Conformation to masculine norms and men's perceived self-efficacy in osteoporosis management and fall prevention

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ABSTRACT

Men suffer one-third of osteoporosis-related fractures worldwide. The gendered belief surrounding osteoporosis as a female disease and the influence of male stereotypes impact men's self-management of osteoporosis.

We aimed to explore how gendered beliefs, and male stereotypes affect older men's self-efficacy to manage osteoporosis and prevent falls by examining their conformity to societal masculine norms.

Men ≥ 60y at high fracture risk, recruited in Canada, completed an online survey. Conformity to masculine norms was ascertained with the Conformity to Masculine Norms Inventory-22 (CMNI-22) with scores 0-66; subsequently standardized (mean=50, SD=10). Primary outcomes included self-efficacy for osteoporosis management (OSES), calcium intake, exercise participation (subscales of OSES), and falls efficacy (FES-I). Linear and logistic multivariate regression models were calculated to determine the associations between CMNI and OSES and FES-I considering important co-variables.

Two hundred and seven (mean age 71 [SD = 7] years) participants completed the survey; all reported male sex at birth and identified as men, with an average CMNI-22 raw score 28 (SD = 8); 73% had post-secondary education, 86% identified as White, 54% had osteoporosis, 43% experienced ≥ 2 falls in the past year, and 61% had sustained a fracture. Those in the highest CMNI-22 tertile group tended to report other country of birth than Canada, less years since immigration and being of other race/ethnicity than White. The mean OSES was 781 (SD = 209) in the lowest CMNI-22 tertile vs. 689 (SD = 261) in the highest tertile (p = 0.02). The median FES-I was 10

(IQR: 8,14) and did not differ between lowest and highest CMNI-22 tertile groups (p = 0.52). Adjusted linear regression models demonstrated that each increase in one unit of CMNI-22 was significantly associated with a decrease in OSES (-3.22; 95% CI [-5.99, -0.45]) and calcium intake self-efficacy (-1.78; 95% CI [-3.41, -0.14]); there was no association with exercise self-efficacy (Table). In adjusted logistic regression models, CMNI-22 was not associated with FES-I (OR 1.00, 95% CI [0.96; 1.03]). A significant interaction was noted between CMNI-22 and the presence of depressive symptoms (p = 0.01) on total OSES and calcium intake self-efficacy.

We observed an association between conformity to masculine societal norms and osteoporosis management self-efficacy in men at high risk for fracture, even after adjusting for race/ethnicity, income and education. Indeed, those with highest conformity to masculine societal norms report less self-efficacy. Interventions targeting osteoporosis management in older men need to address traditional masculine norms and the presence of depressive symptoms to improve self-efficacy and, consequently, health outcomes.

RÉSUMÉ

Les hommes subissent un tiers des fractures liées à l'ostéoporose dans le monde. La croyance genrée entourant l'ostéoporose en tant que maladie féminine et l'influence des stéréotypes masculins impactent l'autogestion de l'ostéoporose chez les hommes. Nous avons cherché à explorer comment les croyances genrées et les stéréotypes masculins affectent les perceptions d'efficacité des hommes âgés à gérer l'ostéoporose et à prévenir les chutes en examinant leur conformité aux normes masculines sociétales.

Des hommes ≥ 60 ans à haut risque de fracture, recrutés au Canada, ont complété une enquête en ligne. La conformité aux normes masculines a été déterminée avec l'Inventaire de la Conformité aux Normes Masculines (ICNM) avec des scores de 0 à 66, ensuite standardisés (sICNM : moyenne=50, ET=10). Les résultats principaux incluaient l'Échelle d'Auto-efficacité pour l'Ostéoporose (EAEO), l'apport en calcium, la participation à l'exercice (sous-échelles de l'EAEO) et l'Échelle Internationale d'Efficacité à la Prévention des Chutes (FES-I). Des modèles de régression linéaire et logistique multivariés ont été calculés pour déterminer les associations entre le sICNM et l'EAEO et la FES-I en tenant compte des covariables importantes.

Deux cent sept participants (âge moyen 71 (ET=7) ans) ont complété l'enquête ; tous ont rapporté un sexe masculin à la naissance et s'identifiaient comme hommes, avec un score brut moyen de ICNM de 28 (ET=8) ; 73% avaient une éducation post-secondaire, 86% s'identifiaient comme Blancs, 54% avaient l'ostéoporose, 43% avaient subi ≥ 2 chutes au cours de l'année précédente, et 61% avaient subi une fracture. Ceux du groupe du tertile le plus élevé du sICNM avaient tendance à déclarer un autre pays de

naissance que le Canada, moins d'années depuis l'immigration et une autre race/ethnicité que Blanc. Le score moyen de l'EAEO était de 781 (ET=209) dans le tertile le plus bas du sICNM contre 689 (ET=261) dans le tertile le plus élevé (p = 0.02). La médiane de la FES-I était de 10 (EIQ : 8,14) et ne différait pas entre les groupes des tertiles les plus bas et les plus élevés du sICNM (p = 0.52). Les modèles de régression linéaire ajustée ont démontré qu'une augmentation d'une unité du sICNM était significativement associée à une diminution de l'EAEO (-3.22 ; IC 95% [-5.99, -0.45]) et des perceptions d'efficacité en apport de calcium (-1.78 ; IC 95% [-3.41, -0.14]) ; il n'y avait aucune association avec les perceptions d'efficacité de l'exercice. Dans les modèles de régression logistique ajustée, le sICNM n'était pas associé à la FES-I (RC 1.00, IC 95% [0.96, 1.03]). Une interaction significative a été notée entre le sICNM et la présence de symptômes dépressifs (p = 0.01) sur l'EAEO total et les perceptions d'efficacité en apport de calcium.

Nous avons observé une association entre la conformité aux normes masculines sociétales et les perceptions d'efficacité dans la gestion de l'ostéoporose chez les hommes à haut risque de fracture, même après ajustement pour la race/l'ethnicité, le revenu et l'éducation. En effet, ceux ayant la plus grande conformité aux normes masculines sociétales rapportent moins de perceptions d'efficacité. Les interventions visant la gestion de l'ostéoporose chez les hommes âgés doivent aborder les normes masculines traditionnelles et la présence de symptômes dépressifs pour améliorer les perceptions d'efficacité et, par conséquent, les résultats de santé.

