79 (24.2)	
Construction	4,527	1,059 (23.4)	
Agriculture	1,259	271 (21.5)	
Pulp and Paper	276	57 (20.7)	
Forestry	441	85 (19.3)	
Education	1,408	271 (19.2)	
Manufacturing	12,151	2,079 (17.1)	
Chemical/Process	1,724	291 (16.9)	
Electrical	716	118 (16.5)	
Transportation	7,648	1,210 (15.8)	
Municipal	1,006	157 (15.6)	
Primary Metals	543	84 (15.5)	
Food	3,077	475 (15.4)	
Services	26,613	4,044 (15.2)	
Health Care	11,869	1,591 (13.4)	
Schedule 2 (government and related entities)	25,443	3,379 (13.3)	
Automotive	3,475	447 (12.9)	
Missing	665	103 (15.5)	
Total	103,167	15,800 (15.3)	

Hazards involved with fractures from same-level falls in selected industries (lost-time allowed (LTA) claims among individuals 20-80 years)

	Industry						
	Services	Schedule 2	Manufacturing	Health Care	Transportation	Construction	
Hazard*	(n = 4,044)	(n = 3,379)	(n = 2,079)	(n = 1,591)	(n = 1,210)	(n = 1,059)	
	%	%	%	%	%	%	
Bodily motion or position of injured, ill worker	22.2	25.2	21.5	21.1	21.6	25.8	
Ice, sleet, snow	19.5	31.6	29.1	29.4	37.1	24.7	
Liquids, unspecified	10.1			7.0			
Unknown						5.2	

*Hazards constituting 5.0% or more of the hazards in each industry are presented

	20 - 49	years	50 - 80 years		
Industry		Males	Females	Males	
		%	%	%	
Services (n = 4,044)	20.8	18.6	39.0	21.6	
Schedule 2 (government and related entities) (n = 3,379)	17.5	13.0	46.1	23.4	
Manufacturing (n = 2,079)	8.9	23.4	29.1	38.6	
Health Care (n = 1,591)	21.0	2.9	70.5	5.6	
Transportation (n = 1,210)	5.5	31.9	15.9	46.7	
Construction (n = 1,059)	2.4	51.1	2.9	43.6	
Food (n = 475)	14.7	17.9	34.9	32.4	
Automotive (n = 447)	12.8	22.1	29.3	35.8	
Chemicals/Process (n = 291)	15.1	19.2	32.6	33.0	
Education (n = 271)	16.6	6.3	65.3	11.8	
Agriculture (n = 271)	11.4	41.0	24.7	22.9	
Municipal (n = 157)	17.2	21.7	31.8	29.3	
Electrical (n = 118)	6.8	42.4	12.7	38.1	
Forestry (n = 85)	*	42.4	*	49.4	
Primary Metals (n = 84)	*	23.8	**	59.5	
Mining (n = 79)	*	31.6	*	59.5	
Pulp and Paper (n = 57)	10.5	17.5	26.3	45.6	
Missing (n = 103)	15.5	21.4	24.3	38.8	
Total (n = 15,800)	14.9	20.3	37.0	27.7	

Age and sex distribution of fractures from same-level falls by industry (lost-time allowed (LTA) claims among individuals 20-80 years)

* = less than 6 claims (i.e. suppressed cells)

** = suppressed to prevent calculation of values in '*' cells

Chapter 4: Manuscript 2 – Does the Workplace Have a Role in the Prevention of Fragility Fractures?

4.1 Introduction

Osteoporosis is a condition in which bones lose strength and become susceptible to breaking (National Institutes of Health (NIH) 2000). This disease affects at least two million people in Canada and among Canadians 50 years and older, the overall annual cost of osteoporosis is estimated to be more than \$2.3 billion (Osteoporosis Canada 2010, Tarride et al. 2012). A fragility fracture is the clinical manifestation of osteoporosis (Bessette et al. 2008, Papaioannou et al. 2010). The World Health Organization (WHO) defines fragility fracture as "a fracture caused by injury that would be insufficient to fracture normal bone: the result of reduced compressive and/or torsional strength of bone" (WHO 1998). Clinically, a fragility fracture may be defined as a fracture that is caused by minimal trauma, such as a fall from standing height or less, or no identifiable trauma (Brown et al. 2002). Common fragility fracture sites include the hip, forearm, vertebra, humerus and pelvis (O'Donnell et al. 2013). Fragility fractures result in increased mortality, morbidity and chronic pain compared to individuals without fractures, and significant economic costs (Wiktorowicz et al. 2001, Ioannidis et al. 2009, Papaioannou et al. 2009). Furthermore, these fractures account for more than 80% of all fractures among people over 50 years (Osteoporosis Canada 2011). It is estimated that one in two women over age 50 will sustain a fragility fracture, and while often considered a "woman's disease", one in five men will also suffer a fragility fracture (International Osteoporosis Foundation (IOF) 2012).

An emerging patient sub-group of interest is individuals who have sustained a fragility fracture in the workplace. Due to the aging population, the proportion of older people (i.e. age 50 years and older) in the workforce is growing (Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008, Statistics Canada 2016a). Also, these older individuals are choosing to remain in the workforce rather than retire (Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008). Evidence indicates that older individuals are at greater risk for fragility fractures (Brown et al. 2002, Papaioannou et al. 2010). Also falls, which are a frequent precursor for fractures, and fractures themselves, increase with age (Brown et al. 2002, WHO 2007). In addition, the labour

market participation rate of older women has been increasing (Toossi 2004, Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008, Statistics Canada 2016a) – individuals who are particularly at risk for fragility fractures (Hanley & Josse 1996, IOF 2012). Older workers possess a great deal of knowledge, experience and skills, and as such, are an asset to the workforce (Peterson & Spiker 2005, Rogers et al. 2011). Therefore, it is critical to understand fragility fractures that occur in the workplace and consider opportunities to prevent these fractures so that older individuals are able to maintain healthy working lives and continue to contribute in the workplace.

The aim of this study was to use workers' compensation claims data in the province of Ontario, Canada to describe types and patterns of fractures that occur in the workplace that may be due to osteoporosis. In the workplace setting a type of injury that most closely matches the definition of fragility fracture is a "fracture" resulting from a "fall on same level" (e.g. slip, trip and fall – i.e. forces that would not normally fracture healthy bone) (Association of Workers' Compensation Boards of Canada (AWCBC) 2012). At present, it is not possible to definitively conclude that fractures resulting from same-level falls at work are in fact fragility fractures. However, it is likely that this coding scheme would exclude high trauma injuries and be documented for low trauma or fragility fractures. Potential fragility fractures (PFFs) could be defined by common fracture types due to osteoporosis, older age and result from a same-level fall.

The objectives of this study were: i) to estimate the proportion of fractures from same-level falls that may be considered osteoporosis-related (i.e. PFFs) and ii) to describe (in terms of age, sex and industry of the workers) how PFFs differ from other fractures resulting from same-level falls, and how types of PFFs (i.e. forearm, humerus, hip, vertebrae, pelvis) differ from each other. This is the first study to the best of our knowledge that examines PFFs in the workplace. It serves to generate hypotheses and indicate opportunities in the workplace for preventing fragility fractures.

4.2 Methods

The Workplace Safety and Insurance Board (WSIB) administers Ontario's no-fault workplace insurance system which is funded by employer premiums (WSIB 2015a, WSIB 2015b). Legislated by the Workplace Safety and Insurance Act, the WSIB provides medical coverage and

wage loss benefits, and assists in early and safe return to work for people injured in the course of employment or who contract an occupational disease (WSIB 2015a, WSIB 2015b). This study examined administrative workers' compensation claims data from the WSIB which covers approximately 75% of the workforce in Ontario (WSIB 2015a, WSIB 2015b).

The analyses used allowed lost-time (LTA) claims in the WSIB Information Management Catalogue with dates of accident from January 1, 2002 to December 31, 2011 (10 year period). The data were extracted on May 14, 2013. Claims had to be at least one year past the date of registration so that all of the required information was likely to be present in the claim. Claims included were for workers 50 to 80 years of age at the time of accident in order to capture a broad spectrum of older working adults. The threshold of age 50 years was selected as Canadian clinical practice guidelines for osteoporosis and fragility fractures target women and men over 50 years of age due to the burden of the disease in this age group (Papaioannou et al. 2010). The upper end of 80 years was selected as greater numbers of older individuals are choosing to remain in the workforce rather than retire (Walsh 1999, Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008). Specifically, the proportion of workers who are age 70 years or older has been growing (Duchesne 2004).

In this study, age, injury event (i.e. same-level fall), and fracture type (i.e. site) were used to create a definition called "potential fragility fracture" (PFF). This definition is consistent with the Public Health Agency of Canada (PHAC) definition for fragility fracture (O'Donnell et al. 2013) but offers greater specificity as it tries to focus on low trauma injuries. Specifically, PFF cases were defined as LTA claims in the 50-80 year age group coded as "fracture" [nature of injury code: 01200] resulting from "fall on same level" [event codes: 13000 ("fall on same level, unspecified"), 13100 ("fall to floor, walkway, or other surface"), 13200 ("fall onto or against objects"), 13900 ("fall on same level, not elsewhere classified")] (as per the Canadian Standards Association (CSA) Injury Coding Standard Z795 endorsed by the Association of Workers' Compensation Boards of Canada (AWCBC 2012)). Furthermore, only parts of body that were in accordance with fracture sites considered by the PHAC to be related to osteoporosis (i.e. forearm, humerus, hip, vertebrae and pelvis) were included in the case definition (O'Donnell et al. 2013). Part of body data were coded according to CSA Standard Z795 (AWCBC 2012) and PFF types were defined as Forearm [part of body codes: 31300 ("Forearm(s)"), 31200 ("Elbow(s)"), 32000 ("Wrist(s)")], Humerus [21000 ("Shoulder, including clavicle, scapula and

trapezius muscle if shoulder is mentioned")], Hip [25100 ("Hip(s)")], Vertebrae [23000, 23100, 23200, 23201, 23202, 23290, 23300, 23301, 23390, 23400, 23800, 23900, 23901 ("Back, including spine, spinal cord")] and Pelvis [25200 ("Pelvis")].

To address the first objective, claims meeting the case definition for PFFs were considered as a proportion of LTA claims for "fractures" [nature of injury code: 01200] from "fall on same level" [event codes: 13000, 13100, 13200, 13900] among workers aged 50-80 years for the study's 10 year timeframe (i.e. denominator includes fractures to all parts of body).

For the second objective, PFFs were analyzed in terms of the age, sex and industry of the workers and when the fracture occurred. Age was examined as a continuous variable, as well as in two age groups (50-64 years and 65-80 years). Industry was based on the rate group of the injured worker's employer. The WSIB classifies all business activities into 155 rate groups which can be categorized into one of 17 different industries (WSIB 2015c). The industries include Schedule 1 sectors of Agriculture, Automotive, Chemical/Process, Construction, Education, Electrical, Food, Forestry, Health Care, Manufacturing, Mining, Municipal, Primary Metals, Pulp and Paper, Services and Transportation (WSIB 2015a); and Schedule 2 which comprise firms funded by public funds, legislated by the province but self-funded, or privately owned but involved in federally regulated industries (Schedule 2 Employers Group 2014, WSIB 2008). Season and time of day indicated when the fracture occurred. Seasons were defined as winter (December to February), spring (March to May), summer (June to August), and autumn (September to November). The time of day was defined as morning (6:00am to 11:59am), afternoon (12:00pm to 5:59pm), evening (6:00pm to 11:59pm), and night/early morning (12:00am to 5:59am).

Descriptive statistics were derived with the mean and standard deviation calculated for continuous data and proportions calculated for discrete data. In addition, among claims for "fractures" due to "fall on same level", analyses were performed to compare PFFs [i.e. case definition] with other fractures [i.e. case definition with one exception – part of body: all codes not used for PFFs]. Chi-squared tests and t-tests were applied when making comparisons between PFFs and other fractures for age, sex, industry, season and time of day. Furthermore, PFF types (i.e. forearm, humerus, hip, vertebrae, pelvis) were compared with each other on the basis of age and sex using chi-squared tests. Additionally, industry-specific analyses were

undertaken. First, among PFFs and other fractures, the proportion of females and males in each industry was calculated and compared. Second, PFFs as a proportion of same-level fall fractures was calculated for each industry alongside the industry-specific PFF type distribution (i.e. proportions of forearm, humerus, hip, vertebrae and pelvis fractures in each industry). Interpretation of the results was guided first by clinical significance of the difference and then by statistical significance. It was appreciated that with the large sample in this study, even trivial differences would be statistically significant. SAS version 9.3 was used for the data analyses. The Research Ethics Board at the University of Toronto approved this study (reference #28543).

4.3 Results

4.3.1 Proportion of Potential Fragility Fractures

There were 10,228 LTA claims for "fractures" from "fall on same level" to the WSIB with accident dates from January 1, 2002 to December 31, 2011 among workers 50-80 years. This study population comprised 4,894 PFFs and 5,334 other fractures (e.g. ankle, chest, knee). Thus, among workers aged 50-80 years who sustained a fracture from a same-level fall, 47.8% of these fractures may be related to osteoporosis based on the case definition for this study (i.e. same-level fall resulting in forearm, humerus, hip, vertebrae and pelvis fractures in this age group).

4.3.2 Potential Fragility Fractures Compared to Other Fractures from Same-Level Falls

4.3.2.1 Age and Sex

Among workers who had experienced same-level fall fractures, individuals who sustained PFFs had a mean age of 60.8 ± 6.5 years and those who sustained other fractures had a mean age of 59.9 ± 6.4 years (p < 0.0001). Mean ages were considered similar despite the statistical difference. The majority of same-level fall fractures occurred among workers 50-64 years (Table 4.1) but, workers with PFFs were more likely to be in the older (65-80 years) age group (29.6%) compared to those with other fractures (25.2%, p < 0.0001). Importantly, individuals sustaining PFFs were more likely to be female (63.8%) compared to those sustaining other fractures (51.0%, p < 0.0001).

4.3.2.2 Industry

The highest proportions of fractures came from the Services industry (26.9%) for PFFs and Schedule 2 (government and related entities) (24.1%) for other fractures. The Services industry is comprised of organizations involved in sales (e.g. food, clothing) and services (e.g. restaurants, hotels, personal services (e.g. cleaning, grooming), legal services, vehicle repair) (WSIB 2015d). Schedule 2 includes government entities, as well as telephone, airline, shipping and railway industries (WSIB 2008). Overall, PFF and other fracture LTA claims were distributed similarly across the 17 industries. The distribution of these fracture types is not unique, but is comparable to the industry distribution for all LTA claims from 2002 to 2011 (WSIB 2012a, WSIB 2012b).

4.3.2.3 Season and Time of Day

For PFFs and other fractures, the greatest proportion occurred in the winter (37.4% and 37.5%, respectively) and the lowest proportion occurred in the summer (18.5% and 17.1%, respectively) with no appreciable difference between the two fracture groupings. This finding is consistent with slipping hazards contributing to the high proportion of same-level fall fractures in the winter. A previous investigation using this data set reported that over half of fractures from same-level falls in the winter were due to ice, sleet and snow (Adhihetty et al. Manuscript 1). The greatest proportion of PFFs and other fractures occurred in the morning (40.5% and 41.9%, respectively) followed by afternoon (34.4% and 33.3%, respectively). This is consistent with more occupational activities occurring during regular day time business hours.

4.3.2.4 Sex-Distribution by Industry

Among the majority of industries, the proportion of females in the PFFs group was 7.4 to 24.9 percentage points higher than for females in the "other fractures" group (see Table 4.2). Furthermore, in some industries the sex with the higher proportion of fractures was reversed between the two groups. For instance in the Manufacturing industry, females comprised 53.7% of the PFFs group but males made up 67.0% of the other fractures group. However, the percentage point difference in the proportion of females in the PFFs group versus the other fractures group was low in a few industries (-0.5 to 3.2) including Construction, Health care and Education industries which are traditionally associated with male or female dominated occupations (Wootton 1997, Gabriel & Schmitz 2007, Statistics Canada 2015).

4.3.3 Potential Fragility Fracture Types

4.3.3.1 Age and Sex

Among each of the PFF types (Table 4.3), the majority of fractures occurred among workers in the younger (50-64 years) age group. Furthermore, for vertebrae (76.8%) and forearm (71.8%) fractures, workers were more likely to be in the younger age group compared to pelvis (61.3%) and hip (58.4%) fractures (p < 0.0001). The sex distribution indicated that vertebrae, forearm and humerus fractures were more likely to occur among females (62.5% to 65.6%) and pelvis and hip fractures were more equally distributed between males and females (p < 0.0001).

4.3.3.2 Potential Fragility Fracture Proportion and Type Distribution by Industry

Table 4.4 provides the proportion of same-level fall fracture claims that are PFFs within each industry. The Food (55.0%), Services (53.7%) and Automotive (53.3%) industries had the highest proportions of PFFs. In contrast, Forestry (28.3%), Electrical (33.3%) and Construction (36.5%) had the lowest proportions of PFFs.

The total (i.e. reference) distribution for PFF types is as follows: forearm (75.7% of all PFFs), humerus (10.9%), hip (6.9%), vertebrae (5.9%), and pelvis (0.4%). Table 4.4 provides this distribution by each industry. Pelvis fractures were excluded from the table due to small values. While most industries were similar to the reference distribution, some industries had higher or lower percentage point differences for particular fracture types. For example, the Food industry was 4.4 percentage points higher for forearm fractures and 6.4 percentage points lower for humerus fractures. Despite these slight industry-specific differences, it was clear that forearm was the PFF type with the highest proportion in all of the sectors.

4.3.4 Discussion

This study found that many fractures occurring at work meet the fragility fracture definition based on fracture type (i.e. site) and worker age, as well as being described as a same-level fall, which approximates a low trauma event. This suggests fragility fractures are occurring in the workplace. On this basis, this study estimated that nearly half of same-level fall fractures among workers 50-80 years may be related to osteoporosis. The distributions of age and sex for claimants with PFFs are different than for claimants experiencing other fractures. The results are

supportive of PFFs being fragility fractures. For example, those presenting with PFFs are disproportionately older (65-80 years) and women which is consistent with age and sex patterns for fragility fractures (Hanley & Josse 1996, Brown et al. 2002, Papaioannou et al. 2010, IOF 2012). Furthermore among the majority of industries, the proportion female was higher in the PFFs group compared to the other fractures group, likely due to osteoporosis as this disease impacts women more than men (Hanley & Josse 1996, IOF 2012). However, the proportion of females within the two fracture groups was very similar for Construction, Health care and Education. This likely reflects the workers within these industries being dominated by one sex, female for Health Care and Education, and male for Construction. In Construction it appears that there are too few women to show a relationship between sex and PFF, whereas in Health care and Education the majority of workers are women, attenuating the relationship between sex and fracture type.