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CONTRIBUTION OF AUTHORS

Ramiya Veluppillai, Dr Deborah DaCosta and Dr Suzanne Morin designed the study. Ramiya Veluppillai generated, analysed and interpreted the data. Dr Suzanne Morin supervised data analysis, and Dr Suzanne Morin and Dr Deborah Da Costa participated in the interpretation. Dr. Suzanne Morin obtained the funding. Ramiya Veluppillai wrote the initial draft of the thesis and Dr. Suzanne Morin edited the final version of the thesis.

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ABBREVIATIONS

BMD: Bone mineral density

CMNI-22: Conformity to Masculine Norms Inventory-22

FES-I: Falls Efficacy Scale-International

FRAX: Fracture risk assessment tool

GLTEQ: Godin Leisure-Time Exercise questionnaire

GSE: General Self-Efficacy scale

MCID: Minimum Clinically Important Difference

OSES: Osteoporosis Self-Efficacy Scale

PHQ-8: Patient Health Questionnaire-8

CHAPTER 1: BACKGROUND

1.1 Osteoporosis

1.1.1 Prevalence and Burden of Osteoporosis

Osteoporosis is a skeletal disorder characterized by diminished bone mass and microarchitectural deterioration of bone tissue, leading to increased bone fragility and susceptibility to fractures (1, 2). Fractures related to osteoporosis most frequently affect the forearm, hip, spine, upper arm, and pelvis (3). In 2016, approximately 2.2 million Canadians aged 40 and older, were diagnosed with osteoporosis (3). During 2019, 665 osteoporosis-related fractures per 100,000 Canadians aged 40 and above were documented; of these 156 were specifically hip fractures. Hip fractures have the most severe consequences among osteoporosis-related fractures (3). Within the first year following a hip fracture, the risk of mortality in women is approximately 25% and 35% in men. Osteoporosis often goes undetected as it develops without symptoms, only becoming apparent when fractures occur; these lead to serious subsequent health issues and even increase the risk of death (4, 5). Fragility fractures, which occur spontaneously or following minor incidents such as falling from standing height or lower, are prevalent among those with osteoporosis (6). Vertebral fractures increase the risk of future fractures – making the probability five times higher for additional vertebral fractures and two to three times higher for fractures at other sites in the initial year following the fracture, compared to people whom have not experienced vertebral fractures (7).

In Canada, about a quarter of community-dwelling individuals transition to nursing homes within a year of sustaining a hip fracture (8). Also in Canada, the annual

cost of caring for osteoporosis-related fractures was estimated at $4.6 billion, in 2016 (9). Since the incidence of osteoporosis increases with age, the burden of the disease will get worse in the coming years. This increase is in part the result of the aging Canadian population who frequently suffers from several other health issues, which increases the risk of fractures. The growing public health concern is further exacerbated by the difficulty in precisely identifying patients who are at high risk for fractures, the underuse of proven strategies to prevent falls, the underuse of osteoporosis medication and the lack of lifestyle modifications. (10, 11).

While osteoporosis can affect anyone, the risk is not evenly distributed across all populations (12). Several factors contribute to an elevated risk of osteoporosis-related fractures, encompassing both primary and secondary causes. The literature supports notable differences in skeletal health between men and women, as well as age-related variations in osteoporosis prevalence. Women typically experience a higher incidence of fractures, particularly after menopause due to loss of estrogens which is essential for bone health. In contrast, men are more likely to sustain fractures at a younger age, primarily due to trauma (13). However, as men age, they also suffer from osteoporotic fractures, similar to women (14).

Osteoporosis prevalence varies significantly across different racial and ethnic groups due to a combination of genetic, lifestyle, environmental, and socioeconomic factors. Among elderly non-White individuals, the incidence of osteoporosis is expected to increase due to the aging population and existing disparities in healthcare access and prevention strategies (15). While this incidence is expected to rise in all groups as the population ages, these disparities may result in a more pronounced increase among

non-White elderly populations. Although fracture prevalence is lower in Black individuals compared to White adults, Black women experience higher mortality rates and greater physical impairment and financial hardship following fragility fractures (16). Non-White individuals are also more likely to be discharged without rehabilitative care following fractures. Similar disparities exist in treatment rates among Hispanic and Asian populations compared to White populations, with lower utilization of pharmacological therapies, especially among men of color (17, 18).

Individuals from lower socioeconomic backgrounds also experience higher rates of osteoporosis and fractures, compared to individuals with higher socioeconomic status (19). Individuals from lower socioeconomic backgrounds often have limited access to preventive healthcare services. This includes fewer opportunities for bone density screening, early diagnosis of osteoporosis, and timely interventions. Similarly, financial constraints limits access to effective treatments for osteoporosis, such as medications, physical therapy, and follow-up care (20). Also, lower levels of education can lead to reduced health literacy, making it challenging for individuals to understand the importance of bone health, recognize early symptoms of osteoporosis, and follow prescribed treatment regimens. They may be less aware of risk factors for osteoporosis and the importance of lifestyle changes in maintaining bone health, in comparison to individuals with higher levels of education (21). Lower socioeconomic status is often associated with poorer diet quality. For instance, individuals from lower socioeconomic backgrounds have limited access to nutrient-rich foods essential for bone health, such as fruits, vegetables, dairy products, and other sources of calcium and vitamin D. Financial constraints can lead to food insecurity, resulting in inadequate nutritional

intake that negatively affects bone density and increases the risk of fractures (22). Also, individuals from lower socioeconomic backgrounds also have fewer opportunities for regular physical activity due to lack of access to safe recreational areas, gyms, or exercise programs (23).

Comorbidities present at the time of a fracture also play an important role in subsequent clinical outcomes (24). Comorbidities associated with increased fracture risk include conditions that affect bone density and quality. For instance, Type 1 diabetes mellitus impacts bone microarchitecture by reducing BMD (25). Rheumatoid arthritis causes chronic inflammation, which affects bone health (26). Hyperthyroidism accelerates bone loss due to excessive production of thyroid hormones. Certain gastrointestinal disorders, such as celiac disease, impair nutrient absorption that are necessary for bone mass maintenance (27). Chronic obstructive pulmonary disease, which is often treated with glucocorticoids, also contributes to bone loss and leads to increased fracture risk (28).

1.1.2 Osteoporosis Diagnosis

Osteoporosis is defined by a bone mineral density (BMD) of 2.5 standard deviations equal or below the peak bone mass, corresponding to a T-score of −2.5 or less, as measured by dual-energy x-ray absorptiometry (29). Clinically, osteoporosis can be diagnosed in individuals 50 years or older who have experienced a low-trauma fracture of the hip, vertebrae, humerus, or pelvis after turning 40, or who have a 20% or greater fracture risk over the next ten years of major osteoporotic fractures as assessed by a fracture risk assessment tool (30).

BMD is associated with fracture risk; a one standard deviation (SD) decrease in BMD increases fracture risk by 1.5-fold to 2.0-fold (31). However, fracture risk is also influenced by important clinical risk factors both in addition to and independently of BMD. These clinical risk factors include age, sex, BMI, lifestyle choices and specific medical conditions and histories. Evaluating the combination of these factors with BMD measurements provides a comprehensive assessment of an individual's probability of experiencing a major osteoporotic fracture, such as those occurring in the hip, spine, humerus, and forearm (30). There are many fracture risk assessment tools of which the Fracture Risk Assessment Tool (FRAX) is the most commonly used. The FRAX calculates the absolute risk of a major osteoporotic fracture (hip, spine, humerus, and forearm) over the following 10 years (31). It incorporates a range of specific inputs: age, sex, BMI, lifestyle factors (such as excess alcohol consumption and smoking status), fracture history, a parent's history of hip fracture, use of glucocorticoids, presence of rheumatoid arthritis, and conditions leading to secondary osteoporosis. Additionally, it includes the option to input BMD measurements of the femoral neck. BMD measurement of the femoral neck provides a direct assessment of bone strength and is a strong predictor of fracture risk. Including femoral neck BMD in the FRAX calculation enhances the tool's accuracy in predicting future fractures (32). FRAX assists healthcare providers in estimating their patients’ fracture risk and is often incorporated in national clinical guidelines on treatment thresholds. FRAX is recognized and used in 64 countries, including Canada, with nearly 6 million FRAX assessments being conducted annually (33).

Early identification of patients at high risk for osteoporotic fractures is important for improving clinical outcomes and reducing the burden on the healthcare system (31, 34).

1.1.3 Osteoporosis Management and Fracture Prevention

There are several strategies to manage osteoporosis and reduce the risk for fractures (35, 36, 37). Recommendations for reducing fall and fracture risk in postmenopausal women and men aged 50 and older include physical activity and nutritional management in an integrative approach. Nutritional management for osteoporosis involves ensuring adequate intake of essential nutrients that support bone health, such as calcium and vitamin D, as well as maintaining a balanced diet rich in fruits, vegetables, and proteins. Adequate calcium and vitamin D intake is universally recommended to help reduce falls and fractures. Individuals should aim to obtain 800–1200 mg of calcium through their diet each day. If daily intake falls below 800 mg, calcium supplements are recommended. Sunlight is considered a primary natural source of vitamin D, that can be complemented by fortified foods, with supplementation recommended for those with limited sun exposure or high risk of deficiency (38).

Physical activity has been shown to play an important role in enhancing quality of life by preventing or treating degenerative diseases associated with aging (39). In fact, physical activity can effectively slow down or even reverse the decline in BMD in elderly individuals with osteoporosis (40). Even without substantial changes in bone density, exercise enhances skeletal health and reduces fall risk. Exercise maintains/improves joint flexibility and strength, contributing to better overall skeletal health. Improved posture and gait mechanics from regular exercise reduce the risk of falls and associated

fractures (41). Clinical Practice Guideline for the management of osteoporosis and fracture prevention in Canada recommend the implementation of balance and functional training at least biweekly to mitigate fall risk (30). This includes exercises that involve dynamic balance and functional movements such as Tai Chi, shifting body weight to the limits of stability (the process of moving the body's center of gravity, reaching the maximum point where balance can be maintained without needing support), and exercises that enhance the capacity to perform daily activities, like chair stands. Furthermore, progressive resistance training is advised at least twice weekly, to target major muscle groups to incrementally build muscle strength. Additionally, physical activities that are safe and adaptable, such as walking, yoga, or Pilates, are encouraged. For those at a high risk of fractures, modifications to these activities are necessary, and the engagement of exercise professionals with expertise in osteoporosis is recommended for personalized guidance on exercise intensity and progression (30).

Initiation to pharmacotherapy is recommended for postmenopausal women and men over the age of 50 who have sustained substantial previous fractures or who exhibit a 10-year fracture risk of ≥ 20% or for those that are older than 70 years with a T-score ≤ –2.5, because of the elevated subsequent fracture risk following a recent fracture (30). US guidelines for osteoporosis management suggest that treatment should be recommended for those with a 10-year fracture risk ≥ 20% or a hip fracture risk ≥3% as estimated by the FRAX (31).

First-line pharmacotherapy through bisphosphonates such as alendronate, risedronate, and zoledronic acid are recommended by the Canadian clinical practice guideline for those meeting treatment criteria, with oral bisphosphonates often preferred

due to their accessibility and lower cost (42). For those unable to tolerate bisphosphonates due to any contraindications or adverse effects, denosumab is suggested, but it requires a long-term commitment to prevent rapid bone loss and vertebral fractures after stopping the medication. Patients with a recent severe vertebral fracture or multiple vertebral fractures and a T-score ≤ –2.5 should consider anabolic therapy options like teriparatide or romozosumab. When deciding on treatment, healthcare professionals must consider both the cost and how manageable the treatment regimen will be for the patient (30, 43). Other international guidelines, including those from the American College of Physicians, the US Bone Health and Osteoporosis Foundation, and the UK clinical guideline for the prevention and treatment of osteoporosis, also recommend bisphosphonates as the first-line therapy for osteoporosis in postmenopausal females and males, while denosumab and anabolic therapies are also for individuals with intolerance or contraindications to first-line treatments or for those at higher risk (44, 45, 46).

Fracture Liaison Services are important for improving the management of osteoporosis. These coordinated care programs aim to identify, treat, and manage patients with fragility fractures, ensuring they receive appropriate evaluation and treatment for osteoporosis to prevent future fractures. The multidisciplinary approach typically involves healthcare professionals such as doctors, nurses, and physiotherapists who collaborate to provide comprehensive care and education on bone health and fracture prevention (47, 48). These services have shown improvement in the identification and timely initiation of treatment for osteoporosis, optimizing patient outcomes, and enhancing the management of fracture risk (30).