In analyzing PFF types by age, the highest proportions were found among the younger group (50-64 years) for vertebrae, forearm and humerus fractures which is consistent with literature indicating that these types of fragility fractures tend to occur at a younger age than those of the hip and pelvis (Johnell et al. 2004, IOF 2012, Soles & Ferguson 2012). It should be noted that a fracture is an indication of future fracture risk. People who have had a fragility fracture at any site are at twice the risk for subsequent fractures regardless of sex or bone quality (Klotzbuecher et al. 2000, Kanis et al. 2004). The large number of PFFs among the 50-64 year age group suggests that this younger group of workers may benefit from secondary fracture prevention interventions so as to avoid subsequent and potentially more serious fractures (e.g. hip) as these individuals age. Moreover, in the industry-specific analysis of PFF types, it was evident that forearm was the most common fracture type across all industries. As such, it may be prudent to focus on forearm fractures if considering workers to target for secondary fracture prevention initiatives. Studies of patients with forearm fractures have examined the effect of interventions comprised of education and reminders (for follow-up) among patients and their physicians (Cranney et al. 2008, Majumdar et al. 2008, Rozental et al. 2008). These studies reported positive results such as increased investigation and treatment for osteoporosis, and could provide guidance for workplace interventions to address forearm fracture.

Analysis of PFF types by sex indicates that this study population of workers appears to have a greater proportion of males than is typically seen among studies of fragility fracture patients (i.e.

among the majority of fracture types and those with more cases) (Johnell & Kanis 2006). This is an important finding because there is a lack of awareness about osteoporosis in men (Phillipov et al. 1998, Wilson et al. 2011) and diagnosis and treatment of men with fragility fractures is inadequate (Papaioannou et al. 2008). A prospective cohort investigation examined community dwelling men aged 50 years and older who were participating in the Canadian Multicentre Osteoporosis Study (Papaioannou et al. 2008). After five years of follow-up only 10.3% of men with a fragility fracture had been diagnosed with osteoporosis and 9.5% had been treated for this condition. With the potential to capture higher proportions of men with fragility fractures at work, this setting could provide an opportunity to improve diagnostic and therapeutic efforts in males.

There are well established treatment guidelines (Papapioannou et al. 2010, Cosman et al. 2014) and efficacious therapies for osteoporosis and fragility fractures (Papapioannou et al. 2010). However, regardless of sex, there exists a significant gap in care. Among men and women who sustained fragility fractures, investigation or treatment for osteoporosis was typically less than 50%, and in many cases, far less (Elliot-Gibson et al. 2004, Papapioannou et al. 2004, Giangregorio et al. 2006). In recent years various interventions such as physician and/or patient education, alerts or follow-up, and fracture liaison services have sought to address the care gap with moderately positive outcomes, but a gap still remains (Little & Eccles 2010, Papapioannou et al. 2010, Sale et al. 2011, Ganda et al. 2013, Aizer & Bolster 2014). In light of this, workplace health promotion initiatives could potentially reduce the gap in care.

The workplace may be useful for health promotion as it provides access to a large and relatively stable population that is often situated in a small number of geographic sites (Harden et al. 1999, Goetzel & Ozminkowski 2008, Sorensen et al. 2011). Furthermore, many employed adults spend a significant amount of time at work. Additionally, this population generally shares a common purpose and culture which may encourage sustained peer support and positive peer pressure if engaging in a program (Harden et al. 1999, Goetzel & Ozminkowski 2008). A workplace-based chronic disease management program to prevent osteoporosis and fragility fractures could serve as a unique strategy to protect workers 50 years and older. Such a program could support bone health, reduce risk factors for fracture (primary prevention), and enhance early recognition and management of fragility fractures (secondary prevention) through education to enhance health-promoting behaviours and/or screening initiatives (Papaioannou et

al. 2010). This program could fall within an organization's wellness strategy or could be integrated within occupational health and safety training (e.g. fall prevention).

Growing evidence supports the effectiveness of disease management programming (e.g. improved health, cost savings) and its importance in workplace settings given the increasing population of aging workers (Pelletier 2009, Sorensen et al. 2011, Nyman et al. 2012, Caloyeras et al. 2014, Goetzel et al. 2014, Smith et al. 2015). Support exists for workplace programs for other chronic conditions like cardiovascular disease and diabetes, showing increases in positive health behaviours (e.g. diet, exercise) and significant improvements in physical indicators related to risk factors for disease (Groeneveld et al. 2010, Arena et al. 2013, Huang et al. 2013, Bevis et al. 2014, Weinhold et al. 2015). It appears that only three studies have examined workplacebased osteoporosis prevention interventions (education and/or screening) (Peters et al. 2006, Niu et al. 2010, Tan et al. 2016). Positive changes were reported such as increased calcium intake, physical activity, follow-up with health care providers and maintenance of bone mineral density. However, these studies on office (sedentary) workers and teachers were limited in size (two of three studies) and focused on primary prevention, women and those younger than 50 years. While these findings are encouraging, further research is needed to examine the potential of the workplace as a setting to prevent osteoporosis and fragility fractures among older workers of both sexes and include both primary and secondary prevention of fractures.

The current study provides preliminary evidence on industries where it may be valuable to initiate a workplace-based disease management program to prevent osteoporosis and fragility fractures. The Services and Schedule 2 (government and related entities) industries reported the highest proportions of PFFs (i.e. fraction of total PFFs). The Food, Services and Automotive industries reported the highest proportions based on PFFs as a fraction of same-level fall fractures within individual industries. Importantly, each of these industries is affiliated with one of four Ontario Safe Work Associations which provide sector-specific health and safety advice, products, services and information (e.g. best practices, training) (WSIB 2015e, Health & Safety Ontario 2015) and could be key partners in prevention efforts.

This study has a number of strengths. By focusing on fracture claims with events coded as "fall on same level", other more traumatic or high impact incidents are likely to be excluded, such as events involving being struck by or against objects, caught in or compressed by equipment or

objects, crushed in collapsing materials, assaults and transportation accidents (AWCBC 2012). Additionally, the coding of injuries at the WSIB is reliable and consistent according to coding rules and guidelines, with coders achieving 90% to 95% agreement in quality assessment checks (Van Eerd et al. 2006). Finally, this appears to be the first study that examines PFFs at work with the purpose of considering whether the workplace can be a site for targeting the prevention of fragility fractures.

This study has limitations, many of which relate to the case definition applied. First, while 'same-level fall' is often cited in the definition of fragility fractures, it is not the only way that these fractures can be sustained. Other circumstances, such as bending, reaching or lifting loads may cause fragility fractures (National Osteoporosis Foundation 2010), and these would not likely be captured in the current study. Second, while PFFs were sustained from same-level falls which suggests low trauma, it is not possible to definitively conclude that these were in fact low trauma fractures. However, a review by Warriner et al. (2011a) reported that any prior fracture, regardless of the degree of trauma, may suggest underlying poor bone health and an increased risk for future fracture. Therefore even if some PFFs in this study resulted from circumstances exceeding low trauma, osteoporosis may still be a concern. Nevertheless, future research should seek to verify the validity of the PFF case definition (i.e. "fracture" from "same-level falls") as low trauma via a review of workers' compensation claim files. Third, only those fracture sites considered by the Public Health Agency of Canada as related to osteoporosis were used in the case definition for this study. However, other studies considered additional fracture sites, such as ribs and tibia and fibula (in women), as associated with osteoporosis (Kanis et al. 2000, Warriner et al. 2011b). Thus, the current study may underestimate the proportion of same-level fall fractures related to osteoporosis among older workers. Finally, administrative data may be limited by missing or misclassified data, or errors within the data (Van Eerd et al. 2006, Hulley et al. 2007). For instance, in this study 10% of data were missing for time of day. Another example is that on the Form 7, which is submitted by the employer to the WSIB for injury reporting, the cause could be inaccurately described (e.g. slip without fall vs. same-level fall). Additionally, in some sectors within the industry analyses, there were too few workers within some of the cells to be able to report findings.

4.3.5 Conclusion

During the study period, half of fractures from same-level falls among workers 50 years and over (n = 4,894) would be commonly considered as fragility fractures. As such, there exists a unique opportunity for the workplace to play a role in the prevention of fragility fractures. A workplace-based disease management program could address risk factors for fracture (primary prevention) and improve early identification and management of fragility fractures (secondary prevention) via education to enhance health-promoting behaviours and/or screening initiatives. This study indicated that secondary fracture prevention, especially among workers 50-64 years old and those with forearm fractures, may help to prevent subsequent and more serious fractures and reduce the care gap. Furthermore, a disease management program at work could have the potential to identify both men and women with these fractures and make equitable gains in addressing this condition. Overall, a workplace-based disease management program may serve as a novel strategy to bridge the care gap and optimize bone health among a growing population of older workers. This study provides initial evidence to start considering the workplace's role in the prevention of fragility fractures, however further research and exploration of this disease management model is needed.

Characteristics of lost-time allowed (LTA) claims for potential fragility fractures and other fractures from same-level falls among workers 50-80 years

Characteristic	Potential Fragility Fractures N = 4,894 n (%)	Other Fractures N = 5,334 n (%)	p-value
Age			
50 - 64 years	3,445 (70.4)	3,991 (74.8)	<0.0001
65 - 80 years	1,449 (29.6)	1,343 (25.2)	
Sex			
Females	3,124 (63.8)	2,721 (51.0)	< 0.0001
Males	1,770 (36.2)	2,612 (49.0)	
Missing	- (0.0)	1 (0.0)	
Industry			
Services	1,318 (26.9)	1,135 (21.3)	< 0.0001
Schedule 2 (government & related entities)	1,066 (21.8)	1,283 (24.1)	
Manufacturing	682 (13.9)	725 (13.6)	
Health Care	592 (12.1)	619 (11.6)	
Transportation	318 (6.5)	439 (8.2)	
Construction	180 (3.7)	313 (5.9)	
Food	176 (3.6)	144 (2.7)	
Automotive	155 (3.2)	136 (2.5)	
Education	90 (1.8)	119 (2.2)	
Chemical/Process	89 (1.8)	102 (1.9)	
Agriculture	64 (1.3)	65 (1.2)	
Municipal	37 (0.8)	59 (1.1)	
Primary Metals	28 (0.6)	33 (0.6)	
Mining	20 (0.4)	29 (0.5)	
Electrical	20 (0.4)	40 (0.7)	
Pulp and Paper	21 (0.4)	20 (0.4)	
Forestry	13 (0.3)	33 (0.6)	
Missing	25 (0.5)	40 (0.7)	
Season			
Winter	1,828 (37.4)	2,001 (37.5)	0.3
Spring	1,154 (23.6)	1,309 (24.5)	
Autumn	1,009 (20.6)	1,114 (20.9)	
Summer	903 (18.5)	910 (17.1)	
Time of day			
Morning	1,984 (40.5)	2,236 (41.9)	0.3
Afternoon	1,682 (34.4)	1,775 (33.3)	
Evening	535 (10.9)	537 (10.1)	
Night/Early morning	221 (4.5)	235 (4.4)	
Missing	472 (9.6)	551 (10.3)	

Sex distribution of potential fragility fractures and other fractures from same-level falls, by industry (lost-time (LTA) claims among workers 50-80 years)

	Potential Fragility Fractures		Other Fractures N = 5,334		Difference in
					proportions of females
	N = 4	,894			between the groups
Industry	Females	Males	Females	Males	(Percentage point
industry	(%)	(%)	(%)	(%)	difference)
Services ¹	67.8	32.2	60.4	39.6	7.4
Schedule 2 (government & related entities)	72.1	27.9	61.6	38.4	10.5
Manufacturing	53.7	46.3	33.0	67.0	20.7
Health Care	94.1	5.9	91.3	8.7	2.8
Transportation	32.7	67.3	20.0	80.0	12.7
Construction	8.3	91.7	5.1	94.9	3.2
Food	63.1	36.9	38.2	61.8	24.9
Automotive	50.3	49.7	39.0	61.0	11.3
Education	84.4	15.6	84.9	15.1	-0.5
Chemical/Process	59.6	40.4	41.2	58.8	18.4
Agriculture	62.5	37.5	41.5	58.5	21.0
Municipal	56.8	43.2	49.2	50.8	7.6
Primary Metals	25.0	75.0	*	**	
Mining	*	**	*	**	
Electrical	30.0	70.0	22.5	77.5	7.5
Pulp and Paper	52.4	47.6	*	**	
Forestry	*	**	*	**	
Missing	52.0	48.0	30.0	70.0	22.0
Total	63.8	36.2	51.0	49.0	12.8

¹ Missing value in Services industry for sex: Other Fractures ($\overline{n = 1}$)

* = less than 6 claims (i.e. suppressed cells)

** = suppressed to prevent calculation of values in '*' cells

	Vertebrae	Forearm	Humerus Pelvis Hip		Hip	
Characteristic	N = 289	N = 3,703	N = 532	N = 31	N = 339	p-value
	n (%)	n (%)	n (%)	n (%)	n (%)	
Age						
50 - 64 years	222 (76.8)	2,657 (71.8)	349 (65.6)	19 (61.3)	198 (58.4)	< 0.0001
65 - 80 years	67 (23.2)	1,046 (28.2)	183 (34.4)	12 (38.7)	141 (41.6)	
Sex						
Females	181 (62.6)	2,412 (65.1)	349 (65.6)	14 (45.2)	168 (49.6)	< 0.0001
Males	108 (37.4)	1,291 (34.9)	183 (34.4)	17 (54.8)	171 (50.4)	

Age and sex of potential fragility fractures, by type (allowed lost-time (LTA) claims among workers 50-80 years)

Potential fragility fractures as a proportion of same-level fall fractures and proportions of potential fragility fracture types, by industry (allowed lost-time (LTA) claims among workers 50-80 years)

	Potential	Potential fragility fracture types ^{1,2}				
Inductor	fragility	Forearm	Humerus	Нір	Vertebrae	
industry	fractures	N = 3,703	N = 532	N = 339	N = 289	
	%	%	%	%	%	
Food	55.0	80.1	4.5	6.8	8.0	
Services	53.7	75.6	10.6	8.5	4.7	
Automotive	53.3	75.5	10.3	4.5	9.0	
Pulp and Paper	51.2	90.5	*		*	
Agriculture	49.6	82.8	*	*	*	
Health Care	48.9	74.5	12.3	6.8	5.7	
Manufacturing	48.5	73.0	11.7	7.9	6.3	
Chemical/Process	46.6	79.8	7.9	6.7	*	
Primary Metals	45.9	67.9		*	*	
Schedule 2 (government and related entities)	45.4	77.9	12.7	4.4	4.6	
Education	43.1	77.8	11.1	*	*	
Transportation	42.0	75.2	9.1	7.9	7.5	
Mining	40.8	55.0	*	*	*	
Municipal	38.5	78.4	*	*	*	
Construction	36.5	75.0	9.4	6.1	7.8	
Electrical	33.3	65.0	*		*	
Forestry	28.3	53.8	*	*	*	
Missing	38.5	52.0	20.0	20.0	8.0	
Total	47.8	75.7	10.9	6.9	5.9	

¹ Pelvis fractures (0.4% of Total) excluded from table due to small values per industry

² For shaded cells, n = 0

* = less than 6 claims (i.e. suppressed cells)

Chapter 5: Manuscript 3 – Are Fragility Fractures that Occur in the Workplace Different from Those that Happen Elsewhere?

5.1 Introduction

Little is known about fragility fractures that occur in the workplace. However, the proportion of older adults in the workplace is growing (Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008, Statistics Canada 2016a). In particular, labour market participation rates of older women, who are at greater risk for fragility fractures, have been increasing (Hanley & Josse 1996, Toossi 2004, Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008, International Osteoporosis Foundation (IOF) 2012, Statistics Canada 2016a). Analysis of Ontario workers' compensation data indicated that among allowed lost-time fracture claims, the sub-group "fall on same level" was the code most similar to the definition of fragility fracture and represented approximately 28% of events (Adhihetty et al. Manuscript 1). In turn, it was the most common injury event code among allowed lost-time fracture claims (WSIB 2015a, WSIB 2015b). Likewise in the US, same-level falls were the primary cause of work-related fractures (32%), followed by being struck by an object or equipment (21%) (Bureau of Labour Statistics (BLS) 2014). Different types of fractures accounted for more than half of the ten most costly occupational same-level fall injuries (Courtney et al. 2001). Additionally, fractures from same-level falls are considered one of the most disabling occupational injuries with respect to days the injured individual is off work, with a median of 36 lost work days compared to 21 days for fractures caused by being struck by an object or equipment (Courtney & Webster 2001, BLS 2014).

Considering the risk of these fractures among a growing population of older workers and the potential disability and costs, there is a need to better understand fragility fractures in the workplace. In particular, the context of the workplace – the environment where the fracture occurred – may play an important role in shaping individuals' beliefs about their risks for osteoporosis and fragility fractures. It may be hypothesized that an individual who sustains a fragility fracture at work may be less likely to believe that osteoporosis or poor bone health contributed to their fracture, compared to those who sustain a fragility fracture elsewhere. This is consistent with the Health Belief Model (HBM) which is based on the theory that an

individual's beliefs about the threat posed by a health problem, and their perceptions about the benefits of trying to avoid it, influence their decision about whether to take action (Rosenstock et al. 1994, National Institutes of Health (NIH) 2005). For example, they may be more likely to attribute the fracture to workplace exposures such as a cluttered or slippery work space as the principle cause, rather than underlying bone health issues like osteoporosis. This could be a barrier to these individuals accepting the need to attend to bone health and treatment to reduce risk of a subsequent fracture. Also, for individuals who receive workers' compensation for their fracture, claims and processes are very much oriented around the "accident" event and environmental causes. Thus, this places more emphasis on an external cause, rather than considering that external cause in the context of a person with osteoporosis. Indeed, workers may feel at risk for their workers' compensation support if the cause is attributed to bone health alone. As such, workplace context may pose an additional barrier to individuals making the connection between osteoporosis and their fragility fracture, thus hindering perception of risk for osteoporosis and future fractures.