The perception of healthcare professionals towards managing osteoporosis contributes to how it is management. Primary healthcare physicians have documented concern about structural barriers to care, medication costs, adherence issues, side effects, and the reliability of information patients found independently (64). Physicians often perceive a lack of patient knowledge about osteoporosis, while patients believe both they and their doctors need more information. Osteoporosis is often seen as less important than diseases like diabetes, osteoarthritis, cardiovascular disease, and hypertension (65). There is a systemic issue that downplays osteoporosis in such a way due to its non-acute nature and its silent progression. Primary care physicians recognize the need for an integrated approach involving both primary and specialized care to improve osteoporosis management and proactive prevention of fragility fractures (66). Focus groups also indicate a need for better educational resources for both patients and providers and suggest integrating fracture risk assessment tools into electronic medical records to streamline their use (64).

1.2 Osteoporosis in Men

1.2.1 Osteoporosis in Men

Osteoporosis poses a considerable health burden in men, constituting approximately 20% of all osteoporosis cases and contributing substantially to overall fracture rates (49). Each year, Canadians endure on average 30,000 hip fractures, with 25% of these affecting men (50). Furthermore, men experience globally 33% of all vertebral and hip fractures (51). Up to 25% of men aged 50 and above will experience at least one osteoporosis-related fracture during their lifetime (1). Hip fractures are

associated with an increased mortality rate; men experiencing higher mortality rates compared to women (43) and are twice as likely to require institutionalization compared to women following a fracture (52, 53, 54).

Important differences exist between men and women concerning bone development and loss. During early life, various factors such as sex hormones, physical activity levels, and body size influence bone development, with puberty being an important period for bone formation in both sexes (55). Sex and age-related differences play an important role in bone health, influenced by the general aging process and deficiencies in sex steroids such as estrogen and testosterone, which are important for maintaining bone density and strength (56). During puberty, males enter puberty later and undergo a longer period of pubertal growth compared to females, which creates differences in bone development. Testosterone in males contributes to the development of larger skeletons and increase bone mass through various mechanisms, including conversion into estrogens and direct enhancement of bone tissue formation (57). By young adulthood, most men possess advantages that protect their bones from fragility fractures compared to women, such as higher peak bone mass, larger bone size, and greater bone strength (58, 59). Specific risk factors can influence these characteristics, such as glucocorticoid use, reduce bone formation and increase bone loss, leading to diminished bone quality and loss of microarchitectural integrity. Fractures often occur when weakened bones experience excessive strain, typically from falls or routine activities.

Factors such as limited education, lower socio-economic and living conditions, along with genetic predispositions have been recognized in various studies as risk

elements that contribute to the development of osteoporosis and fractures (60, 61, 62). Several other factors contribute to the elevated risk of fractures, Secondary osteoporosis arises from underlying medical diseases or treatments that affect bone metabolism. Endocrine disorders like hyperthyroidism and Cushing's syndrome increase bone resorption, while hypogonadism, involving reduced levels of sex hormones, contributes to bone loss. Chronic diseases such as diabetes, rheumatoid arthritis, and chronic kidney disease impair bone quality, and gastrointestinal disorders like celiac disease and Crohn's disease hinder nutrient absorption essential for bone health. Long-term use of medications such as glucocorticoids and anticonvulsants can further decrease bone density, increasing the risk of secondary osteoporosis (63, 64). It is therefore important that healthcare professionals pay attention to rule out these secondary causes of osteoporosis in men (65, 66). BMD testing is recommended for men as it is for women, in the assessment of fracture risk. However, due to men's lower fracture incidence, BMD tests are less frequently requested for men than for women. This discrepancy may arise from several factors: healthcare providers might not routinely consider osteoporosis in men, there may be a lack of awareness about the risk among men themselves, and societal perceptions often underplay the vulnerability of men to osteoporosis (67, 68).

1.2.2 Men’s Perception of the Management of Osteoporosis & Fragility Fractures

Societally, osteoporosis is often perceived as a disease predominantly affecting women (69, 70). A large care gap in osteoporosis management has been highlighted across both sexes, with worse gaps in diagnosis, therapy, and overall awareness among men (53). While 42–56% of Canadian women experiencing fragility fractures do

not receive pharmacotherapy for bone health, 90% of Canadian men with similar fractures go untreated (53). This gap stems from the fact that existing knowledge and medical practices are predominantly based on studies conducted in women and awareness of the disease among women populations (71). According to a systematic review of qualitative studies looking at men's perceptions of living with osteoporosis, men reported that they were not sufficiently informed about the risk of osteoporosis, expressing concerns over the lack of clinical expertise of their healthcare providers in managing their disease (72). Furthermore, some men compared receiving an osteoporosis diagnosis to being labeled as a "post-menopausal woman," emphasizing the impact of gender stereotypes on their self-image. This perception often made them feel as though they were forced into adopting a less masculine identity, posing challenges in their personal lives (73). Men reported a noticeable lack of attention in clinical settings regarding osteoporosis, in comparison to women. Many felt that health providers often overlooked the possibility that men could suffer from osteoporosis, leading to frustrations about being inadequately informed about their risk and the impact of medications designed primarily for women (72). Healthcare providers have been less likely to offer osteoporosis treatment to men, and men have been less inclined to accept treatment even after it has been recommended or prescribed (70). The broader topic of men experiencing female-associated diseases will be addressed in detail later in section 1.4.2.

In a qualitative study examining older Canadian men's experiences and behaviours regarding bone health after a fragility fracture, it was highlighted that, following a fracture, men predominantly reported discontinuing activities instead of

adopting new, health-promoting ones (70). This contrasts with women, who become more cautious and engage in healthier behaviors following a fracture. Similarly, in other musculoskeletal diseases, older women have been observed adapting their lifestyles to manage their disability—balancing the loss of certain activities with new, compensatory behaviors. Yet, men are generally less proactive in health-related behaviors, such as seeking medical information online, compared to women (74).

Educational interventions in bone health should be specifically designed for men, as currently available programs effective in women do not resonate with men (70). Targeted educational programs could enhance men's understanding, health perceptions, and preventive actions regarding osteoporosis (75).