The objective of this study was to examine whether differences existed in patient characteristics (i.e. demographic and occupational traits), the circumstances leading to fracture (e.g. hazards, activity involved, place and time of fracture) and beliefs about risk for osteoporosis and fractures, between workers whose fragility fracture occurred at work compared to other settings with the goal of identifying modifiable factors that could prevent fractures in older workers (50 years and over).

5.2 Methods

In the province of Ontario, Canada the Ministry of Health and Long-term Care funds a chronic disease management strategy for osteoporosis and fracture prevention (Jaglal et al. 2010). The main component of the Ontario Osteoporosis Strategy is the Fracture Clinic Screening Program (FCSP). This fracture liaison service exists at approximately 35 moderate to high volume fracture clinics across Ontario and involves screening coordinators identifying patients with fragility fractures (defined as low trauma fractures in persons aged 50 years or older, both men and women). While they are in the clinic setting for fracture care, the coordinator also intervenes to educate patients about their low trauma fracture, its potential link to an underlying bone health issue and the need to follow-up with their primary care physician for appropriate fracture risk

assessment and guideline consistent treatment of osteoporosis. Letters are sent to the primary care physician with similar information.

Data from the FCSP is gathered for quality assurance and monitoring of the program and entered in a database (Beaton et al. 2014, Yong et al. 2016). In 2012 an anonymous Work Survey was developed to examine fragility fractures among workers (Rotondi et al. 2016). Eligibility for the survey was restricted to English-speaking fragility fracture patients who were screened as part of the FCSP (i.e. confirmed fragility fractures), 50 years of age or older, employed for pay at the time of fracture and had agreed to follow up as part of the FCSP. Eligible patients were identified from the FCSP database if they met the criteria and were mailed the questionnaire three to six months after their fracture. A reminder letter was mailed to all patients two weeks later to thank them for their participation, and if they had not yet completed the survey, to encourage them to do so.

All surveys were completed on paper, devoid of any identifiable information. The survey was kept anonymous to protect worker privacy and allay any potential concerns that their response could impact their insurance claim status. The survey was designed to capture important features of patients' occupations, circumstances leading to fracture and health beliefs about osteoporosis and fracture, and to do so in a way that was comparable for discussion across settings (i.e. at work versus elsewhere). Demographic data obtained included age, sex and fracture type (i.e. part of body). Occupational information analyzed included job title, employment hours and shift work participation. Self-reported job title was coded according to a National Occupational Classification (NOC) code. The NOC is the nationally accepted reference that classifies and describes occupations in the Canadian economy (Human Resources and Skills Development Canada 2013). Occupational groups arose from aggregation of job titles to the highest level possible in the NOC (i.e. skill type). Self-reported circumstances leading to fracture involved analysis of the season, time of day, place (i.e. indoors or outdoors), activity being engaged in, hazards and initiating event (e.g. slip, trip). Seasons were defined as winter (December to February), spring (March to May), summer (June to August), and autumn (September to November). The time of day was defined as morning (6:00am to 11:59am), afternoon (12:00pm) to 5:59pm), evening (6:00pm to 11:59pm), and night/early morning (12:00am to 5:59am). Multiple responses were only permitted for the survey question on hazards. Finally, among individuals who sustained their fractures at work, information about insurance coverage for wage

replacement and/or expenses related to the injury (e.g. workers' compensation, self-insurance) was obtained.

In addition to examining the circumstances of the fracture, this study explored the likelihood that this group of working patients believed their fragility fracture was due to a bone health issue. Two survey questions based on the HBM examined patients' perceptions of bone health. One question assessed the health belief of perceived susceptibility (i.e. "Do you think that your current fracture puts you at a greater risk for another fracture in the future?"). The other investigated whether patients perceived the link between their fracture and osteoporosis (i.e. "Do you think that your bone their the future and osteoporosis (i.e. "Do you think that your bone the link between their fracture and osteoporosis (i.e. "Do you think that your bone the link between their fracture and osteoporosis (i.e. "Do you think that your bone the link between the strength?").

Survey respondents were stratified into two groups: individuals who had fractured at work versus elsewhere (i.e. not at work, transit to/from workplace); and were compared in terms of demographic and occupational traits, circumstances leading to fracture and perceptions of bone health. The mean, standard deviation and range were calculated for continuous data, and frequencies and proportions were calculated for discrete data. Chi-squared tests, Fisher's exact tests and t-tests were used to compare the two groups (p-values less than 0.05 were considered statistically significant).

Multinomial logistic regression was used to examine the relationship between the health belief of perceived susceptibility ('yes', 'no' and 'don't know') and whether or not the individual sustained the fragility fracture at work (Allison 1999). The model was adjusted for age and sex as these potential confounders may influence perceived susceptibility with respect to osteoporosis (Johnson et al. 2008). Specifically, older individuals and women show higher levels of perceived susceptibility than younger individuals and men, respectively (Johnson et al. 2008). Odds ratios with 95% confidence intervals were derived from the regression analysis. SAS version 9.4 was used for all data analyses. The Research Ethics Boards at St. Michael's Hospital (reference #14-182) and the University of Toronto (reference #31016) approved this study.

5.3 Results

The Work Survey was mailed to 596 eligible patients from December 2012 to July 2013, on average 170 days (or 5.5 months) following screening. By December 2013, 292 surveys had

been returned via mail, generating a response rate of 49.0%. Of the 292 survey respondents, 275 (94.2%) met the eligibility criteria. Among this group of working individuals (i.e. in workforce at time of fracture), 17.2% sustained their fragility fractures at work (n = 47) and 82.8% sustained their fragility fractures elsewhere (n = 227) (setting was missing for n = 1).

5.3.1 Age, Sex and Type of Fracture

Individuals who sustained fragility fractures at work had a mean age of 59.6 ± 6.4 years and those who sustained fragility fractures elsewhere had a mean age of 58.4 ± 6.0 years (Table 5.1). Approximately 80% of respondents were female but those who had a fracture at work were more likely to be male (32.6%) compared to those who fractured elsewhere (17.0%, p = 0.02). The most common fracture type among both groups was wrist fracture (At work: 38.3%, Elsewhere: 40.9%).

5.3.2 Occupational Group

The two most common occupational groups reported were Business, finance and administration and Sales and service occupations which accounted for about half of respondents. When the proportion of fractures 'At work' and 'Elsewhere' were examined by occupational group some interesting patterns were observed. Of those who fractured 'At work', the largest proportion was in Sales and service occupations (31.9%) followed by Business, finance and administration (17.0%). Surprisingly none of the respondents in the 'At work' group reported being in Health occupations. Among those who fractured 'Elsewhere', the largest proportion was in Business, finance and administration occupations (29.8%) followed by Sales and service (18.2%). A greater proportion of patients with 'At Work' fractures (14.9%) were employed as Trades, transport and equipment operators and related occupations compared to those with fractures occurring 'Elsewhere' (4.9%).

5.3.3 Employment Hours and Shift Work

Among the two groups, the proportions of patients working full-time and part-time (includes part-time, casual and self-employed) hours were the same. The majority (68.1%) were working full-time hours at the time of fracture. The proportion of individuals engaged in shift work was also similar among the groups with most not involved in shift work (87.5% overall).

5.3.4 Workers' Compensation

Thirty-eight patients who sustained fragility fractures at work reported being eligible for provincial workers' compensation coverage. For these individuals, compensation claims had been allowed for the majority (84.2%) and fewer than five claims (<10.6%) were pending at the time the Work Survey was completed.

5.3.5 Season, Time of Day and Place

Fractures 'At work' and 'Elsewhere' occurred with the greatest proportions in the winter (51.1% and 42.0%, respectively) and morning (48.9% and 42.7%, respectively) (Table 5.2). The next highest proportion in the 'At work' group was in the afternoon (34.0%), whereas for the 'Elsewhere' group, it was found in the evening to early morning hours (31.7%). Most fragility fractures occurred outdoors (70.7% overall). However, a greater proportion of fractures occurred indoors in the 'At work' group (44.7%) compared to the 'Elsewhere' group (26.1%, p = 0.01).

5.3.6 Activity, Hazards and Initiating Event

Fragility fractures occurring 'At work' and 'Elsewhere' were distributed similarly across activities. The majority of individuals were walking when they sustained their fracture (At work: 53.2%, Elsewhere: 55.3%). The most commonly reported hazard among both groups was Slippery surface (At work: 51.1%, Elsewhere: 56.8%). Fragility fractures occurring 'At work' and 'Elsewhere' were distributed similarly across initiating events with the majority being slips (At work: 44.7%, Elsewhere: 47.6%).

5.3.7 Perceptions of Bone Health

When asked about perceived susceptibility ("Do you think that your current fracture puts you at a greater risk for another fracture in the future?"), both groups reported a similar pattern with approximately one-third of respondents selecting each of the responses, 'yes', 'no' and 'don't know' (Table 5.3). When asked about the perceived link between their fracture and osteoporosis ("Do you think that your broken bone could have been caused by poor bone strength?"), both groups had a similar distribution of responses with approximately 90% responding 'no' or 'don't know'.

5.3.8 Setting and Perceived Susceptibility

The results of the multinomial logistic regression indicated that there was no association between setting (i.e. whether fracture occurred 'At work' vs. 'Elsewhere') and perceived susceptibility with both groups being equally unlikely to make the link between their fracture and bone health, adjusting for age and sex. However, sex was significantly associated with perceived susceptibility with males almost three times more likely to respond 'don't know' rather than 'yes' compared to females (OR 2.74 (1.13-6.64)), and more than three times as likely to respond 'no' versus 'yes' compared to females (OR 3.18 (1.33-7.62) to the question of whether they think their current fracture puts them at risk for a future fracture.

5.4 Discussion

Among a population of working fragility fracture patients, individuals who sustained their fractures at work were similar in terms of demographics, occupational characteristics, fracture circumstances, and perceived susceptibility to those who experienced a fracture outside of their work role (i.e. elsewhere). The average age of patients in the current study was approximately 10 years less than the mean age of 68 ± 12 years for 37,920 patients enrolled in the FCSP from 2008 to 2013 (Yong et al. 2016); indicative of a younger working population. Similar to the total sample in this study, the six-year evaluation of the FCSP reported that the majority of patients were female (83%) and had sustained a non-hip fracture (88%).

Among both the 'At work' and 'Elsewhere' groups the most common circumstances involved walking, slippery surfaces, slipping and winter. This finding is consistent with winter slipping hazards like ice and snow contributing to a high proportion of same-level fall fractures in the winter (Adhihetty et al. Manuscript 1). An implication for the prevention of fragility fractures among all older working adults is that similar environmental safeguards are required both in and out of the workplace (e.g. snow removal, salt to eliminate ice, cleaning floors of melted snow). However, there may be greater opportunities to control hazards in the workplace as employers have a responsibility to create safe workplaces for their employees. They are also likely motivated to minimize financial impacts related to workplace fractures such as increases in workers' compensation premiums and costs for replacement staff or production delays.

Workplace context did not appear to affect perceptions of bone health. The majority of patients who sustained a fragility fracture at work had allowed workers' compensation claims, indicative of a work-related injury. As such, the workplace context could have interfered with their perception of susceptibility for osteoporosis and fragility fractures. Research evidence indicates that fragility fracture patients are less likely to associate their fracture with bone health if they believed it was an isolated or unusual event that was unavoidable and surrounded by sudden and/or forceful circumstances (Sale et al. 2012). Such may be the case with fragility fractures that happen at work. However, the current study does not support that the workplace context makes this perception more definitive.

Regardless of setting, the majority of survey respondents lacked awareness of their susceptibility for fragility fractures and do not appear to make the link between osteoporosis and fragility fractures. Studies examining perceptions of bone health among fragility fracture patients are consistent with these findings (Bogoch et al. 2006, Giangregorio et al. 2008, Sujic et al. 2013). One study examining fragility fracture patients reported that despite 44% of patients acknowledging that they had osteoporosis, only 17% of them believed that their fracture was related to osteoporosis (Giangregorio et al. 2008). Furthermore, less than 45% of patients perceived themselves at risk for a future fracture. By comparison, the proportions reported in the current study were much lower. Another investigation involved participants of the FSCP and may be considered more comparable to the current study population (Sujic et al. 2013). That study reported that even after a post-fracture intervention, most fragility fracture patients continued not to associate their fracture with osteoporosis. At baseline, only 7% of patients believed their fracture could have resulted from osteoporosis. Only an additional 8% made the link between their fracture and osteoporosis post-intervention. The findings of the current study indicate that a lack of awareness and understanding among fragility fracture patients continues. This suggests the need for greater emphasis on knowledge translation activities and innovative educational programs, such as a workplace-based chronic disease management program to prevent osteoporosis and fragility fractures comprised of education and/or screening (Adhihetty et al. Manuscript 2). This program could be incorporated into an organization's wellness strategy or occupational health and safety training (e.g. fall prevention) (Adhihetty et al. Manuscript 2). Especially, if via the latter, fracture circumstances as highlighted in this study and ways to address them could be emphasized (e.g. training to avoid workplace hazards or
wearing appropriate footwear for slippery surfaces). Furthermore, efforts undertaken to promote bone health in the workplace will spill over outside of work (similar to worksite efforts to control weight, hypertension, and promote healthy behaviours) as individuals recognize actions to reduce their personal risk of fracture (e.g. home environment hazard reduction, diet and exercise to care for bones).

Men, in particular, were found to be three times more likely to respond 'don't know' versus 'yes' and 'no' versus 'yes' compared to women on the perceived susceptibility survey question. This indicates that men are less likely to be aware of their risk for osteoporosis and fragility fractures which is consistent with existing evidence (Johnson et al. 2008, Nayak et al. 2010). Additionally, studies have shown that men lack knowledge about osteoporosis (Phillipov et al. 1998, Wilson et al. 2011). Furthermore, a greater proportion of survey respondents in the 'At work' group were men compared to the 'Elsewhere' group. This is a critical finding as diagnosis and treatment of men with fragility fractures is inadequate (Papaioannou et al. 2008). One Canadian study reported that after five years of follow-up, only 10.3% of men with a fragility fracture had received a diagnosis of osteoporosis and merely 9.5% had been treated (Papaioannou et al. 2008). The workplace may provide an opportunity to reach more men with fragility fractures (Adhihetty et al. Manuscript 2). As such, this setting could serve as a conduit to improve knowledge and awareness among men, as well as diagnostic and therapeutic efforts for this group.

This appears to be the first study to examine a working fragility fracture population to compare fractures that happened at work versus elsewhere in terms of patient characteristics, fracture circumstances and health beliefs. Additionally, since an anonymous survey was utilized, it protected the privacy of injured workers, a vulnerable population, while obtaining evidence to address the knowledge gap on workplace fragility fractures. Despite these strengths, the study also has limitations. First, though necessary to protect worker privacy, this anonymous survey sent by mail had a low response rate. Second, at three to six months post-fracture, some patients may not accurately recall the details of their injury incident, especially among those responding to the survey at the higher end of this range. Third, selection bias may be present because not all fracture clinics in Ontario are affiliated with the FCSP, and not all fragility fractures may get treated at a fracture clinic. Individuals who sustain fragility fractures that are treated outside of a fracture clinic or by fracture clinics not affiliated with the FCSP may be part of unique or under-

serviced populations (e.g. live in remote rural area). Selection bias may also be present because fragility fracture patients that choose to participate in the FCSP and the Work Survey may be healthier (e.g. no or fewer co-morbidities) or have more time and resources. Therefore, this research may be limited in its ability to generalize the results to all working fragility fracture patients. Finally, the number of fractures sustained by workers is small thereby limiting the conclusions.

5.5 Conclusion

Among this working population of fragility fracture patients, fragility fractures that occurred in the workplace were similar to those that happened outside of work in terms of the characteristics of the individuals who sustain these injuries, their beliefs about risk for osteoporosis and fractures, and the circumstances leading to fractures. This indicates that existing clinically oriented fracture prevention initiatives (e.g. post-fracture interventions such as fracture liaison services) are relevant to individuals who sustain their fractures at work. Overall, in order to prevent fragility fractures among older people at work, this study suggests a role for workplace health and safety (i.e. level of the organization) as well as personal health (i.e. level of the individual) strategies. Environmental safeguards are required to create safer workplaces, and greater knowledge and awareness among older working adults is needed so that they understand their risk for osteoporosis and fragility fractures. In particular, the workplace could be used to enhance knowledge translation, education and screening to prevent osteoporosis and fragility fractures. Prevention in the workplace may also serve to reach more men at risk for fragility fractures. Additionally, workplace-based initiatives could reinforce bone health for workers while they are at work as well as outside of work. This study serves as a foundation for further research and to inform future efforts to prevent these fractures among older people at work. The role of the workplace in enabling health decision making among older adults could enhance productivity and longevity on the job and maintain overall health.

Atv		‹	Elsewhe		
Characteristic ¹	ristic ¹ N = 47		N = 227	p-value	
	% (n)		% (n)		
Age					
Age (mean, SD, range)	59.6 (6.4, 5	1-78)	58.4 (6.0, 5	0-81)	0.2
Sex					
Females	67.4	(31)	83.0	(186)	0.02
Males	32.6	(15)	17.0	(38)	0.02
Fracture type					
Wrist	38.3	(18)	40.9	(92)	
Ankle or lower leg	34.0	(16)	29.3	(66)	0.0
Shoulder	17.0	(8)	14.7	(33)	0.8
Other (e.g. elbow, hip, multiple)	10.6	(5)	15.1	(34)	
Occupational group					
Business, finance and administration	17.0	(8)	29.8	(67)	
occupations					
Sales and service occupations	31.9	(15)	18.2	(41)	
Occupations in education, law and social,	14.9	(7)	16.0	(36)	
community and government services					0.01
Management occupations	10.6	(5)	14.7	(33)	0.01
Health occupations	0.0	(0)	8.4	(19)	
Trades, transport and equipment	14.9	(7)	4.9	(11)	
operators and related occupations					
Other occupations	10.6	(5)	8.0	(18)	
Employment hours					
Full-time hours	68.1	(32)	68.1	(154)	1.0
Part-time or variable hours	31.9	(15)	31.9	(72)	1.0
Shift work					
No	85.1	(40)	88.0	(198)	0.6
Yes	14.9	(7)	12.0	(27)	0.0

Demographic and occupational characteristics of employed fragility fracture patients who sustained fractures at work and elsewhere

¹ Among the characteristics, proportions generated for the 'At work' and 'Elsewhere' groups may have different denominators due to missing responses. Missing values: Age (n=4), Sex (n=4), Fracture type (n=2), Occupational group (n=2), Employment hours (n=1), Shift work (n=2).

Circumstances of fragility fractures among employed patients who sustained fractures at work and elsewhere

	At w	ork	Elsew	here		
Characteristic ¹	N =	47	N = 2	227	p-value	
	% (n)		% (n)			
Season						
Winter	51.1	(24)	42.0	(95)		
Spring	25.5	(12)	28.3	(64)	0.7	
Fall	12.8	(6)	15.9	(36)	0.7	
Summer	10.6	(5)	13.7	(31)		
Time of day						
Morning	48.9	(23)	42.7	(97)		
Afternoon	34.0	(16)	25.6	(58)	0.1	
Evening or Night/early morning	17.0	(8)	31.7	(72)		
Place						
Outdoors	55.3	(26)	73.9	(167)	0.01	
Indoors	44.7	(21)	26.1	(59)	0.01	
Activity						
Walking	53.2	(25)	55.3	(125)		
Walking fast or running	14.9	(7)	12.0	(27)	0.6	
Pushing, pulling, lifting or lowering an object	10.6	(5)	6.2	(14)	0.0	
Other	21.3	(10)	26.6	(60)		
Hazards (one or more hazards could be selected) ²						
Slippery surface	51.1	(24)	56.8	(129)		
Involved equipment/objects	23.4	(11)	10.1	(23)		
Uneven surface	21.3	(10)	27.8	(63)		
Distractions	10.6	(5)	15.9	(36)	N/A	
Poor lighting	<10.6	(<5)	8.4	(19)		
Cluttered surface	<10.6	(<5)	6.2	(14)		
Other	0.0	(0)	2.2	(5)		
Initiating event						
Slip	44.7	(21)	47.6	(107)		
Trip	19.2	(9)	16.0	(36)	0.0	
Misstep (i.e. misplaced or awkward step)	17.0	(8)	12.9	(29)	0.0	
Other	19.2	(9)	23.6	(53)		

¹ Among the characteristics, proportions generated for the 'At work' and 'Elsewhere' groups may have different denominators due to missing responses (except for Hazards, see footnote 2). Missing values: Season (n=1), Place (n=1), Activity (n=1), Initiating event (n=2).

² 'At work' and 'Elsewhere' columns do not total to 100% as survey participants could select more than one hazard.

Perceptions of bone health among employed fragility fracture patients who sustained fractures at work and elsewhere

Perceptions of bone health ¹		At work		Elsewhere		Total	
		N = 47		N = 227		N = 274	
		% (n)		% (n)		% (n)	
Do you think that your current fracture puts you at a							
greater risk for another fracture in the future? (Q1)							
Yes	28.3	(13)	31.6	(71)		31.0	(84)
No	39.1	(18)	33.8	(76)	0.8	34.7	(94)
Don't know	32.6	(15)	34.7	(78)		34.2	(93)
Do you think that your broken bone could have been							
caused by poor bone strength? (Q2)							
Yes	*		**			11.4	(31)
No	61.7	(29)	65.3	(147)	0.5	64.7	(176)
Don't know	**	•	**	¢		23.9	(65)

¹ For the survey questions on perceptions of bone health, proportions generated for the 'At work' and 'Elsewhere' groups may have different denominators due to missing responses. Missing values: Q1 (n=3), Q2 (n=2).

* = Less than 5 patients (i.e. suppressed cells).

** = Suppressed to prevent calculation of values reported in '*' cells.

Odds ratios and 95% confidence intervals from multinomial logistic regression analysis of relationships between perceived susceptibility and setting, adjusted for age and sex

Variable	No vs. Yes OR (95% CI)	Don't know vs. Yes OR (95% CI)
Setting (at work, reference: elsewhere)	1.10 (0.49-2.46)	0.90 (0.39-2.07)
Age (in years)	1.00 (0.96-1.06)	1.02 (0.97-1.07)
Sex (males, reference: females)	3.18 (1.33-7.62)	2.74 (1.13-6.64)

Chapter 6: Manuscript 4 – Fragility Fractures at Work: Let's Sort It Out -Consensus Group Recommendations

6.1 Introduction

A fragility fracture is a consequence of osteoporosis (Papaioannou et al. 2010). The World Health Organization (WHO) defines fragility fracture as "a fracture caused by injury that would be insufficient to fracture normal bone: the result of reduced compressive and/or torsional strength of bone" (WHO 1998). Fragility fractures are associated with increased mortality, morbidity and chronic pain compared to people without fractures, and significant economic costs (Wiktorowicz et al. 2001, Ioannidis et al. 2009, Papaioannou et al. 2009). Evidence indicates that older individuals are at increased risk for fragility fractures (Brown et al. 2002, Papaioannou et al. 2010). These fractures account for greater than 80% of fractures among people over age 50 years (Osteoporosis Canada 2011).

Due to the aging population, the proportion of the workforce that is represented by this older age group (i.e. 50 years and over) is increasing (Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008, Statistics Canada 2016a). In addition, many individuals are choosing to postpone retirement to continue working or returning to some form of work after retirement (Schellenberg et al. 2005, Marshall & Ferrao 2007, Schellenberg & Ostrovsky 2008). The net effect is a growing segment of the workforce that could experience a fragility fracture. It is estimated that the annual direct costs of treating fragility fractures among older people who are in the workforce in Europe, Canada and the US is approximately \$48 billion per year (International Osteoporosis Foundation 2002). Considering these two factors, the incidence and impact of fragility fractures in the workforce will likely grow, making it, along with other diseases associated with aging, of interest to employers and workplaces looking to retain these experienced and often valued workers (Peterson & Spiker 2005, Rogers et al. 2011).

Of particular interest is individuals 50 years and older who have experienced a fragility fracture in a workplace setting. Little evidence is available about the circumstances of fragility fractures that happen at work. One recent study indicated that fragility fractures that occur in the workplace are similar to those that happen elsewhere (Adhihetty et al. Manuscript 3). However, the workplace could be used to prevent fragility fractures as employers have a responsibility to create safe and healthy environments for their workers and are likely motivated to reduce costs associated with fractures (e.g. workers' compensation, replacement staff) (Adhihetty et al. Manuscript 3). Furthermore, existing workplace injury prevention interventions appear to focus on slips, trips and falls (STFs) and do not emphasize bone health issues that could underlie fragility fractures. Therefore, it is vital to understand ways to prevent fragility fractures in order to support older individuals' health and contributions to the workforce. Currently there is a knowledge gap regarding how to prevent workplace fragility fractures. The objective of this study was to conduct a series of consensus groups (CGs) with stakeholders using an open card sorting methodology to facilitate development of recommendations for fragility fracture prevention in the workplace.

6.2 Methods

6.2.1 Overview of Methods

Open card sorting is an exercise that provides insight into how individuals categorize information by having participants sort cards into groups of their choice and then label these groups according to their content (Lewis & Hepburn 2010, Cane et al. 2012). This inductive technique is often used as an input into information structures of new or existing websites or products (Maurer & Warfel 2004). Card sorting generates an overall structure by placing information into groups that make sense to users or participants. The open card sorting methodology was selected to generate meaningful fragility fracture prevention recommendations from various stakeholders through their interaction with relevant data and each other. To conduct the card sorting exercise this study used survey data from patients participating in a post-fracture care program who had sustained their fragility fractures at work (i.e. Work Survey). Open card sorting was used to develop logical clusters based on survey respondents' occupations. The occupation clusters from the three CGs were consolidated into summary clusters, then prevention recommendations were analyzed within summary clusters.

6.2.2 Data Source

The Fracture Clinic Screening Program (FCSP) of the Ontario Osteoporosis Strategy developed an anonymous Work Survey in 2012 to examine fragility fractures among workers (previously described elsewhere) (Adhihetty et al. Manuscript 3). Eligibility for the survey was restricted to English-speaking fragility fracture patients who were screened as part of the FCSP (i.e. confirmed fragility fractures), 50 years of age or older, employed for pay at the time of fracture (i.e. workers) and had agreed to follow up. The survey was mailed to patients three to six months after their fracture and all survey responses were based on anonymous self-report of information.

The Work Survey was sent to 596 eligible patients from approximately December 2012 to July 2013 with a response rate of 49.0% (n = 292). Of the 94.2% of respondents (n = 275) that met the eligibility criteria, 17.2% sustained fragility fractures at work (n = 47). This group, which is the focus of the current analysis, had a mean age of 59.6 ± 6.4 years and 67.4% were female.

6.2.3 Study Design and Procedures

6.2.3.1 Card Development

Cards used for this exercise were developed with the assistance of a graphic designer. Each card contained information pertaining to one survey respondent. The first side of the card indicated the individual's self-reported job title and any relevant details extracted from responses to openended questions on the Work Survey pertaining to occupation (e.g. type of work the individual was doing and business, industry or service that was involved). The second side of the card contained information on the circumstances of the fracture, specifically the season, time of day, place (i.e. indoors or outdoors), activity being engaged in (e.g. walking, walking fast/running), hazards (e.g. slippery surface, uneven surface) and initiating event (e.g. slip, trip). In order to make the information on the cards easy and quick to review, and to assist CG participants with seeing patterns within the data, graphical depictions and text was placed on the card (see Figure 6.1).

In order to ensure that the cards were easily understandable and depicted the information as required, 10 cards were piloted using artificial data. Ten individuals external to the research team were asked to review the cards and provide feedback on clarity of information and ease of

grouping the cards according to occupation. The feedback received was discussed with the graphic designer and incorporated into the design of the cards used with CGs.

6.2.3.2 Participants

The Work Survey data was presented to three CGs of four participants each. Groups of this size were used to encourage members to actively participate and to enable sufficient interaction and discussion to occur. CG participants were all members of the study's Knowledge Translation Advisory Committee and represented a range of stakeholders who could inform prevention efforts including patients, patient educators, Osteoporosis Canada managers and researchers with expertise in bone health, occupational health and knowledge translation. Two of the CGs involved a mix of Osteoporosis Canada representatives and researchers. The last CG included patients and patient educators to permit a high level of comfort and frankness in discussion. The Research Ethics Boards at St. Michael's Hospital (reference #14-182) and the University of Toronto (reference #31016) approved this study.

6.2.3.3 Data Collection

CGs engaged in a two-part exercise which started with an open card sorting activity to establish clusters based on survey respondents' occupations. This was the first step because clustering based on occupation would enable targeting of subsequent prevention efforts by workplace setting. Next, fracture circumstances (e.g. time, place, activities, hazards) within occupation clusters were explored with the purpose of generating recommendations for how to prevent fragility fractures in the workplace. Each CG session was led by the same two co-facilitators and assistant, and involved the same set of 47 cards. One co-facilitator (TB) had the main task of administering the session and was external to the research team to provide for greater objectivity. The other co-facilitator (CA) provided subject matter expertise relevant to the Work Survey data and wrote key observations and recommendations on large flip chart pages that were visible to all participants. The assistant also took field notes throughout which served as a means of triangulation (Patton 1999). This validated the flip chart notes and ensured sufficient details were captured to generate a comprehensive and robust account of the proceedings.

In preparation for the CGs, a mock CG session was conducted by the co-facilitators and assistant with four volunteers consisting of research personnel and trainees. The purpose of the mock

session was to identify potential problems with the card sorting activity and recommendation development exercise (e.g. clarity to participants), streamline processes (timing, equipment) and incorporate suggestions for improvement provided by mock participants.

All CGs started their sessions with the open card sorting activity involving the side of the cards depicting job title. Participants were seated around a table and the pre-shuffled cards were placed randomly on the table. The co-facilitator (TB) asked the participants to collectively decide how to group or cluster the cards based on similarity of job title. Participants were free to pick up and shift cards as they wished but were instructed not to turn them over. When a cluster had started to form, it was placed on a magnetic wall with magnets, with the option to add or move cards to other clusters. Once the group achieved consensus on the final clusters, participants worked together to create a unique name for each cluster that differentiated it from the others. Subsequently the final clusters were documented (i.e. photos and notes).

The second part of the exercise involved the co-facilitators maintaining the cluster configurations, but turning each of the cards over to show the side with the fracture circumstances. The CG was asked to comment on any patterns observed among the circumstances in each cluster. Then the CG was asked to generate recommendations for how to prevent fragility fractures in each occupation cluster and which clusters may be a priority for prevention efforts. After recommendations were provided for each cluster, the information was member-checked by a co-facilitator (CA) repeating points from the flip charts back to the participants for verification. If participants provided additional information or corrections, these were again verified orally by the co-facilitator until all participants were satisfied with the information documented.

6.2.4 Data Analysis

The occupation clusters from the three CGs were consolidated into summary clusters, then prevention recommendations were analyzed within summary clusters. First, the cluster that each survey respondent was categorized to was compared across the three CGs. Color coding was used to distinguish different occupation clusters. Across the CGs, similar clusters were mapped to each other and color-coded in like shades. Clusters were considered similar based on logical groupings and labels that had been provided by each CG. Groupings and labels were used if two out of three CGs were aligned, and any further discrepancies were discussed between the co-

facilitators (CA, TB) and resolved to generate the summary clusters. The names for the summary clusters were based on labels and descriptors which had been provided by the CGs.

Next, the CGs' observations and prevention recommendations for each occupation cluster were aligned according to summary cluster. Sources of data for this analysis included the member-checked notes recorded on flip charts which had been transcribed in detail and field notes taken by the assistant during the CG sessions. These two sources of data were independently verified against each other by two investigators (CA, LP) for consistency and accuracy.

Analysis of prevention recommendations was guided by inductive thematic analysis (Braun and Clarke 2006). Immersion took place by repeated reading of the data and active reading to search for meaning and patterns. All data were coded manually by the principal investigator (CA) and then codes sharing similar meanings were condensed under categories. Subsequently an initial thematic map was developed indicating the relationships between categories. This process was followed for each summary cluster before a preliminary overall thematic map was developed. Analysis was data-driven and involved constant comparison between the data set, codes and developing categories and themes. Two investigators (CA, LP) discussed the coding of the data, categories and initial thematic maps. Discrepancies in the coding, new categories and themes, and labels for these were also discussed. Together the researchers considered amendments to the thematic maps until consensus was reached.

6.3 Results

Three CG sessions were held between May and July 2015 in Toronto. Each session had four participants and lasted approximately three hours.

6.3.1 Open Card Sorting

The number of occupation clusters ranged from seven to eleven among the three CGs. When compared across CGs, clusters had good alignment and the few discrepancies were resolved between the investigators (CA, TB) resulting in six summary clusters: "Education", "Management/Administration", "Service/Retail", "Transportation/Delivery", "Physical/Manual Labour" and "Miscellaneous". Figure 6.2 depicts how the occupation clusters from the different CGs mapped on to each other and the resulting summary clusters. This figure also provides examples of occupations found in each summary cluster.

6.3.2 Recommendation Development and Synthesis

Thematic maps of fragility fracture prevention recommendations were developed for all of the summary clusters except "Miscellaneous" as it had no recommendations. Additionally all CGs recognized that certain recommendations applied across many or all occupation clusters, which led to the addition of a "General" summary cluster and accompanying thematic map. The many common elements identified within the thematic maps for "Education", "Management/Administration", "Service/Retail", "Transportation/Delivery", "Physical/Manual Labour" and "General" were synthesized into an overall thematic map (Figure 6.3).

6.3.3 Thematic Analysis

Three key themes were identified that could be modifiable in workplace injury prevention interventions or studies. The three overarching themes arising from the recommendation development exercise were: *improve worker-environment interactions, increase awareness* and *implement process improvements*. The first two are major themes which were present in all summary clusters. The final minor theme was identified in two of the six summary clusters. Within the first theme, *improve worker-environment interactions*, there were three sub-themes: *housekeeping, flooring* and *personal protective equipment*. Additionally, the last sub-theme had two lower level themes, *footwear* and *lighting*. Within the theme of *increase awareness* were three sub-themes: *notification, training* and *promotion/knowledge translation*. The final theme, *implement process improvements*, had no sub- or lower level themes.

6.3.3.1 Improve Worker-Environment Interactions

The recommendation to *improve worker-environment interactions* can be described as activities and decisions in the workplace by the employer and/or worker to decrease or remove exposure to hazards potentially associated with fractures. For example, CGs observed among many workers across different summary clusters a common scenario occurring in the winter of slipping while walking, walking fast or running which involved a slippery surface, especially outdoors. While not the only scenario, such observations as these led to the generation of recommendations falling under the sub-themes. The sub-theme, *housekeeping*, referred to property management or maintenance and clean-up of hazards at the worksite. It captured preventative activities such as clearing snow and ice, using salt or sand on sidewalks and utilizing mats indoors. CG participants' recommended there needs to be sufficient cleaning staff available and attentive to

monitor hazards. Additionally, while the organization is accountable for housekeeping, workers should also take personal responsibility for keeping their work areas clean and identify or remove hazards if possible.

The sub-theme, *flooring*, indicated the need for appropriate flooring and transitions in flooring (i.e. ensuring non-slip surfaces throughout).

Personal protective equipment comprised actions to combat hazards in the environment and included lower level themes of *footwear* and *lighting*. For most summary clusters CG participants recommended workers use seasonally appropriate footwear, especially in winter and slippery conditions. Additionally, they advised that people should have alternate shoes available so their footwear is suitable for the changing environment. *Lighting* was a lower level theme only among "Transportation/Delivery" and included recommendations to use a flashlight or head lamp.

6.3.3.2 Increase Awareness

The theme, *increase awareness*, emerged from CG participants' recommendations that workers needed to be more cognizant of the environment and hazards, as well as osteoporosis and the risk for fracture. The sub-theme, *notification*, identified ways to alert people to hazards which may contribute to fractures. Participants provided suggestions to draw people's attention to hazards or necessary behaviours (e.g. being careful always and not just when a hazard is apparent, keeping personal workspace tidy). Forms of *notification* included use or increased use of safety pylons, yellow markings on floors to indicate edges, signs, oral safety announcements and reminders.

Training emerged as a means of increasing awareness which likely requires an investment of time and resources to change people's knowledge and potentially behaviours. *Training* was recommended to educate staff, especially those older than 50 years, and employers about fall hazards and prevention (i.e. falls may translate into fractures), osteoporosis, risk for fracture and myths about fragility fractures (e.g. osteoporosis as an old woman's disease). Forms of *training* to support this primary prevention included in-person workshops, videos, e-learning modules and exhibits at health fairs.