1.3 Self-efficacy

1.3.1 Self-Efficacy in Chronic Disease Management

Self-efficacy is a psychological concept developed by Albert Bandura which describes a person's confidence in their ability to carry out actions and accomplish particular goals (76). Self-efficacy is defined by one's confidence in using one's current ability to accomplish goals. It has an important role in how individuals approach objectives, carry out tasks, and deal with challenges (77). Self-efficacy influences the cognitive processes involved in goal-setting and problem-solving. Individuals with high self-efficacy in general set challenging goals and maintain a strong commitment to achieving them (78). Higher self-efficacy also leads to more effort and perseverance, since individuals with high self-efficacy are more likely than those with low self-efficacy to attribute failure to a lack of effort or adverse conditions, rather than a lack of ability,

and so they maintain a proactive approach to overcoming obstacles (79). Individuals with high self-efficacy are more likely to see possible risks as controllable and bounce back from setbacks fast. When faced with challenging circumstances, they feel less depressed and anxious than those who have less self-efficacy (80). Self-efficacy as a concept has an important role in many fields. In the workplace, self-efficacy can impact job performance and career advancement. In sports, athletes with high self-efficacy are more likely to achieve peak performance and recover from injuries. In healthcare, it influences patients' ability to manage chronic diseases, adhere to treatment regimens, and engage in health-promoting behaviors.

Self-efficacy plays such an important role in managing chronic diseases, because it is associated with a variety of health behaviors. Patients with high self-efficacy are more likely to adhere to prescribed medications, follow dietary guidelines, and maintain regular exercise routines than patients with low self-efficacy. This adherence is important for managing chronic illnesses effectively and preventing complications (81). High self-efficacy allows patients to actively monitor their health status, recognize symptoms, and report them to healthcare providers. Highly self-efficient individuals with Type 2 diabetes mellitus, for example, are more likely to regularly check blood glucose levels and adjust insulin doses accordingly (82). Patients with high self-efficacy are more confident in their ability to make and sustain health behaviour changes, such as quitting smoking, reducing alcohol consumption, or adopting a healthier diet (83). Self-efficacy also enhances a patient's ability to make informed decisions about their health. For instance, a hypertensive patient with high self-efficacy might be better at identifying how stress affects their blood pressure and to

use strategies for managing stress, than someone with the same condition with lower self-efficacy (84). High self-efficacy has an important role in motivating individuals to actively participate in preventive health behaviors. For example, individuals with strong self-efficacy are more likely to engage in regular physical activity, which can help maintain a healthy weight, strengthen their cardiovascular system, and improve their overall physical fitness (85). Additionally, they are more inclined to manage their weight effectively through balanced nutrition and portion control, reducing the risk of obesity-related complications. Individuals with high self-efficacy are more inclined to attend routine medical check-ups and screenings, allowing for early detection and management of any potential health issues. These proactive behaviors are useful for managing chronic diseases, such as diabetes, hypertension, and osteoporosis, as they can prevent the progression of these diseases and reduce the likelihood of severe complications. By consistently engaging in these preventive behaviors, individuals can better their health outcomes and quality of life (86). Overall, higher self-efficacy is associated to improved outcomes, which in turn, ultimately reduces the strain on the healthcare system (87).

Self-efficacy is generally measured using validated questionnaires and scales that assess an individual's confidence in their ability to perform specific tasks or behaviors. The General Self-Efficacy scale (GSE) and the Self-Efficacy for Managing Chronic Disease 6-Item Scale, which provide reliable and valid assessments of self-efficacy across various contexts, are commonly used tools to measure general self-efficacy (88, 89). The GSE scale was designed to assess general perceived self-efficacy to predict how individuals deal with daily challenges and adapt after

experiencing stressful life events. The Self-Efficacy for Managing Chronic Disease 6-Item Scale measures an individual's confidence in managing symptoms and challenges associated with chronic diseases. These tools have been tested in-depth for accuracy and have been widely accepted in both clinical and research settings (90, 91).

1.3.2 The Role of Self-Efficacy in Osteoporosis Management and Fall Prevention

Self-efficacy influences osteoporosis management and prevention behaviors in several ways. Individuals with high self-efficacy are more likely to adhere to taking prescribed medications. They believe in their capacity to manage the complexities of their treatment and are better equipped to handle side effects and other barriers. Also, having a strong sense of self-efficacy in the effectiveness of osteoporosis medication empowers individuals and fosters a favorable attitude towards the medication (81).

Higher osteoporosis management self-efficacy is associated with better adherence to calcium intake, vitamin D supplementation, and regular weight-bearing exercises, as studied in post-menopausal women (92). Educational programs combined with physical activity interventions, such as resistance training, have been effective in increasing osteoporosis self-efficacy among older adults, which leads to better bone health and reduced fracture risk (93).

A calcium-rich and balanced diet is essential for bone health. Individuals with high self-efficacy are more likely to make and maintain dietary changes, to ensure the adequate intake of calcium and vitamin D in their diet (94). This confidence in their ability to influence their own health outcomes allows them to seek out and consume nutrient-rich foods to manage their osteoporosis. These individuals are often more

proactive in educating themselves about nutrition and might seek the guidance of healthcare professionals to optimize their diet.

Individuals who have a high level of self-efficacy are more inclined to research osteoporosis and how to manage it because they think they can make a beneficial impact on their health. This confidence motivates them to be proactive in learning about their disease. They actively research and gather information on osteoporosis, including its causes, symptoms, and progression (95). They also make an effort to understand and weigh the advantages and disadvantages of various treatment alternatives, including drugs, dietary modifications, and lifestyle changes (96). Furthermore, those who have a high level of self-efficacy also stay up to date on recent advancements in the treatment of osteoporosis (95).

1.3.3 Assessing Self-Efficacy in Osteoporosis Management: Tools and Importance

Self-efficacy plays an important role in managing and preventing osteoporosis. Since high levels of self-efficacy are consistently associated with better health outcomes and improved quality of life, it is important to measure this concept in a clinical setting. Healthcare professionals can identify patients who can benefit from additional support and customized interventions by measuring their self-efficacy.

The Osteoporosis Self-Efficacy Scale (OSES) is a validated tool designed to measure the self-efficacy of individuals in managing their osteoporosis (97). This scale was based on Bandura's theory of self-efficacy. The OSES has demonstrated high internal consistency, with Cronbach's alpha values typically ranging from 0.90 to 0.93 for the total scale. Each subscale also shows strong internal consistency, with alpha values above 0.85 (98). The scale has been validated through correlations with other measures

of health behaviors and outcomes. For instance, higher OSES scores have been associated with greater engagement in osteoporosis-preventive behaviors, such as exercise and calcium intake (99). The OSES has been used in various studies involving different populations, including postmenopausal women, older men and women over the age of 50, and individuals at risk of osteoporosis. The scale has also been adapted and validated in multiple languages and cultural contexts.