Promotion/knowledge translation indicated how awareness of workplace fragility fractures could be increased by leveraging existing resources (e.g. stakeholders, organizations, training). The majority of these recommendations emerged from the "General" summary cluster. CG participants recommended that relevant authorities (e.g. government), workplace stakeholders (e.g. associations, unions, employers, occupational health and safety departments, human resource professionals) and external organizations (e.g. Osteoporosis Canada) be partners in health promotion efforts and used to reach and influence workers. Participants indicated that a potential intervention in the workplace to prevent fragility fractures could involve a combination of hazard identification and bone health promotion, with referral to family physicians for investigation of osteoporosis as required. A number of recommendations were connected to disseminating the message that a fall could translate into a fragility fracture. It was suggested that workplace fall prevention initiatives (e.g. new and existing employee health and safety training, health fairs) incorporate a focus on fracture prevention. Additionally it was recommended that the workplace could be used as a setting to draw attention to and address osteoporosis and fragility fractures among men.

Furthermore, CGs pointed out that workplaces need to consider safety before esthetics (e.g. unattractive black mats over shiny, but slippery floors). Also, CG participants believed that workplaces typically emphasize more hazardous events (e.g. involving heavy machinery, chemicals) but need to consider that even mundane incidents like same-level falls can lead to detrimental effects like fractures. Participants suggested that the importance of fragility fractures be reinforced by highlighting their economic costs (e.g. lost productivity). Finally, participants indicated that a corporate culture which fosters health and safety was a prerequisite for developing greater awareness of the need to prevent hazards and associated fragility fractures in the workplace.

6.3.3.3 Implement Process Improvements

Implement process improvements may be seen as measures within workplace procedures and systems to enhance safety and health. This was a minor theme only identified in "Management/Administration" and "Service/Retail". CGs observed some individuals in these summary clusters to be rushing (i.e. walking fast or running) and as such, recommendations provided by CGs addressed time pressures. More flexibility with respect to time and scheduling

was suggested for managers, and slowing down work (e.g. production schedule) and increasing the frequency of breaks was recommended within "Service/Retail".

6.3.4 Comparing and Prioritizing Summary Clusters

Additional similarities and differences were noted based on CGs' prioritization of clusters. "General", "Education" and "Transportation/Delivery" were considered by two or more CGs as a priority for targeting fragility fracture prevention efforts based on ability to translate knowledge in those settings (i.e. accessibility) and need for intervention among those workers. First, CGs identified the "General" summary cluster as a priority because many recommendations applied broadly across workplace settings (e.g. *promotion/knowledge translation* sub-theme recommendations).

Second, from a knowledge translation perspective, "Education" was seen as a defined group and easily accessible in the workplace and via school boards and unions. Efforts targeted to "Education" have the added benefit of reaching many people, potentially including other workers like custodial staff and students who may be at risk for fragility fractures later in life. While not a prioritized group, from this similar knowledge translation perspective, CGs identified "Service/Retail" and "Management/Administration" as reachable via the workplace and related organizations (e.g. unions, associations), with potentially large audiences.

Lastly, "Transportation/Delivery" was considered a priority due to unique aspects of that work. CGs observed that fractures occurred while workers were not driving (i.e. outside vehicle). These workers appeared to be moving and constantly exposed to different environments, rather than a single workplace where certain safety controls could be applied. CGs recommended that self-awareness and self-surveillance are critical as these workers need to be prepared to manage the nature of their job which includes transitions (e.g. indoors to outdoors, one surface to another), hazards in the environment and time pressures. CG participants commented that employers may not be conscious of the full scope or varied nature of "Transportation/Delivery" occupations.

The *housekeeping* sub-theme for "Transportation/Delivery" referred to the location of the employer, as well as the place of delivery. Being that it is difficult to control the latter, CGs recommended a greater emphasis on personal responsibility (e.g. carrying own salt, using indoor

dock if possible). Within the *training* sub-theme, CGs indicated that greater support for "Transportation/Delivery" workers was needed because they often work on their own, outside the confines of the employer, so individual education or self-education was important. Additionally, within the *promotion/knowledge translation* sub-theme, it was recommended that prevention messaging needs to be targeted toward individuals rather than their employer's workplace. However, this may be a challenge as these workers are typically in constant transit and not as accessible as workers in "Education". Finally, CG participants commented that given the nature of this summary cluster's work, following a fracture "Transportation/Delivery" workers may have more difficulty returning to work and getting appropriate accommodation in the workplace while healing, thus emphasizing the need for support for this summary cluster. While not a prioritized group, "Physical/Manual Labour", was similarly identified as being difficult to reach, requiring a greater emphasis on personal responsibility with potential difficulty with returning to work following a fracture.

6.4 Discussion

Stakeholder recommendations for workplace fragility fracture prevention centred around two major themes pertaining to the need to *improve worker-environment interactions* in order to limit exposure to hazards potentially associated with fractures, and *increase awareness* of hazards, osteoporosis and fracture risk. Improving worker-environment interactions is a basic tenet of sound occupational health and safety practices and policies (Canadian Centre for Occupational Health and Safety 2016). Consistent with CGs' recommendations for this theme, studies discussing fall prevention initiatives, some of which were specific to older workers, advocated identification and control of hazards including improved housekeeping, better design of walking surfaces to improve surface traction and more suitable footwear (Leamon 1992, Bentley & Haslam 2001a, b, Courtney et al. 2001, Layne & Pollack 2004).

Existing workplace STF prevention programs (i.e. multifaceted interventions, including two or more components) could be leveraged to improve fracture prevention as the hazards involved with fractures appear common to STFs. These programs may be preferred over single interventions as they can address multiple recommendations (i.e. sub-themes). However, the evidence on evaluated STF prevention programs is limited. One study evaluated a multi-faceted STF prevention program among employees at three hospitals with the goal of reducing STF

workers' compensation claims (Bell et al. 2008). This comprehensive program included analysis to identify common causes of STFs, hazard audits, modifications in housekeeping procedures and products, introduction of STF preventive products and procedures, awareness campaigns, ice and snow removal initiatives, flooring changes and slip-resistant footwear for certain employee subgroups. Compared to the pre-intervention period (1996-1999), the hospitals' total STF workers' compensation claims rate declined by 58% post-intervention (2003-2005). Many components in the STF prevention program aligned with CG recommendations. Other studies examined the effectiveness of occupational STF prevention initiatives but these did not involve evaluation of an implemented intervention, nor were they programmatic in nature. Verma et al. (2011) reported that use of slip-resistant shoes and measures to increase the surface traction of flooring were effective in preventing occupational STFs among restaurant workers. Another study considering prevention of STFs among postal workers indicated that post offices with lower injury rates appeared to have better safety communication, hazard remediation and corrective action following incidents (Bentley & Haslam 2001a). The initiatives in these two studies were captured as components of the STF prevention program of Bell et al. (2008), and would be relevant components for a workplace fall prevention program addressing fractures.

The second major theme, *increase awareness*, could be addressed by employing a workplacebased chronic disease management program to prevent osteoporosis and fragility fractures (Adhihetty et al. Manuscript 2). Aligning with CG recommendations, such an intervention could enhance workers' understanding of osteoporosis and the risk for fracture, while also increasing cognizance of workplace hazards associated with fractures. Furthermore, the program could support bone health by focusing on reducing risk factors for osteoporosis (primary prevention), and enhancing early recognition and management of fragility fractures (secondary prevention) via education to enhance health-promoting behaviours and/or screening initiatives (Papaioannou et al. 2010). The program could be geared toward workers 50 years and older and fall within an organization's wellness strategy or be integrated within occupational health and safety training (e.g. fall prevention) (Adhihetty et al. Manuscript 2).

Workplace-based programs for chronic conditions (e.g. cardiovascular disease, diabetes) have reported increases in positive health behaviours (e.g. diet, exercise) and physical improvements among participants (Groeneveld et al. 2010, Arena et al. 2013, Huang et al. 2013, Bevis et al. 2014, Weinhold et al. 2015). However, it appears that only three studies have examined workplace-based osteoporosis prevention interventions involving education and/or screening (Peters et al. 2006, Niu et al. 2010, Tan et al. 2016). One study involved female teachers aged 20 years and older who did not have osteopenia or osteoporosis (Peters et al. 2006). This study examined how osteoporosis education and screening in the workplace affected lifestyle choices and the decision to discuss osteoporosis risk with a health care provider. The education component was comprised of a presentation on osteoporosis, risk factors and prevention strategies, sampling of calcium-rich food, a calcium intake calculation activity and individual counselling about risk level based on screening. After participating in the intervention, 65.8% (n = 25) indicated that they had made one or more lifestyle changes (i.e. increased calcium intake, exercise and follow-up with a health care provider). This study was methodologically weak as it only utilized a post-intervention evaluation. The second study examined the impact of a workplace-based brief high-impact exercise (HIE) intervention on bone mineral density (BMD) in healthy premenopausal female office workers (Niu et al. 2010). This 12-month randomized controlled trial compared participants who completed stretching exercises (n = 46) to those who completed the HIE intervention involving stretching and vertical and versatile jumps (n = 45). Both groups attended respective 16 minute video-guided sessions three times a week at work. The HIE participants maintained their femoral neck BMD, and there was a significant difference in the change in BMD between the groups which suggested that HIE may help to prevent bone loss. The final study evaluated the efficacy of a workplace osteoporosis prevention intervention to improve diet and physical activity behaviours among females aged 25-49 years engaged in sedentary office-based work (Tan et al. 2016). Women with osteoporosis were excluded. This 6-month cluster randomized trial of workplaces (eight in each arm) compared workplaces in the intervention arm (n = 287 women) with those in the control arm receiving printed resources (n = 287 women)298 women). The intervention consisted of three workshops involving education and behavioural strategies to address diet and physical activity goals pertaining to osteoporosis prevention (e.g. food sampling, nutrition label reading, attempting targeted exercises, using strategies and resources to facilitate the incorporation of exercises into participants' schedules). The intervention arm reported a significantly greater increase in calcium intake and duration of load-bearing moderate to vigorous physical activity compared to the control arm.

While these studies on office workers and teachers show the potential for a workplace-based program to address osteoporosis and fragility fractures, they were limited in size (two of three

studies) and focused on women alone and those younger than 50 years. Furthermore, the interventions in these studies only involved primary prevention and were not programmatic in nature. It would be ideal for a workplace-based program addressing osteoporosis and fragility fractures to be directed to older workers of both sexes to make equitable gains in addressing this condition and multi-faceted in nature (i.e. able to address multiple CG recommendations). Specifically, the program should address hazards associated with fractures (i.e. workplace health) and individual fracture risk (i.e. bone health), and involve both primary and secondary prevention of fractures. Further research is needed to examine the potential of the workplace as a setting for such a prevention program.

Beyond STF prevention efforts in general and the study by Peters et al. (2006) of teachers, there does not appear to be literature on osteoporosis and/or fragility fracture prevention interventions for the "Education" or "Transportation/Delivery" sectors. This points to the need for further research and consideration to be able to design appropriate fracture prevention programs in these sectors. While CGs identified parties to leverage in health promotion efforts to reach and influence workers (i.e. *promotion/knowledge translation* sub-theme recommendations), a starting point may be to consider engaging with Ontario's Safe Work Associations. They provide sector-specific health and safety advice, products, services and information (e.g. best practices, training) (Workplace Safety & Insurance Board 2016, Health & Safety Ontario 2015) and could be key partners in future efforts to design sector specific fracture prevention programs. Specifically, the Public Services Health & Safety Association which serves school boards, universities and colleges, and the Infrastructure Health & Safety Association 2016, Public Services Health & Safety Association 2016, Infrastructure Health & Safety Association 2016).

This study has a number of strengths as well as limitations. This appears to be the first study to consider fragility fracture prevention recommendations for the workplace. The study's methods were tailored to make the findings meaningful (i.e. based on a variety of stakeholder perspectives) and actionable (i.e. indicates types of workers to be targeted and suggestions for intervention). Repeating the card sorting and recommendation development exercise with three CGs, one of which was focused on the patient perspective, and finding similar patterns in the way the cards were sorted and achieving saturation in themes in the recommendations (i.e. common themes and sub-themes among different summary clusters), enhanced the validity of the

findings. Furthermore, use of triangulation (multiple data sources), contributed to validity and ensured the proceedings were sufficiently detailed and comprehensive. Despite these strengths, the study was limited as it was based on data from a small sample of patients who sustained fragility fractures at work which was available from an anonymous survey with a low response rate. As such, the results may not be representative of the population of interest. However, this was the only currently available data on workers who sustained fragility fractures at work and provides initial insights about prevention needs of this population.

6.5 Conclusion

This research provides foundational knowledge about where to direct efforts to prevent fragility fractures in the workplace among older workers. Improving worker-environment interactions to limit exposure to potential fracture hazards, and increasing awareness of hazards, osteoporosis and fracture risk are critical components for workplace fragility fracture prevention. Augmenting existing fall prevention initiatives or employing a disease management program are options to consider when developing a workplace program to prevent osteoporosis and fragility fractures. Given the aging workforce, such a prevention program may assist employers in upholding their responsibility to create a healthy environment, avoid costs associated with fractures, while enhancing older individuals' workplace productivity and overall health.

Figure 6.1: Two sides of a card used in the open card sorting activity with Consensus Groups: front (black side) indicating worker's self-reported job title and relevant occupation details, and back (white side) depicting the circumstances of the fracture, specifically the season, time of day, place, activity being engaged in, initiating event and hazards involved



Figure 6.2: Approximate mapping of Consensus Groups' occupation clusters, resulting summary clusters and occupation examples by summary cluster

Consensus Group #1	Consensus Group #2	Consensus Group #3	Summary Cluster	Occupation Examples
Teachers	Teaching occupations	Education	Education	High school teacher, Educational assistant
Managers		Professional/Semi professional		Director, Billing analyst,
	Office (sedentary)	Professional/semi-professional	Management/Adminstrative	Administrative assistant
Ciencal/Administration		Government		
Bakers	Bakers	Dotail		Apparel clerk, Service greeter
Constan	Conviso (Potoil	Retail	Service/Retail	
Service	Service/Retail	Retail Automotive		
Transportation (drivers)	Transportation	Drivers (Delivery	Transportation (Dolivory	Truck driver, Parts delivery
	Delivery	Driversy Delivery	Transportation/ Delivery	person
Mixed/Moderate Labour	Manual Jahour (Field work			General labourer, Welder,
Heavy Labour	Mariuar labour/Field work	Physical Labour	Physical/Manual Labour	Housekeeper
Vulnerable & Awkward (manual work)	Custodial			
Real Estate Agent	Missellaneous		Misselleneous	
Security Guard	Security Guard		iviiscellaneous	

Figure 6.3: Overall thematic map indicating the three themes arising from the recommendation development exercise (black boxes) as well as sub-themes (grey) and lower level themes (white)



IMPLEMENT PROCESS IMPROVEMENTS

Chapter 7: Discussion

The purpose of this chapter is to: 1) summarize the four studies within this thesis, 2) synthesize the results and indicate implications for prevention, 3) discuss the strengths and limitations of this research, 4) highlight other relevant research, 5) describe recommendations for future research and 6) outline next steps with respect to knowledge translation (KT) and a future intervention to prevent fragility fractures in the workplace.

7.1 Summary of the Four Studies

The overall goal of this research was to conduct preliminary work to develop a KT intervention to prevent fragility fractures in the workplace. The overall objective of this thesis was to examine fragility fractures (or surrogate: fractures resulting from same-level falls) that occur in the workplace with respect to the characteristics of the workers who sustain these fractures and the circumstances leading to fracture.

7.1.1 Study 1

The objectives of the first study were to use Ontario workers' compensation claims data to describe fractures from same-level falls at work in terms of i) burden (proportion of total claims) ii) characteristics of workers (age and sex), industry and circumstances (when and how fractures occurred) and iii) age and sex subgroups by industry. Using a descriptive quantitative analysis, this study examined allowed lost-time (LTA) workers' compensation claims from 2002 to 2011 for workers aged 20 to 80 years. The analyses focused on LTA claims coded as "fracture" resulting from "fall on same level", but comparisons were made with non-fracture injuries from same-level falls (e.g. sprains, strains).

There were 828,704 LTA claims over the 10 year period, and 12.4% (n = 103,167) were for same-level falls among workers 20 to 80 years old. The data indicated that 15.3% of LTA claims for fall on same level had fracture as nature of injury (n = 15,800). The overall age and sex distribution for these fractures indicated that older females (50 to 80 years) had sustained the

greatest proportion of fractures (37.0%) followed by older males (27.7%), younger males (20 to 49 years) (20.3%) and younger females (14.9%).

The results of this study led to six implications for the prevention of fractures from same-level falls. First, the distributions of sex, industry, season and time of day were similar among fracture and non-fracture injuries, but the distributions of age and part of body differed. This indicates that fracture prevention interventions may only need to differ from same-level fall prevention initiatives in terms of age (i.e. fractures were more likely in the older age group) and part of body (e.g. large proportion of fractures affected the upper extremities). Second, slippery conditions produced by ice, sleet, snow and liquids were common hazards involved with fractures from same-level falls. Such hazards can be prevented by improving housekeeping practices at the worksite and educating workers to increase awareness of hazards and negative outcomes like fractures. Third, in the older age group (50 to 80 years), women represented the larger proportion of fractures. This may indicate poor bone health and the need for fracture screening among older women. Fourth, in the younger age group (20 to 49 years), men represented the larger proportion of fractures. These fractures appear to be associated with more heavy and hazardous industries where little attention may be given to injuries arising from same-level falls. If considering fracture prevention in younger men, further investigation is necessary to determine whether safety training about same-level fall injuries, including fractures, is adequate for this group. Fifth, older men (50 to 80 years) represented the second highest proportion of same-level fall fractures overall. Fractures in this group could be a result of poor bone health as well as dangerous occupational hazards. More research is required to explore these possible causes for occupational same-level fall fractures among older men. Lastly, traditional male and female dominated occupations appeared to influence the proportions of men and women sustaining same-level fall fractures in different industries. This may indicate the need to tailor prevention interventions in certain workplaces by sex on the basis of whether they involve male or female dominated occupations.

7.1.2 Study 2

This study refined the scope of the research by using Ontario workers' compensation claims data over the same 10 year period as the first study, but focused on older workers aged 50 to 80 years. The aim of the study was to describe types and patterns of fractures that may be due to

osteoporosis. Worker age, injury event (i.e. same-level fall) and fracture type (i.e. forearm, humerus, hip, vertebrae and pelvis) were used to create a definition called "potential fragility fracture" (PFF). The objectives of this study were to use a descriptive quantitative analysis: i) to estimate the proportion of fractures from same-level falls that may be considered osteoporosis-related (i.e. PFFs) and ii) to describe (in terms of age, sex and industry of the workers) how PFFs differ from other fractures resulting from same-level falls, and how types of PFFs (i.e. forearm, humerus, hip, vertebrae, pelvis) differ from each other.