The OSES scale evaluates multiple dimensions of self-efficacy related to osteoporosis management, including confidence in participating in weight-bearing exercises, maintaining a calcium-rich diet, and preventing falls. This scale contains two primary subscales: the Exercise Self-Efficacy Subscale and the Calcium Intake Self-Efficacy Subscale. The Exercise Self-Efficacy Subscale score ranges from 0-600 and assesses the confidence of a person in their ability to engage in physical activities that promote bone health, with questions on performing weight-bearing exercises, belief in maintaining a consistent exercise routine and on confidence in engaging in exercises that improve balance and coordination to reduce the risk of falls. This Calcium Intake Self-Efficacy Subscale score ranges from 0-600 and evaluates the confidence of individuals in their ability to seek out and maintain a calcium-rich diet, essential for bone health, through questions on the consumption of calcium-rich food, the belief in the ability to adhere to calcium supplement plans when dietary intake is insufficient, and on the confidence in making informed dietary choices that support appropriate calcium intake. The OSES uses a Likert scale format, typically ranging from 0 (not at all confident) to 100 (very confident). The scale score ranges from 0-1200. The optimal cut-off point of OSES for predicting osteoporosis was determined to be 858 (100). Higher

scores indicate greater self-efficacy in managing osteoporosis through exercise and calcium intake. OSES is an example of a clinical tool that allows for individualized care since healthcare providers can identify patients with low self-efficacy who may require additional support, education, and intervention.

When studying differences between older men and women of the OSES, men reported higher self-efficacy in exercise, while women reported higher self-efficacy in dietary calcium intake (101). The study found that men felt more confident than women when it came to exercise for bone health. They believed they could start and stick to an exercise routine, even if it was difficult. On the other hand, women felt more confident about getting enough calcium from their diet, including eating calcium-rich foods and taking supplements regularly. Understanding what variables impact men's confidence in health self-management can help create better strategies for preventing and managing osteoporosis (101).

1.3.4 Falls and Their Impact on Adults with Osteoporosis

Falls are an important concern for adults with osteoporosis and are a leading cause of injury in older adults (102). Adults with osteoporosis are more likely to experience fractures following a fall compared to those without the disease (103). Fractures cause individuals to be more cautious in their movements, which in turn can further affect balance and increase fall risk (104). Chronic pain from osteoporotic fractures can also alter posture and lead to falls (105). Muscle weakness, associated with sarcopenia, impairs balance and coordination (106). Fear of falling is one of the most prevalent psychological impacts of osteoporosis. This fear can develop after a fall or even in anticipation of a fall due to the knowledge of their fragile bone condition. Fear

of falling can become a persistent concern, creating a cycle where the fear itself heightens the likelihood of future falls (107). The fear of falling can lead to reduced physical activity since individuals become more cautious and avoid situations where they perceive a high risk of falling. This avoidance can result in decreased muscle strength, balance, and overall physical fitness, further increasing the likelihood of falls (108). Additionally, fear of falling can contribute to social isolation, as individuals may withdraw from social activities and interactions to avoid potential fall risks. This isolation can negatively impact mental health, leading to feelings of loneliness, depression, and decreased quality of life (109).

Falls efficacy is the psychological concept which is defined by the confidence individuals have in their ability to avoid falls during everyday activities (110). Belief in one's ability to prevent falls plays an important role in promoting behaviors aimed at reducing fall risks. Individuals with high self-efficacy are more likely to engage in various fall prevention strategies (111).

High falls efficacy is associated with reduced fear of falling and greater engagement in daily activities, improved physical fitness, and overall better quality of life, while low falls efficacy can lead to activity restriction, decreased physical health, and increased fall risk. A history of falls can negatively affect falls efficacy. Strength training programs have been effective in boosting falls efficacy and reducing fall incidence (112). Balance training exercises, like tai chi and yoga, enhance stability and coordination, and individuals confident in their ability to benefit from these activities are more likely to participate regularly, leading to better balance and reduced fall risk (113).

Making home and community environments safer by reducing tripping hazards, installing grab bars, and improving lighting can increase confidence and reduce fall risk (111). Canes and walkers are examples of assistive equipment that offer extra stability and support, particularly for those with mobility problems. Individuals who have confidence in their ability to use these devices efficiently are more likely to integrate them into their daily routines, which lowers the risk of falls dramatically (114). Rearranging furniture, installing handrails, tightening loose carpets, and upgrading lighting can all contribute to making a home safer and reducing the risk of falls. Individuals with high falls self-efficacy are more likely to take the initiative to make these modifications and maintain a safer home environment (111). Individuals feel encouraged to take proactive measures to improve their safety, lower the frequency of falls, and promote overall well-being and independence when they have a strong belief in their ability to prevent falls. This is especially true for older adults and those with chronic illnesses that limit their mobility (115). Educating individuals about fall prevention strategies and training them to navigate their environments safely can also improve falls efficacy.

For patients with chronic illnesses affecting mobility, such as Parkinson's disease, higher falls efficacy is associated with better management of symptoms and increased independence in daily activities (116). Improved falls efficacy can lead to more active and independent lifestyles, which lowers the likelihood of social isolation and the consequences that go along with it. Increased engagement in social, recreational, and everyday activities is encouraged by increased confidence in preventing falls, which improves general well-being.

1.3.5 Measuring Falls Efficacy: The Falls Efficacy Scale-International

The Falls Efficacy Scale-International (FES-I) was developed to assess an individual's fear of falling during various social and physical activities, both indoors and outdoors (117). The full version of the FES-I consists of 16 items that cover a wide range of daily activities, such as getting dressed, taking a bath or shower, and walking on different surfaces. The FES-I has demonstrated high internal consistency with Cronbach's alpha values typically above 0.90. Higher FES-I scores (indicating greater concern about falling) have been associated with a higher likelihood of future falls, reduced physical activity, and poorer functional outcomes (117). The FES-I has been used widely across various populations, including older men and women, individuals with chronic illnesses, and those with a history of falls. It has been validated and used in multiple countries and cultural contexts. Both men and women report similar patterns of concern regarding falls in relation to daily activities.

Each item is scored on a four-point scale, where 1 indicates no concern and 4 indicates severe concern about falling. The Falls Efficacy Scale-International short version (FES-I short) was developed for shorter assessments (118). The shorter version allows healthcare providers to assess falls efficacy more quickly, making it suitable for settings where time is limited, such as busy clinics or during home visits. Older adults may have limited energy. Hence, a shorter assessment reduces the burden on these individuals, making it easier for them to complete the evaluation without fatigue or frustration. In general, shorter assessments are generally associated with higher response rates and minimizes the risk of participant dropout (119).