The study identified 4,894 PFFs. This indicated that among workers aged 50-80 years who sustained a fracture from a same-level fall, nearly half of these fractures may be related to osteoporosis.

PFFs have a different age and sex distribution than other fractures from same-level falls. Consistent with age and sex patterns for fragility fractures (Hanley & Josse 1996, Brown et al. 2002, Papaioannou et al. 2010, IOF 2012), workers with PFFs were disproportionately older (65-80 years, p < 0.0001) and women (p < 0.0001). Additionally, with the exception of a few sectors dominated by a particular sex, in most industries the proportion female was higher in the PFFs group compared to the other fractures group, likely due to osteoporosis affecting women more than men (Hanley & Josse 1996, International Osteoporosis Foundation (IOF) 2012). Age analysis of PFF types indicated that the highest proportions were among the younger group (50-64 years) for vertebrae, forearm and humerus fractures. This is consistent with literature reporting that these types of fragility fractures tend to occur at a younger age than those of the hip and pelvis (Johnell et al. 2004, IOF 2012, Soles & Ferguson 2012).

The large number of PFFs among the 50-64 year age group suggests that this younger group of workers may benefit from secondary fracture prevention interventions in order to avoid subsequent fractures as these individuals age. Additionally, in the industry-specific analysis of PFF types, forearm was the most common fracture type across all industries, indicating that it may be prudent to focus on forearm fractures for secondary fracture prevention initiatives.

Sex analysis of PFF types indicated that this study population of workers appeared to have a greater proportion of males than is typically seen among studies of fragility fracture patients (Johnell & Kanis 2006). With the potential to capture higher proportions of men with fragility

fractures at work, this setting could provide an opportunity to improve diagnostic and therapeutic efforts in males.

The Services and Schedule 2 (government and related entities) industries reported the highest proportions based on PFFs as a fraction of total PFFs. The Food, Services and Automotive industries reported the highest proportions based on PFFs as a fraction of same-level fall fractures within those industries. As such, these industries may be valuable to focus on when considering workplace interventions to prevent fragility fractures.

A workplace-based chronic disease management program to prevent osteoporosis and fragility fractures could serve as a unique strategy to protect workers 50 years and older. Such a program could support bone health, reduce risk factors for osteoporosis (primary prevention), and enhance early recognition and management of fragility fractures (secondary prevention) via education to enhance health-promoting behaviours and/or screening initiatives (Papaioannou et al. 2010). This program could fall within an organization's wellness strategy or could be integrated within occupational health and safety training (e.g. fall prevention). The collective findings of this study – such as an emphasis on workers 50-64 years and those with forearm fractures for secondary fracture prevention, use of the workplace to target men, and focus on particular industries – could inform a workplace-based program to prevent osteoporosis and fragility fractures.

7.1.3 Study 3

This study used survey data from fragility fracture patients aged 50 years and older who were employed at the time of their fracture and participating in a post-fracture care program in Ontario. The objective of this study was to examine whether differences existed in patient characteristics (i.e. demographic and occupational traits), the circumstances leading to fracture (e.g. hazards, activity involved, place and time of fracture) and beliefs about risk for osteoporosis and fractures, between workers who fractured at work compared to other settings. A descriptive quantitative analysis was employed.

The Work Survey was mailed to eligible patients from December 2012 to July 2013, approximately 5.5 months following screening. By December 2013, 275 surveys from eligible patients had been returned and indicated that 17.2% of patients had sustained their fragility

fractures at work (n = 47) and 82.8% had sustained their fragility fractures elsewhere (n = 227). Overall, fragility fractures that occurred in the workplace were similar to those that happened outside of work in terms of the characteristics of patients who sustained these injuries, the circumstances leading to fractures and patients' beliefs about risk for osteoporosis and fractures.

The mean age of respondents was approximately 60 years and about 80% were female. The two occupational groups with the greatest numbers of fracture patients were Sales and service occupations and Business, finance and administration occupations which represented about half of all respondents. For both the 'At work' and 'Elsewhere' groups the most common circumstances involved walking, slippery surfaces, slipping and winter. This implied that environmental safeguards are required both in and out of the workplace in order to prevent fragility fractures among older working adults.

Workplace context did not appear to affect patients' perceived susceptibility for osteoporosis and fragility fractures. The majority of patients who sustained workplace fragility fractures had allowed workers' compensation claims (84.2%), indicative of a work-related injury. Therefore workplace context could have interfered with perceptions of bone health, but the study did not provide support for this hypothesis. However regardless of setting, the majority of survey respondents lacked awareness of their susceptibility for fragility fractures and do not appear to make the link between osteoporosis and fragility fractures. Only 31.0% of all patients felt that their fracture put them at greater risk for a future fracture, and only 11.4% believed that their fracture could have been caused by poor bone strength. Men, in particular, were found to be three times more likely to respond 'don't know' versus 'yes' and 'no' versus 'yes' compared to women when asked, "Do you think that your current fracture puts you at a greater risk for another fracture in the future?". The findings of the current study are consistent with other studies indicating a lack of awareness and understanding among fragility fracture patients, especially men (Phillipov et al. 1998, Bogoch et al. 2006, Giangregorio et al. 2008, Johnson et al. 2008, Nayak et al. 2010, Wilson et al. 2011, Sujic et al. 2013). This supports the need for innovative knowledge translation activities that could leverage the workplace, such as a workplace-based chronic disease management program to prevent osteoporosis and fragility fractures comprised of education and/or screening.

7.1.4 Study 4

The objective of this final study was to conduct a series of consensus groups (CGs) with stakeholders using an open card sorting methodology to facilitate development of recommendations for fragility fracture prevention in the workplace. This methodology was selected to generate meaningful prevention recommendations from various stakeholders through their interaction with relevant data and each other. To conduct the card sorting exercise this study used the Work Survey data of patients who had sustained their fragility fractures at work. Open card sorting was used to develop logical clusters based on survey respondents' occupations. The occupation clusters from the three CGs were consolidated into summary clusters, then prevention recommendations were analyzed within summary clusters.

The number of occupation clusters ranged from seven to eleven among the three CGs. Consolidation resulted in six summary clusters: "Education", "Management/Administration", "Service/Retail", "Transportation/Delivery", "Physical/Manual Labour" and "General". Thematic maps of fragility fracture prevention recommendations were developed for the summary clusters and the many common elements within the thematic maps were synthesized into an overall thematic map.

The three key themes arising from the recommendation development exercise were: i) *improve worker-environment interactions* in order to limit exposure to hazards potentially associated with fractures, ii) *increase awareness* of hazards, osteoporosis and fracture risk, and iii) *implement process improvements*. The first two are major themes which were present in all summary clusters. The final minor theme was identified in only two summary clusters. Within the first theme, *improve worker-environment interactions*, there were three sub-themes: *housekeeping, flooring* and *personal protective equipment*. In addition, the last sub-theme had two lower level themes, *footwear* and *lighting*. Within the theme of *increase awareness* were three sub-themes: *notification, promotion/knowledge translation* and *training*. The final theme, *implement process improvements*, had no sub- or lower level themes.

The first major theme, *improve worker-environment interactions*, could be addressed by leveraging existing workplace slip, trip and fall (STF) prevention programs to improve fracture prevention as the hazards involved with fractures appear common to STFs. The second major theme, *increase awareness*, could be tackled by employing a workplace-based chronic disease

management program to prevent osteoporosis and fragility fractures. Such an intervention could enhance workers' knowledge of osteoporosis and the risk for fracture, while also increasing understanding of workplace hazards associated with fractures.

The summary clusters, "General", "Education" and "Transportation/Delivery", were considered by two or more CGs as a priority for fragility fracture prevention efforts based on increased ability to translate knowledge in those settings (i.e. accessibility) and need for intervention among those workers. Tailoring may be required to better address the two major themes within the "Education" and "Transportation/Delivery" summary clusters. However, there appears to be a lack of literature on osteoporosis and/or fragility fracture prevention interventions in these contexts which points to the need for further research. Nevertheless, this study provides foundational knowledge about where initial efforts to prevent workplace fragility fractures among older workers can be directed.

7.2 Synthesis of the Four Studies

Based on the findings of the four studies, considerations for developing a KT intervention to prevent fragility fractures in the workplace are summarized below.

Age and Sex (Demographics)

- Fractures from same-level falls among women 50-80 years may be indicative of poor bone health which suggests the need for fracture screening among older women.
- Fractures from same-level falls among men 20-49 years appear to be associated with more heavy and hazardous industries where little attention may be given to same-level fall injuries. If seeking to prevent fractures in younger men, further investigation is required to understand safety training for this group and whether adequate education is provided about same-level fall injuries, and fractures as a potential outcome.
- Fractures among men 50-80 years could be due to poor bone health as well as exposure to dangerous occupational hazards. Further research is needed to explore these potential causes for workplace same-level fall fractures among older men as literature is lacking.

- There appears to be a lack of awareness and understanding among male fragility fracture patients about their risk for osteoporosis and fragility fractures. This research suggests that the workplace may provide an opportunity to reach more men with these fractures. As such, this setting could serve as a conduit to improve knowledge and awareness among men, as well as diagnostic and therapeutic efforts for this group.
- Workers aged 50-64 years (i.e. younger segment of older workers) may benefit from secondary fracture prevention interventions in order to avoid subsequent fractures as these individuals age.

Fracture Type (Site)

• Based on the commonality of forearm (or wrist) fractures, it may be prudent to focus on these fractures when developing secondary fracture prevention initiatives.

Industry and Occupation

- A range of industries and occupational groups appear to be suitable targets for a workplace fragility fracture prevention intervention. If considering sectors with the highest proportions of fractures based on total fractures (i.e. volume), it may be beneficial to focus on Services industries and Sales and service occupations, and Schedule 2 (government and related entities) industries and Business, finance and administration occupations. If considering ease of knowledge translation and worker need based on Consensus Group recommendations, it may be helpful to focus on Education and Transportation/Delivery related occupations. For any occupational sector, it may be necessary to tailor the intervention in order to increase the likelihood that it is appropriate for the workers and specific workplace setting.
- There appears to be a need to tailor prevention initiatives in particular workplaces by sex depending on whether they involve male or female dominated occupations.

Hazards

• The findings are consistent with slipping hazards contributing to the high proportion of samelevel fall fractures and fragility fractures in the winter. These hazards can be prevented by improving workplace housekeeping practices and educating workers to enhance awareness of hazards and detrimental outcomes such as fractures.

• Environmental safeguards appear to be required both in and out of the workplace in order to prevent fragility fractures among older working adults.

Perceived Susceptibility (Health Beliefs)

• Workplace context did not appear to affect patients' perceived susceptibility for osteoporosis and fragility fractures. Overall, there is a lack of awareness and understanding among fragility fracture patients regarding their risk for osteoporosis and fragility fractures. This is consistent with other studies and suggests the need for innovative knowledge translation activities that could leverage the workplace.

Fracture Prevention

- Existing clinically oriented fracture prevention initiatives (e.g. post-fracture interventions such as fracture liaison services) appear to be relevant to individuals who sustain their fractures at work.
- Interventions to prevent fractures may only need to differ from same-level fall prevention initiatives on the basis of age (i.e. fractures were more likely in the older age group) and part of body (e.g. large proportion of fractures affected the upper extremities). Furthermore, preventing same-level falls might help to decrease the risk of fracture. However, employers and workplaces may be more receptive to more generic fall prevention initiatives that can address fractures as well as other injuries from same-level falls.
- The first major stakeholder recommendation *improve worker-environment interactions* could be addressed by leveraging existing workplace slip, trip and fall (STF) prevention programs to improve fracture prevention as the hazards involved with fractures appear common to STFs.
- The second major stakeholder recommendation *increase awareness* could be tackled by employing a workplace-based chronic disease management program to prevent osteoporosis and fragility fractures. Such an intervention could enhance workers' knowledge of

osteoporosis and the risk for fracture, while also increasing understanding of workplace hazards associated with fractures.

Appendix E provides further details of the relevant findings from the four studies along with the implications for prevention.

7.3 Strengths and Limitations

7.3.1 Strengths

This research consisting of two phases and four studies has several strengths. Overall, there is a lack of research on fragility fractures that occur in the workplace. Specifically evidence to inform the development of a KT intervention to prevent workplace fragility fractures is limited. Given a growing population of older workers, as well as interest in diseases of aging like osteoporosis, and fragility fractures as an outcome, this work contributes much needed foundational evidence to the literature. There were a number of firsts among the four studies. Study 1 appears to be the first Canadian study to examine workplace fractures from same-level falls and it provides findings on males which are often lacking in the fracture literature. Study 2 is the first investigation to examine PFFs at work with the purpose of considering whether the workplace can aid in the prevention of fragility fractures. Study 3 is the first study to examine a working fragility fracture population to compare fractures that happened at work versus elsewhere. Finally, Study 4 appears to be the first study to consider fragility fracture prevention recommendations for the workplace. In addition, two sources of data were leveraged to inform the research questions. A further strength of the research is the consistency in findings between the two sources when the same or similar characteristics of workers and fracture circumstances were examined (e.g. fracture type (i.e. site), time of day, season, hazards).

The use of WSIB data for the first two studies which comprised Phase I is beneficial as the WSIB covers approximately 75% of Ontario's workforce (WSIB 2015a, 2015b), meaning the data represents the majority of the working-age population. Furthermore, the coding of injuries at the WSIB is reliable and consistent based on coding rules and guidelines, with coders attaining 90% to 95% agreement in quality assessment checks (Van Eerd et al. 2006). In addition, the case definition applied in Study 2, which focuses on low trauma injuries, offers greater specificity than the PHAC definition (O'Donnell et al. 2013).

Use of anonymous survey data for the third and fourth studies which comprised Phase II was a strength as it protected the privacy of injured workers, while obtaining evidence to address the knowledge gap on workplace fragility fractures. Furthermore, Study 4's methods were tailored so that the results would be meaningful and actionable. Use of triangulation and repetition of the card sorting and recommendation development exercise with multiple CGs ensured the procedures were comprehensive and contributed to validity of the findings.

7.3.2 Limitations

As with all research, limitations of the current studies need to be acknowledged. In Phase I, Studies 1 and 2 used administrative data which may be limited by missing or misclassified data, or data errors (Van Eerd et al. 2006, Hulley et al. 2007). In addition, the focus of these studies was on fractures as an injury type. Though they were sustained from same-level falls which suggests low trauma, it is not possible to confirm whether these were high or low trauma fractures. However, evidence indicates that any prior fracture, irrespective of the degree of trauma, may suggest underlying bone health issues and a greater risk for future fracture (Warriner et al. 2011). Thus, even if some fractures in these studies resulted from circumstances surpassing low trauma, osteoporosis may still be a concern. Study 2 in Phase I had further limitations which related to the case definition utilized for PFFs. 'Same-level fall' is typically used in the fragility fracture definition, but there are other ways these fractures can be sustained, and these would not likely be captured in the study. Finally, only those fracture sites considered by the Public Health Agency of Canada as related to osteoporosis were used in the case definition (O'Donnell et al. 2013). As such, Study 2 may underestimate the proportion of samelevel fall fractures related to osteoporosis among older workers.

Studies 3 and 4 of Phase II were limited as they were based on data from a small sample of fragility fracture patients which was available from an anonymous survey with a low response rate. While administering the survey in this manner was necessary to protect worker privacy, the results may not be fully representative of the population of interest. For instance, selection bias may be present because not all Ontario fracture clinics are affiliated with the FCSP, not all fragility fractures may get treated in a fracture clinic, and Work Survey participants may be heathier or have more resources than other working fragility fracture patients. Therefore, the ability to generalize the results in Studies 3 and 4 to all working fragility fracture patients may be

limited. However, these studies were based on the only currently available data for the population of interest and provide preliminary insights about the prevention needs of older individuals who sustain fragility fractures at work.

7.4 Other Evidence for Developing an Intervention

In addition to the findings of this thesis, reviews of post-fracture interventions (e.g. physician and/or patient education, alerts or follow-up, and fracture liaison services) also provide useful lessons which can be applied when developing a workplace intervention (Sale et al. 2011, Ganda et al. 2013, Aizer & Bolster 2014). For instance, more intensive or coordinated interventions, such as those involving dedicated personnel, bone mineral density testing or both, were found to have more positive outcomes (e.g. increased osteoporosis investigation and treatment) (Sale et al. 2011, Ganda et al. 2013, Aizer & Bolster 2014). A workplace intervention could align with this multi-component approach by applying an intervention that involves reduction of hazards associated with fractures, as well as bone health awareness (e.g. osteoporosis and fragility fracture risks and preventative measures). Furthermore, this intervention could be coordinated through a particular department in the workplace (e.g. human resources, workplace health and safety). Similarly, Aizer & Bolster (2014) indicated that direct discussion with patients appears to be more effective than written materials. This reinforces the point that more involved interventions have a greater likelihood of success. As such, opportunities for direct communication and engagement with workers should be sought and emphasized in a workplace intervention.

Second, evidence indicates that interventions should be adapted to address the needs of specific patient populations, and in particular, different types of fracture may be a consideration when undertaking secondary fracture prevention (Aizer & Bolster 2014). This aligns with the findings of this thesis which indicate the need to consider the particular worker population that will be the target of the intervention. Furthermore, forearm fractures were identified as a fracture site to focus on for secondary fracture prevention initiatives among workers.

Third, it was suggested that interventions taking place in the period immediately after the fracture have a better opportunity to change participants' behaviour than initiatives that commence later (Ganda et al. 2013). Therefore, timing of the initiative should be a consideration when developing a workplace intervention.
Fourth, Aizer & Bolster (2014) highlighted the importance of stakeholder engagement and noted that local bone health champions have been used to facilitate the success of fracture liaison services. Similarly, for a workplace intervention, it may be useful to identify a bone health champion that can periodically visit the worksite where the intervention is taking place and be available if advice is needed. For instance, this individual could be an occupational health practitioner with an interest in chronic diseases or bone health specifically, or a representative or patient advocate from Osteoporosis Canada with an interest in advancing osteoporosis and fragility fracture prevention initiatives in the workplace.

Finally, one review identified gender disparity in several studies, with lower levels of recognition, investigation and treatment for osteoporosis among men (Ganda et al. 2013). It was suggested that gender disparity needs to be addressed on multiple levels, which include the patient, health professional and health system. Reaching men via a workplace intervention will likely improve workers' awareness, but also that of their physicians, given that male workers may consult with them about osteoporosis and fragility fractures post-intervention.

Overall, post-fracture interventions provide lessons which can be applied when developing a KT intervention to prevent fragility fractures in the workplace.

7.5 Recommendations for Future Research

This thesis encompasses foundational work necessary to develop a KT intervention to prevent fragility fractures in the workplace. Four areas of future research would serve to solidify the evidence base and support development of an impactful intervention that is able to prevent or decrease the negative effects of osteoporosis and fragility fractures among a growing population of older workers.

First, future research should seek to verify the validity of the PFF case definition (i.e. "fracture" from "same-level falls") by investigating the proportion of PFFs that are indeed low trauma fractures. This could be done through an in-depth review of a sample of workers' compensation claim files identified as PFFs. This exercise would involve obtaining details on the circumstances of these injuries from claim file memos and narrative reports on forms from the worker, employer and health professionals.

Second, workplace studies of low trauma fractures among men are lacking. For instance, research is required to explore poor bone health and dangerous occupational hazards as potential causes for workplace same-level fall fractures among older men. Additionally, further investigation is needed to understand workplace safety training among younger men and whether adequate education is provided about same-level fall injuries and fractures as a potential outcome.

Third, the Work Survey examined a number of variables and the sample of working fragility fracture patients was small. In the future it would be ideal to conduct a more focused investigation on health beliefs with a larger sample of fragility fracture patients who had sustained fractures at work. Such a study would permit examination of perceived susceptibility in greater depth, in addition to other components of the HBM to assess whether they have an impact. Also validated tools, such as the Osteoporosis Health Belief Scale (Kim et al. 1991), could be utilized.

Fourth, there appears to be an absence of literature on osteoporosis and/or fragility fracture prevention interventions in particular occupational sectors, such as Education and Transportation/Delivery. Future research should consider development of KT interventions tailored for specific workplace contexts to address the themes of i) improving worker-environment interactions to limit exposure to potential fracture hazards, and ii) increasing awareness of hazards, osteoporosis and fracture risk. A randomized controlled trial to test such a workplace intervention would be appropriate.

7.6 Next Steps for Knowledge Translation and a Future Intervention

This thesis concentrated on the first two activities of the first stage (Development) in the UK Medical Research Council (MRC) process for developing and evaluating complex interventions (Figure 2.1) (Craig et al. 2008a, 2008b). In particular, since previous research in this area was lacking, this thesis focused on developing the evidence base in light of relevant theory. As suggested by the fourth item in Section 7.5, future research should involve developing a KT intervention to prevent fragility fractures in the workplace (i.e. Modeling process and outcomes, the third activity in Development). Testing and evaluation of the intervention will follow and address the other stages of the MRC process (i.e. Feasibility and Piloting, Evaluation, and Implementation).

7.7 End of Thesis Knowledge Translation Plan

The end of thesis KT plan has two components. First, the research results will be presented in a meeting to the project's KT Advisory Committee. The Committee represents a range of stakeholders able to inform fragility fracture prevention efforts including patients, patient educators, Osteoporosis Canada managers and researchers with expertise in bone health, occupational health and knowledge translation. Following presentation of the findings, the Committee's advice will be sought to identify an occupational sector, and particular workplaces within that sector, where a fragility fracture prevention intervention should be piloted. In addition, the Committee will be asked to consider the research results and advise on how to tailor the intervention to that particular workplace and workers, suggestions for workplace partners and how to connect to them (e.g. managers, health and safety or human resource professionals at those worksites who may be interested in participating in a pilot intervention).

The second component of the KT plan will involve a strategy for disseminating key research results to different audiences via various routes. Traditional passive dissemination methods will be used (e.g. presentations at academic conferences, publications in peer-reviewed journals and lay language products such as print and online newsletter articles), as well as more active dissemination with current and potential future partners (e.g. Osteoporosis Canada, Ontario Workplace Safety and Insurance Board, workplaces proposed for the pilot intervention). The messages will be tailored to the unique needs of each audience and purpose.

7.8 Conclusion

This thesis contributes to a greater understanding of fragility fractures (or surrogate: fractures resulting from same-level falls) that occur in the workplace with respect to the characteristics of the workers who sustain these fractures, and the circumstances leading to fracture. This research which consists of four studies provides the basis to develop a KT intervention to prevent fragility fractures in the workplace among older adults.

It appears that a range of industries and occupational groups are suitable targets for workplace fragility fracture prevention. Based on volume (i.e. largest fraction of total fractures), it may be valuable to focus on Services industries and Sales and service occupations, and Schedule 2 (government and related entities) industries and Business, finance and administration occupations. If considering ease of KT and worker need based on CG opinion, it may be useful to focus on Education and Transportation/Delivery related occupations. For any occupational sector, tailoring may be required to increase the likelihood that the intervention is appropriate for the workers and particular workplace environment. For instance, it may be necessary to tailor prevention initiatives by sex depending on whether the sector involves male or female dominated occupations.

This research indicated that the workplace setting may provide the opportunity to reach more men. As such, a worksite intervention could assist in making equitable gains among both sexes with respect to addressing osteoporosis and fragility fractures. Furthermore, when developing secondary fracture prevention initiatives, it was determined based on fracture volumes that it may be prudent to focus on forearm fractures and a younger segment of older workers (i.e. 50-64 years). The latter may benefit from secondary fracture prevention interventions by avoiding subsequent fractures as they age. Additionally, regardless of setting (i.e. at work or elsewhere), study findings indicate a lack of awareness and understanding among working fragility fracture patients regarding their risk for osteoporosis and fragility fractures.

The final study of the thesis culminated in stakeholder recommendations for workplace fragility fracture prevention and identified areas that had also been highlighted in the previous three studies. This investigation presented two major themes. The first was to *improve worker-environment interactions* in order to limit exposure to hazards potentially associated with fractures (e.g. slippery conditions generated by ice, snow and liquids). This could be addressed by leveraging existing workplace STF prevention programs to improve fracture prevention as the hazards involved with fractures and STFs appear to be common. The second theme was to *increase awareness* of hazards, osteoporosis and fracture risk. This recommendation could be addressed by employing a workplace-based chronic disease management program to prevent osteoporosis and fragility fractures. This intervention could improve workers' understanding of osteoporosis and the risk for fracture, while also improving knowledge of workplace hazards associated with fractures.

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The next step involves using the findings of this thesis to develop, tailor and test a KT intervention to prevent fragility fractures in the workplace. With the growth of the aging workforce, such a program may serve to sustain and enhance the health, longevity at work and productivity of older workers.

Candidate's Role

The candidate (Chamila Dilanjali Adhihetty) conceived the research objectives examined in this thesis, developed the research protocol with contributions from thesis committee members (Dr. Susan Jaglal, Dr. Dorcas Beaton and Dr. Sheilah Hogg-Johnson), performed analyses of administrative data, designed portions of the Work Survey relevant to this thesis, performed analyses of survey data, recruited consensus group (CG) members, conducted CG sessions and analyses and wrote the thesis manuscripts.

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Appendices

Appendix A: University of Toronto Research Ethics Board Approval Letter (Phase I)



OFFICE OF THE VICE-PRESIDENT, RESEARCH AND INNOVATION

PROTOCOL REFERENCE # 28543

February 12, 2016

Dr. Susan Jaglal DEPT OF PHYSICAL THERAPY FACULTY OF MEDICINE Ms. Chamila Adhihetty DEPT OF PHYSICAL THERAPY FACULTY OF MEDICINE

Dear Dr. Jaglal and Ms. Chamila Adhihetty,

Re: Your research protocol entitled, "An examination of fragility fractures that occur in Ontario workplaces"

ETHICS APPROVAL Original Approval Date: February 22, 2013 Expiry Date: February 21, 2017 Continuing Review Level: 1 Renewal: Data Analysis Only

We are writing to advise you that you have been granted annual renewal of ethics approval to the above-referenced research protocol through the Research Ethics Board (REB) delegated process. Please note that all protocols involving ongoing data collection or interaction with human participants are subject to re-evaluation after 5 years. Ongoing research under this protocol must be renewed prior to the expiry date.

Please ensure that you submit an Annual Renewal Form or a Study Completion Report 15 to 30 days prior to the expiry date of your protocol. Note that annual renewals for protocols cannot be accepted more than 30 days prior to the date of expiry as per our guidelines.

Any changes to the approved protocol or consent materials must be reviewed and approved through the amendment process prior to its implementation. Any adverse or unanticipated events should be reported to the Office of Research Ethics as soon as possible. If your research is funded by a third party, please contact the assigned Research Funding Officer in Research Services to ensure that your funds are released.

Best wishes for the successful completion of your research.

Yours sincerely,

Flindthe Reter

Elizabeth Peter, Ph.D. REB Chair

Research Oversight and Compliance Office - Human Research Ethics Program McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M3S 188 Canada Tel: +1 416 946-3273 Fax: +1 416 946-3763 ethics.review@utoronto.ca <u>http://www.research.utoronto.ca/for-researchers-administrators/ethics/</u>

Appendix B: St. Michael's Hospital Research Ethics Board Approval Letter (Phase II)

St. Michael's

Inspired Care. Inspiring Science.

Research Ethics Office Telephone: (416) 864-6060 Ext. 2557 Facsimile: (416) 864-6043 E-mail: pateld@smh.toronto.on.ca

October 18, 2016

Dr. Dorcas Beaton, Mobility Research Unit Program, St Michael's Hospital

Dear Dr. Beaton,

Re: REB# 14-182 - Impact of Your Fracture on Your Work: Research use of an anonymous quality assurance survey

REB APPROVAL:	Original Approval Date	October 27, 2014
	Annual/Interval Review Date	October 27, 2017

Thank you for your communications dated September 19, 2016 requesting an annual review and approval regarding the above named study.

This letter will serve as an extension of the St. Michael's Hospital (SMH) Research Ethics Board (REB) approval for the study for a period of 12 months effective from October 27, 2016 – October 27, 2017. Continuation beyond that date will require further review of REB approval.

The deliberation, review or approval of this submission did not include a Research Ethics Board member involved with this study.

During the course of this investigation, any significant deviations from the approved protocol and/or unanticipated developments or significant adverse events should immediately be brought to the attention of the REB.

The St. Michael's Hospital (SMH) Research Ethics Board (REB) operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans, the Ontario Personal Health Information Protection Act, 2004, and ICH Good Clinical Practice Consolidated Guideline E6, Health Canada Part C Division 5 of the Food and Drug Regulations, Part 4 of the Natural Health Product Regulations, and the Medical Devices regulations. Furthermore, all investigational drug trials at SMH are conducted by Qualified Investigators (as defined in the latter document).

Good luck with your investigations.

With best wishes

Dr. David Mazer

Chair, Research Ethics Board DM/PB/BJM /TPS Dr. Philip Berger Vice Chair, Research Ethics Board Dr. Brenda McDowell Vice Chair, Research Ethics Board Appendix C: University of Toronto Research Ethics Board Approval Letter (Phase II)



OFFICE OF THE VICE-PRESIDENT, RESEARCH AND INNOVATION

PROTOCOL REFERENCE # 31016

November 20, 2014

Dr. Dorcas Beaton INST OF HEALTH POLICY, MANAGEMENT & EVALUATION DALLA LANA SCHOOL OF PUBLIC HEALTH Ms. Chamila Adhihetty INST OF HEALTH POLICY, MANAGEMENT & EVALUATION DALLA LANA SCHOOL OF PUBLIC HEALTH

Dear Dr. Beaton and Ms. Chamila Adhihetty,

Re: Administrative Approval of your research protocol entitled, "Impact of your fracture on your work: Research use of an anonymous quality assurance survey"

We are writing to advise you that the Office of Research Ethics (ORE) has granted administrative approval to the above-named research protocol. The level of approval is based on the following role(s) of the University of Toronto (University), as you have identified with your submission and administered under the terms and conditions of the affiliation agreement between the University and the associated TAHSN hospital:

- Graduate Student research hospital-based only
- Storage or analysis of De-identified Personal Information (data)

This approval does not substitute for ethics approval, which has been obtained from your hospital Research Ethics Board (REB). Please note that you do not need to submit Annual Renewals, Study Completion Reports or Amendments to the ORE unless the involvement of the University changes so that ethics review is required. Please contact the ORE to determine whether a particular change to the University's involvement requires ethics review.

Best wishes for the successful completion of your research.

Yours sincerely,

Thomasic

Dario Kuzmanovic REB Manager

Appendix D: Work Survey ("The Impact of Your Fracture (Broken Bone) on Your Work")



THE IMPACT OF YOUR FRACTURE (BROKEN BONE) ON YOUR WORK

The Impact of Your Fracture (Broken Bone) on Your Work



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Thank you for taking the time to consider this survey. Below is some information that will help you understand why we need your help and value your responses.

- Why is a survey about your fracture (broken bone) and your work being done? This survey is being done as part of the Fracture Clinic Screening Program ("FCSP") to understand the impact of your fracture on your ability to work, and your sense of productivity while at work. The FCSP is a post-fracture osteoporosis screening program that was started to identify and assess men and women who have had a fracture due to a fall from standing height or less in an effort to prevent future fractures (broken bones). This survey will also help to estimate the costs associated with your fracture (i.e. costs from missed work or not being able to work at your full ability). We know work is important to people for many reasons: financial, social, sense of who we are. Fractures can interrupt work. We are interested in how people are managing at work 3 to 7 months after a fracture like yours.
- What do you need to do? If you wish to help with this survey, please complete the survey and return it to the evaluation team using the enclosed, pre-addressed stamped envelope. You will not be contacted for any additional information in the future.
- What will we do with the survey responses? The information that you and other people provide will be gathered to give us an idea of whether and how fractures are impacting the work lives of people like you. This survey is <u>anonymous</u>. All the information you provide us will remain confidential and will only be reported as group data with no identifying information. Because of this it is important that you do <u>NOT</u> sign your name anywhere on this survey.
- Who can help? To complete the survey, you must have been working for pay at the time of your fracture and to be able to read and respond to this survey in English. If this is you, we need your help!
- Any questions? Please feel free to call Ms. Denise Linton (Survey Coordinator) toll free at 1-855-437-4397.



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THE IMPACT OF YOUR FRACTURE (BROKEN BONE) ON YOUR WORK



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- 1.4 Do you think that your current fracture puts you at a greater risk for another fracture in the future? (Please check one box)
 - Yes
 Don't know
 No
 Decline to answer
- 1.5 Do you think that your broken bone could have been caused by poor bone strength? (Please check one box)

Ο.	Yes	0.	Don't know
0	No	0.	Decline to answer

SECTION 2: DETAILS ABOUT HOW YOU BROKE YOUR BONE

2.1 When did you break your bone(s)?



2.2 What time of day did you break your bone(s)? (Please check one box)

- Morning (6:00AM 11:59AM)
- Afternoon (12:00PM 5:59PM)
- Evening (6:00PM 11:59PM)
- Late evening/Early Morning (12:00AM 5:59AM)

2.3 Where did your fracture occur?

- Indoors
- Outdoors

2.4 Did you need surgery as a result of your broken bone?

O Yes O No

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- 2.5 How did you break this bone? (Please check one box)
 - ⊖ Slip ⊖ Trip
 - Misstep (i.e. a misplaced or awkward step)
 - Stumble
 - Fall (from standing height or less)
 - Other (Please describe your injury and what happened to cause it)

2.6 Do any of these describe what you were doing when you broke your bone? (Please check one box)

- Sitting
- ⊖ Standing still
- Walking
- Walking fast (i.e. rushing)
- Running

- Stepping over something
- Pushing or pulling something
- Lifting or lowering an object
- Trying to avoid an object or person
- Other (please specify)

2.7 Were any of the following a factor that contributed to your fall/injury? (Check all that apply)

- Uneven surface
- Cluttered surface
- Slippery (wet, icy) surface
- Poor lighting
- Distractions (i.e. other people)
- Involvement of equipment (i.e. caught on machining)
- Other (please provide details):

2.8 Did your fracture occur while you were at work? (Please check one box)

- No, it did not occur at work ⇒ (go to section 3)
- It happened on the way to work, or on the way home from work ⇒ (go to section 3)
- Yes, it happened at work (on site or off site)

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2.8.1 If yes, what kind of coverage do you have to deal with your work injury? (Please check one box)

(Please remember this survey is anonymous)

- WSIB/WCB (Workers' Compensation)
- Personal insurer ⇒ (go to section 3)
- Self employed ⇒ (go to section 3)
- Employed by an organization not covered by WSIB/WCB ⇒ (go to section 3)
- 2.8.2 Did you or your supervisor speak to the WSIB/WCB (Workers' Compensation) about your fracture? (Please check one box) (Please remember this survey is anonymous)
 - O Yes, I have an active claim
 - Yes, we filed a report with the WSIB/WCB but it was not accepted
 - Yes, we have filed a report with the WSIB / WCB, but we have not heard if it is accepted or not
 - No, it happened at work but a claim was never filed
 - No, I am not eligible for WSIB
 - No, Other (please specify):

SECTION 3: YOUR WORK STATUS <u>BEFORE</u> YOUR FRACTURE/BROKEN BONE In this section we want to know about the nature of your paid job in the time before your fracture.

3.1. What was your job title just before you broke your bone(s)?

- 3.1.2. What kind of business, industry or service did you work for? (Please tell us the nature of the business, industry or service and <u>not</u> the name) (i.e. cardboard box manufacturing, road maintenance, retail shoe store, secondary school, dairy farm, municipal government/public service, etc.)
- 3.1.3. What kind of work were you doing? (i.e. factory worker, babysitting in own home, forestry technician, etc.)

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3.1.4. What were your four most important activities or duties in this job? (i.e. stamp press machine operator, caring for children, forest examiner, etc.)

1)	
2)	
3)	
4)	

3.2 Which of the following best describes your work status <u>at the time</u> of your fracture? (*Please check one box*)

- Full time permanent
- Full time temporary or contract
- Casual (hours as needed)
- Other (please specify):

Part time permanent

Part time temporary or contract

- Self employment
- 3.3 At the time of your fracture, did your job involve working shift work? (i.e. day, evening and/or night shift(s)) (Please check one box)
 - ⊖ ¦ Yes
 - O No

SECTION 4: YOUR WORK STATUS AFTER YOUR FRACTURE/BROKEN BONE This section asks questions about your current work situation, since your fracture.