The FES-I includes 7 items selected from the full scale, maintaining the core elements to keep the essential components and lessen the workload for practitioners and respondents. The total scores range from 7-28, with higher total score indicates a greater concern about falling, reflecting lower falls efficacy. The information from the FES-I can help create educational programs that teach individuals how to make their homes safer and change certain habits to reduce the risk of falling.

1.4 Conformity to Masculine Norms

1.4.1 Gender Identity in Clinical Research

Sex refers to the biological differences between males and females, such as chromosomes, hormones, internal and external sex organs. Sex is usually assigned at birth based on physical characteristics (120). Gender, on the other hand, refers to the roles, behaviors, expectations, and societal norms that different societies consider appropriate for men, women, and non-binary individuals. Gender is a social and psychological construct that can vary across different cultures and over time (120).

The definition of gender has frequently been reduced to a binary construct in clinical research. This method of characterising gender as binary perpetuates misleading and oversimplified understandings of gender (121). However, gender is now being defined by the four main facets of: (a) physiological/bodily characteristics (e.g. genitalia); (b) gender identity ; (c) legal gender; and (d) social gender in terms of norm-related behaviours (122). Although this definition of an individual's gender allows for a comprehensive assessment, this can change over time through the influence of external factors (e.g., individual experiences and social influences) (123).

Gender identity, for example, can result health disparities, as transgender and non-binary individuals often face discrimination, stigma, and barriers to healthcare, leading to poorer health outcomes (124). Understanding and integrating gender identity correctly as a facet into clinical research is essential for ensuring that medical studies are inclusive, equitable, and relevant to all populations. The Gender Identity/Gender Dysphoria Questionnaire for Adolescents and Adults is an example of a self-reported survey tool used to measure gender identity. To assess gender identity and roles, instruments such as the Bem Sex-Role Inventory and the Gender Role Expectations of Pain questionnaire are used. Implicit Association Tests such as the Gender-Cognition Implicit Association Test measures the strength of automatic associations between gender categories and self-related concepts. It is used to assess implicit gender identity, revealing unconscious biases and internalized gender norms. Finally, the Single-Item Gender Identity Measure involves a single question asking respondents to select their gender from a list of options, which can include male, female, transgender, non-binary, genderqueer, and an open-ended "other" option. Such a single-item measure is straightforward and easy for respondents to understand, reducing confusion and ensuring higher quality responses. It also takes less time to answer, which can be helpful in surveys with many questions, improving overall response rates. The open-ended option allows respondents to describe their gender identity in their own words, ensuring that everyone can express their identity accurately.

1.4.1 Gender differences in Health Perceptions and Behaviours

Most early scientific research was conducted on male subjects, under the assumption that the results would be applicable to all sexes and genders. Being aware

of health differences between men and women led to more gender-specific research. For example, cardiovascular disease symptoms and outcomes can differ between men and women. More studies now examine how diseases affect women or other minority groups differently, leading to more tailored treatment guidelines.

Gender influences how individuals experience and respond to illness (125). Men have a 43% higher age-adjusted death rate and die at higher rates from 12 of the 15 leading causes of death, including heart disease and cancer, compared to women (126). Women generally perceive their health less favorably and are more likely to report symptoms and seek medical advice. They are more aware of the changes in their bodies, which may lead to earlier detection of health issues (125). Women are generally. more proactive in managing their health, often engaging in preventive care and regular check-ups. They are more likely to use healthcare services for themselves and their families, reflecting their roles as primary caregivers. They also live longer but experience more chronic, non-life-threatening diseases such as arthritis, osteoporosis, and autoimmune diseases (127).

Men often perceive their health more positively than women, even when facing similar health issues. They tend to underreport symptoms and delay seeking medical help, viewing illness as a threat to their masculinity and independence (128). While women more likely to engage in health-seeking behavior (129), men are prone to participate in more than 30 behaviors that heighten their risk of illness, injury, and early mortality. These behaviors are linked to traditional constructions of masculinity, which emphasize toughness, self-reliance, and risk-taking (130). Men are more likely to ignore minor health issues compared to women and seek medical help only when conditions

become severe. This reluctance is influenced by cultural norms that associate masculinity with toughness and self-reliance (131).

1.4.2 Men who Experience Female-Associated Diseases

Men engage in riskier health behaviors and are less likely to seek healthcare, which contributes to poorer health and shorter lifespans compared to women (126). Men with diseases typically associated with women may experience stigma and social isolation (132). Examples of female-associated diseases are breast cancer, lupus erythematosus, thyroid disorders and osteoporosis. The stigma associated to these diseases may worsen the impact of the illness by causing embarrassment, hesitation to talk about symptoms, and postponing getting medical attention (133). Also, support groups and resources are often geared towards women, leaving men without appropriate support networks. So, men may find it difficult to relate to predominantly female support groups, leading to feelings of exclusion and loneliness. Also, these conditions can strain personal relationships. Partners may struggle to understand the unique challenges faced by men with female-associated diseases, leading to misunderstandings and tension.

Men who experience these diseases also face barriers in the healthcare system, including misdiagnosis or delayed diagnosis due to lower likelihood of these diseases being suspected in men. There also is a lack of gender-specific information and resources, making it harder for men to find relevant advice and support (134). Due to these factors, men can face many issues in their life in relevance to their illness. Men are often socialized to avoid expressing vulnerability or admitting to health issues, which can lead to underreporting symptoms and poor communication with healthcare

providers, which can delay diagnosis and worsen the prognosis of the illness (135). As a result, addressing the unique challenges faced by men with female-associated diseases requires a multifaceted approach that includes increasing awareness, improving healthcare provider training, and developing gender-specific support resources to ensure that men receive the appropriate care and support they need.