- 4.1. Which of these best describes your <u>current</u> work status at your place of employment? (If you are <u>NOT</u> back at work yet, what would your current status/contract be?) (Please check one box)
 - Full time permanent
- Full time temporary or contract
- Casual (hours as needed)
- C Retired

- Part time permanent
- Part time temporary or contract
- Self employment

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4.2. Have you been able to return to paid work at some point since your fracture? (Please check one box)

) Ye) No	s ⇒ (go to Box A)
4.2.1	If yes, how long was it after your fracture? days ⇔ (skip Box A)
BOX	A
	What is the main reason for why you have not been able to go back to work? (Please check one bax)
	I was not physically able to perform the jobs that were available at my old employer
	My workplace was not accessible because of my fracture
	My fracture made it too difficult for me to travel or commute
	My old job was temporary and was no longer available
	My old job was seasonal
	I was laid off/fired
	There was another reason (please specify):
⇔ (go	to Section 6)

4.3. If you are back at work, are you now working ? (Please answer 'yes' or 'no' for each item)

In the same job and duties as before your injury?	Ο.	Yes	Ο.	No
In the same job, but different duties than before your injury?	0	Yes	0.	No
The same number of hours?	0.	Yes	0.	No
With the same employer?	0	Yes	0.	No ⇔
				(go to Box B)

BOX B	
If you with (Plea	a are <u>not with the same employer</u> , what is the main reason why you are not back your previous employer? se check one box)
Ο.	I was not physically able to perform the jobs that were available at my old employer
0	My workplace was not accessible because of my fracture
0	My fracture made it too difficult for me to travel or commute
0.	My old job was temporary and was no longer available
0	My old job was seasonal
0.	I was laid off/fired
0	The company closed
٥.	There was another reason (please specify):

4.4. Since your fracture, how many full work days have you missed from work because of your fracture? (Including time off for appointments related to your fracture)



4.5. Since your fracture, how many part work days have you missed from work because of your fracture? (Including time off for appointments related to your fracture)

Part days absent

4.6. How many full days have you missed from work over <u>the past month</u> because of your fracture?

(Including time off for appointments related to your fracture)



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4.7. How many part days have you missed from work over the past month because of your fracture?

(Including time off for appointments related to your fracture)



4.8. Thinking of the days while you have been at your paid work How many days would you say your productivity was reduced to less than half or more because of your fracture?



4.9. In the last month, and only considering the time since your fracture, how much has your fracture interfered with your work productivity (paid work outside of the home) on a scale from 0 - 10, where 0 = no interference and 10 = complete interference?



4.10. On a scale from 0 to 10, where 0 is the worst job performance anyone could have at your job and 10 is the performance of a top worker, how would you rate the usual performance of most workers in a job similar to yours? (Please circle the number)

Worst Performance										Top Performance
Ŷ	1	2	3	4	5	6	7	8	9	10

4.11. Using the same scale 0 to 10 scale, how would you rate your usual job performance over the past year or two? (Please circle the number)



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4.12. Using the same 0 to 10 scale, how would you rate your overall performance on the days you worked during the past 7 days? (Please circle the number)

Worst Performance										Top Performance
0	1	2	3	4	5	6	7	8	9	10

SECTION 5: IMPACT OF FRACTURE ON WORK

These questions ask you to rate the amount of time you had difficulty handling certain parts of your job. Please read and answer every question. Then choose a response.

> "Mark the "does not apply to my job" box only if the question describes something that is not part of your job.

*If you have more than one job, report on your main job only.

5.1. In the past month, how much of the time did your fracture make it difficult for you to do the following?

Your fracture made it <u>difficult</u> for you to	All of the time (100%)	Most of the time	Some of the time (about 50%)	A slight bit of the time	None of the time (0%)	Does Not Apply to My Job
i) work the required number of hours		۵,	Π,	Π.	□s	۵,
ii) get going easily at the beginning of the workday		۵,	Π,	Π.	□s	۰.
iii) start on your job as soon as you arrived at work		۵,	Π,	Π,	□ _s	۵,
iv) do your work without stopping to take breaks or rests		□,	Π,	□.	□s	.
v) stick to a routine or schedule		۵,	Π,	□.	□s	□ ₆

* Adaptation of WLQ-25 @ Lerner, 2001

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Your fracture made it <u>difficult</u> for you to	All of the time (100%)	Most of the time	Some of the time (about 50%)	A slight bit of the time	None of the time (0%)	Does Not Apply to My Job
i) walk or move around different work locations (i.e. go to meetings)		۵,	۵,	Π.	□s	.
ii) lift, carry, or move objects at work weighing <u>more than 10 pounds</u>		□2	۵,	□.	□s	.
iii) sit, stand, or stay in one place for more <u>than 15 minutes</u> while working		۵,	۵,	۰.	□s	.
iv) repeat the same motions over and over again while working	□,	□,	۵,	□.	□s	.
v) bend, twist, or reach while working		Π,	Π,	□.	□₅	□ ₆
vi) use hand-held tools or equipment (i.e. a phone, pen, keyboard, computer mouse, drill, hairdryer, or sander)		۵,	Π,	□.	□s	.

5.2. In the past month, how much of the time did your fracture make it difficult for you to handle certain parts of your job?

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5.3. In the past month, how much of the time did your fracture make it difficult for you to do the following?

Your fracture made it <u>difficult</u> to do the following	All of the time (100%)	Most of the time	Some of the time (about 50%)	A slight bit of the time	None of the time (0%)	Does Not Apply to My Job
i) keep your mind on work		Π,	Π,	□,	□s	.
ii) think clearly when working		□₂	Π,		□s	6
iii) do work carefully		□,	Π,	Π.	□s	□ .
iv) concentrate on your work		□₂	□,	□₄	□s	6
$\boldsymbol{\nu})$ work without losing your train of thought		□,	Π,	□,	□s	.
vi) easily read or use your eyes when working		□,	□,	□,	□s	.

5.4. In the past month, how much of the time did your fracture make it difficult for you to do the following?

Your fracture made it <u>difficult</u> to do the following	All of the time (100%)	Most of the time	Some of the time (about 50%)	A slight bit of the time	None of the time (0%)	Does Not Apply to My Job
 i) speak with someone in person, in meetings, or on the phone 		□,	Π,	□.	□s	□ ₆
ii) control your temper around people when working		□,	Π,	□,	□s	•
iii) help other people to get work done		Π,	Π,	□.	□s	.

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5.5. In the past month, how much of the time did your fracture make it <u>difficult</u> for you to do the following?

Your fracture made it <u>difficult</u> to do the following	All of the time (100%)	Most of the time	Some of the time (about 50%)	A slight bit of the time	None of the time (0%)	Does Not Apply to My Job
i) handle the workload		۵,	Π,	□.	□s	.
ii) work fast enough		□,	Π,		□s	.
iii) finish work on time		Π,	Π,	□.	□s	۵.
iv) do your work without making mistakes		□,	Π,		□s	.
v) feel you've done what you are capable of doing		Π,	Π,	□.	□s	□ .
vi) easily read or use your eyes when working		□,	□,	□,	□s	G

5.6. Have you been unable to seek a promotion or job transfer because of your fracture?

⊖ Yes ⊖¦ No

5.7. Have you had to refuse taking extra projects or responsibilities because of your fracture?

O Yes O No

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SECTION 6: GENERAL INFORMATION		
About you		
6.1 Are you O Male O, Female		
6.2 What is your age today?		
Years		
And finally		
6.3 Would you have been comfortable answering these questions about your work over the phone rather than as an anonymous survey?		
 Yes, I would have been comfortable 		
No, I would not have been comfortable		
IMPORTANT: Please do not enter any information that could be used to identify you (i.e. name, address, date of birth, etc.)		
Please tell us any additional information we may have missed or not captured on how your fracture is impacting your work: (i.e. What is your biggest challenge at work?)		

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Thank you for completing this survey

Below are instructions about how to return your completed survey.

- Please mail it back by placing it in the pre-addressed stamped envelope provided in this package and dropping it in any post office/mail box.
- Should you have any questions about this survey, please contact the Survey Coordinator, Ms. Denise Linton, toll free at 1-855-437-4397. You may leave a message on this confidential voicemail. Please only call about study related information.
- Please remember we are trying to keep your identity confidential. Therefore please DO NOT write your name on the survey.

Thanks again

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Appendix E: Synthesis of findings from the four studies and implications for prevention of fragility fractures in the workplace

Findings [from specified study]	Implications for Prevention
I. AGE & SEX (DEMOGRAPHICS)	
I – a. WOMEN	
When examining fractures from same-level falls, women represented the larger proportion in the older age group (50 to 80 years). [Study 1]	This may be indicative of poor bone health which suggests the need for fracture screening among older women.
I – b. MEN	
When examining fractures from same-level falls, men represented the larger proportion in the younger age group (20 to 49 years). [Study 1]	These fractures appear to be associated with more heavy and hazardous industries where little attention may be given to same-level fall injuries. If seeking to prevent fractures in younger men, further investigation is required to understand safety training for this group and whether adequate education is provided about same-level fall injuries and fractures as a potential outcome.
Older men (50 to 80 years) represented the second highest proportion of fractures from same-level falls overall. [Study 1]	Fractures in this group could be due to poor bone health as well as exposure to dangerous occupational hazards. Further research is needed to explore these potential causes for workplace same-level fall fractures among older men as literature is lacking.
Among individuals who had sustained a fragility fracture, men were found to be three times more likely to respond 'don't know' versus 'yes' and 'no' versus 'yes' compared to women on the perceived susceptibility survey question. [Study 3]	The findings of this study indicate a lack of awareness and understanding among male fragility fracture patients about their risk for osteoporosis and fragility fractures.
Sex analysis of potential fragility fracture (PFF) types indicated that this study population of workers appeared to have a greater proportion of males than is typically seen among studies of fragility fracture patients. [Study 2] Individuals who sustained a fragility fracture at work were significantly more likely to be male compared to those who fractured elsewhere. [Study 3] Consensus groups (CGs) recommended that the workplace could be used as a setting to draw attention to and address osteoporosis and fragility fractures among men. [Study 4]	The findings of these three studies are consistent in indicating that the workplace may provide an opportunity to reach more men with fragility fractures. As such, this setting could serve as a conduit to improve knowledge and awareness among men, as well as diagnostic and therapeutic efforts for this group.
I – c. AGE	
A large number of PFFs (i.e. the majority) occurred among the 50-64 year age group. [Study 2]	This suggests that this younger segment of older workers may benefit from secondary fracture prevention interventions in order to avoid subsequent fractures as these individuals age.

II. FRACTURE TYPE (SITE)	
Forearm was the most common fracture type across	The two studies show consistent findings and indicate
all industries in the industry-specific analysis of PFF	that it may be prudent to focus on forearm (or wrist)
types. [Study 2]	fractures when developing secondary fracture
Wrist was the most common fracture type among	prevention initiatives.
both the 'At work' and 'Elsewhere' fragility fracture	
groups. [Study 3]	
III. INDUSTRY & OCCUPATION	
Same-level falls that resulted in fracture and non-	The industry distributions of fracture and non-fracture
fracture allowed lost-time (LTA) claims were	same-level fall LTA claims (Study 1) and PFF and other
distributed similarly across industries. [Study 1]	fracture LTA claims (Study 2) are not unique, but
PFF and other fracture LTA claims were distributed	comparable to the industry distribution for all LTA
similarly across the 17 industries. [Study 2]	claims from 2002 to 2011.
Within the fracture and non-fracture groups (i.e.	Depending on how the data are examined, it appears
injuries from same-level falls), approximately 50% of	that a range of industries and occupational groups are
claims originated from the Services and Schedule 2	suitable targets for workplace fragility fracture
(government and related entities) industries. [Study	prevention interventions. If considering sectors with
1]	the highest proportions of fractures based on total
The proportion of same-level fall claims that are	fractures (i.e. volume), it may be valuable to focus on
fractures varies across industry, with a high of almost	Services industries and Sales and service occupations,
a quarter of claims in Mining and Construction. [Study	and Schedule 2 (government and related entities)
1]	industries and Business, finance and administration
The Services and Schedule 2 (government and related	occupations. If considering ease of knowledge
entities) industries reported the highest proportions,	translation and worker need based on Consensus
based on PFFs as a fraction of total PFFs. [Study 2]	Group opinion, it may be useful to focus on Education
The Food, Services and Automotive industries	and Transportation/Delivery related occupations. For
reported the highest proportions, based on PFFs as a	any occupational sector, tailoring may be required to
fraction of same-level fall fractures within individual	increase the likelihood that the intervention is
industries. [Study 2]	appropriate for the workers and particular workplace
The two occupational groups with the greatest	environment.
number of fragility fracture patients were Sales and	
service occupations and Business, finance and	
administration occupations which represented about	
half of all respondents. [Study 3]	
The summary clusters, "General", "Education" and	
"Transportation/Delivery", were considered by two or	
more CGs as a priority for fragility fracture prevention	
efforts based on ability to translate knowledge in	
those settings (i.e. accessibility) and need for	
intervention among those workers. [Study 4]	
III – a. INDUSTRY & OCCUPATION BY SEX	
Traditional male and female dominated occupations	The results of these two studies suggest the need to
appeared to influence the proportions of men and	tailor prevention initiatives in particular workplaces by
women sustaining fractures from same-level falls in	sex depending on whether they involve male or
different industries. [Study 1]	female dominated occupations.
In the analysis of sex-distribution by industry, the	
percentage point difference in the proportion of	
females in the PFFs group versus the other fractures	

group was low in a few industries including	
Construction, Health care and Education industries.	
This likely reflects the workers within these industries	
being dominated by one sex, female for Health Care	
and Education, and male for Construction. [Study 2]	
IV. TIME OF DAY	
Fractures and non-fracture injuries from same-level	The results of the three studies are consistent with
falls occurred most often in the morning followed by	more occupational activities occurring during regular
afternoon and were least likely to occur during the	day time business hours.
evening and night/early morning. [Study 1]	
The greatest proportion of PFFs and other fractures	
occurred in the morning followed by afternoon.	
[Study 2]	
Fragility fractures 'At work' and 'Elsewhere' occurred	
with the greatest proportions in the morning. The	
next highest proportion in the 'At work' group was in	
the afternoon, whereas for the 'Elsewhere' group, it	
was found in the evening to early morning hours.	
[Study 3]	
V. SEASON	
Reporting similar proportions, fracture and non-	The findings of the three studies align and are
fracture injuries from same-level falls occurred with	consistent with winter slipping hazards contributing to
the greatest frequency in the winter and were least	the high proportion of same-level fall fractures and
frequent in the summer. [Study 1]	fragility fractures in the winter.
For PFFs and other fractures, the greatest proportion	
occurred in the winter and the lowest proportion	
occurred in the summer with no appreciable	
difference between the two types of fractures. [Study	
2]	
Fragility fractures 'At work' and 'Elsewhere' occurred	
with the greatest proportions in the winter and lowest	
proportions in the summer. [Study 3]	
VI. HAZARDS	
Slippery conditions generated by ice, sleet, snow and	These hazards can be prevented by improving
liquids were common hazards involved with same-	workplace housekeeping practices and educating
level fall fractures. [Study 1]	workers to enhance awareness of hazards and
	detrimental outcomes such as fractures.
For both the 'At work' and 'Elsewhere' fragility	This implied that environmental safeguards are
fracture groups, the most common circumstances	· · · · · · · · · · · · · · · · · · ·
	required both in and out of the workplace in order to
involved walking, slippery surfaces, slipping and	required both in and out of the workplace in order to prevent fragility fractures among older working adults.

VII. PERCEIVED SUSCEPTIBILITY (HEALTH BELIEFS)	
The results of the multinomial logistic regression indicated no association between setting (i.e. whether the fracture occurred 'At work' or 'Elsewhere') and perceived susceptibility, with both groups being equally unlikely to make the link between their fracture and bone health (adjusting for age and sex). [Study 3]	Workplace context did not appear to affect patients' perceived susceptibility for osteoporosis and fragility fractures.
Regardless of setting, the majority of survey respondents lacked awareness of their susceptibility for fragility fractures and do not appear to make the link between osteoporosis and fragility fractures. [Study 3]	The findings indicate a lack of awareness and understanding among fragility fracture patients regarding their risk for osteoporosis and fragility fractures. This is consistent with other studies and suggests the need for innovative knowledge translation activities that could leverage the workplace.
Fragility fractures that occurred in the workplace were similar to those that happened outside of work in terms of: the characteristics of patients who sustained these injuries, the circumstances leading to fractures and patients' beliefs about risk for osteoporosis and fractures. [Study 3]	This indicates that existing clinically oriented fracture prevention initiatives (e.g. post-fracture interventions such as fracture liaison services) are relevant to individuals who sustain their fractures at work.
VIII – b. LEVERAGING SLIP, TRIP & FALL PREVENTION IN	IITIATIVES
The distribution of fractures was similar to non- fracture injuries on the basis of sex, industry, season and time of day; but differed in terms of age and part of body. [Study 1]	Interventions to prevent fractures may only need to differ from same-level fall prevention initiatives on the basis of age (i.e. fractures were more likely in the older age group) and part of body (e.g. large proportion of fractures affected the upper extremities).
The first key theme from the recommendation development exercise was <i>improve worker-</i> <i>environment interactions</i> in order to limit exposure to hazards potentially associated with fractures. This theme had three sub-themes: <i>housekeeping, flooring</i> and <i>personal protective equipment</i> . In addition, the last sub-theme had two lower level themes, <i>footwear</i> and <i>lighting</i> . [Study 4]	The first major theme, <i>improve worker-environment</i> <i>interactions</i> , could be addressed by leveraging existing workplace slip, trip and fall (STF) prevention programs to improve fracture prevention as the hazards involved with fractures appear common to STFs.

VIII – c. DEVELOPING A WORKPLACE-BASED CHRONIC DISEASE MANAGEMENT PROGRAM

The second key theme from the recommendation	The second major theme, increase awareness, could
development exercise was increase awareness of	be tackled by employing a workplace-based chronic
hazards, osteoporosis and fracture risk. Within this	disease management program to prevent
theme there were three sub-themes: notification,	osteoporosis and fragility fractures. Such an
promotion/knowledge translation and training. [Study	intervention could enhance workers' knowledge of
4]	osteoporosis and the risk for fracture, while also
CG participants indicated that a potential intervention	increasing understanding of workplace hazards
in the workplace to prevent fragility fractures could	associated with fractures.
involve a combination of hazard identification and	
involve a combination of hazard identification and bone health promotion, with referral to family	
involve a combination of hazard identification and bone health promotion, with referral to family physicians for investigation of osteoporosis as	