1.4.3 Masculinity Influences on Health-Seeking Behaviors

Traditional masculine norms influence men's health behaviors, leading to higher risks of mortality and morbidity (126). These norms dictate men's attitudes towards health and their utilization of healthcare services, often resulting in decreased health outcomes. These traditional masculine norms, such as being tough, self-reliant, and avoiding vulnerability, discourage men from seeking medical care. Men often view seeking healthcare as incompatible with their masculine identity (131). The feminization of healthcare, where being a passive recipient of medical treatment is seen as less masculine, further discourages men from seeking help (131). To identify the root causes of masculinity-related health issues and to reduce health disparities in men, an ecological model approach is often used (136). On a societal level, societal norms expect men to endure pain and avoid showing vulnerability. On an organizational level, men often distrust the healthcare system, perceiving doctors as unhelpful or incompetent. On an interpersonal level, men prioritize their family's financial needs over their own health concerns. And lastly, on an individual level, men often justify seeking healthcare only when their condition becomes severe or debilitating (131). Men who embrace traditional masculine norms are more likely to engage in behaviors like substance abuse, violence, aggression, and less utilization of preventive health care

(126). Women also serve as a reference group for men's health behaviors. On one hand, men's fear of being perceived as feminine drives them to engaging in behaviors contrary to those they associate with women (e.g., consuming high-fat foods when he sees women opting for low-fat options, or avoiding medical treatment when he notices women attending medical appointments) (126). On the other hand, men might regard women as a reference group because women provide valuable information about health behaviors. For example, perceptions of both men's and women's attitudes toward consensual sex and their willingness to act against sexual violence influence individual men's behaviors (137). Additionally, men's perceptions of other men's and women's health behaviors can influence their own health behaviors. Traits such as toughness, self-reliance, and avoidance of vulnerability often lead to delayed medical appointments and neglect of preventive health measures. Seeking medical help is sometimes perceived as a loss of control and an admission of weakness, which is contrary to traditional masculine identity. This attitude results in avoidance of healthcare services and reluctance to engage in health-promoting behaviors perceived as feminine, such as walking for exercise and healthy eating (138).

However, masculinity also influences health-seeking behaviors positively. Recognizing the positive aspects of masculine identity in health promotion interventions is important. Traditional masculine attributes often include being a leader, having a strong work ethic, and maintaining a masculine physique. These traits foster a sense of responsibility, motivating men to engage in health-promoting behaviors such as staying physically active, eating well, and ensuring adequate rest. The belief that maintaining good health is integral to fulfilling their roles as strong and capable providers highlights

the connection between masculinity and health (139, 140). Physical activity plays an important role in health behaviors, with many men viewing participation in sports and maintaining an athletic physique as ways to demonstrate their masculinity. As men age, they often become more health conscious. This proactive approach to health management includes smarter eating habits and a focus on preventing health issues, reflecting a shift towards a more health-aware masculinity (139).

Perseverance, particularly in overcoming challenges, also positively influences health behaviors. This resilience motivates many men to adopt and maintain healthier lifestyles despite external stressors. Perseverance is seen as a key attribute that can lead to better health outcomes, reinforcing the idea that positive aspects of masculinity can be harnessed to improve health behaviors (139). Traits such as responsibility, self-reliance, and perseverance can be integrated into health programs to resonate more effectively with men.

Overall, understanding both the positive and negative influences of masculinity on health behaviors is important for developing targeted interventions that encourage positive behavior change while respecting and incorporating gender role norms.

1.4.4 Ascertainment of Masculine Norms

Masculine norms refer to the socially constructed expectations and behaviors traditionally associated with being male. Masculinity norms establish a framework outlining how men are expected to act, think, and present themselves within a social context (141). Adherence to masculine norms is a key contributor to men’s lower life expectancy and higher rates of morbidity, since they feel discouraged from seeking medical help or engaging in preventative health measures (142).

Understanding how the aspects of masculine norms impact health behaviours can help identify health disparities between men and women and among different groups of men, leading to targeted interventions that address specific needs.

Certain validated tools have been developed to help quantify the degree to which individuals adhere to traditional societal masculine norms and how these norms influence their behaviors and attitudes. The Male Role Norms Inventory-Revised evaluates traditional masculine role norms, focusing on seven dimensions: Avoidance of Femininity, Negativity toward Sexual Minorities, Self-Reliance through Mechanical Skills, Toughness, Dominance, Importance of Sex, and Restrictive Emotionality. It includes 53 items and has demonstrated good reliability and validity. The Male Role Norms Inventory-Revised is another tool useful for examining specific traditional male role norms and their implications on behavior and attitudes.

The Gender Role Conflict Scale measures the stress and conflict men experience when they feel they are not meeting societal expectations of masculinity. It includes dimensions such as Success, Power, and Competition; Restrictive Emotionality; Restrictive Affectionate Behavior Between Men; and Conflict Between Work and Family Relations. This scale helps identify the psychological impact of conforming to masculine norms and how it affects men's mental health and well-being.

The Bem Sex Role Inventory assesses how well individuals conform to traditional gender roles, categorizing them as masculine, feminine, androgynous, or undifferentiated based on their responses. It provides insight into gender role adherence and its implications on behavior and self-perception.

1.4.5 Development and Validation of the Conformity to Masculine Norms Inventory

These existing traditional measures of masculinity often do not fully capture the wide range of actions, attitudes, and beliefs that constitute masculinity. So, in order to adequately measure quantitative adherence to traditional masculine norms, the Conformity to Masculine Norms Inventory (CMNI) was developed (143). The CMNI is one of the most widely used tools for measuring adherence to traditional masculine norms. The CMNI is considered more comprehensive than the other mentioned tools due to its wide range of dimensions covering various aspects of masculinity. The CMNI has undergone extensive validation studies, demonstrating strong psychometric properties, including high reliability and validity. Overall, the CMNI's relevance to health research is particularly important, since adherence to masculine norms has been linked to health behaviors and outcomes. Hence, by using the CMNI, researchers can better understand how masculine norms influence men's health behaviors, such as seeking medical help or engaging in preventive health measures and develop targeted interventions.

The CMNI was designed to measure conformity to traditional masculine norms across 11 dimensions:

1. Winning: The importance placed on competition and achieving success.
2. Emotional Control: The degree to which men are expected to suppress emotions and avoid emotional expression.
3. Risk-Taking: The tendency to engage in behaviors that involve risk or danger.
4. Violence: The acceptance of aggression and physical force as a means of solving problems.

5. Dominance: The expectation for men to assert control and authority over others.
6. Playboy: The endorsement of a promiscuous and sexually dominant lifestyle.
7. Self-Reliance: The belief in being independent and self-sufficient.
8. Primacy of Work: The prioritization of career and work-related success over other aspects of life.
9. Power over Women: The belief in male superiority and dominance over women.
10. Disdain for Homosexuals: Negative attitudes and behaviors towards homosexual individuals.
11. Pursuit of Status: The drive to achieve social status and recognition.

The specific domains included in the CMNI were chosen based on theoretical and empirical research that identified key aspects of masculinity that are commonly emphasized in Western cultures. These domains reflect the behaviors, attitudes, and traits traditionally associated with being male. The CMNI has demonstrated high internal consistency across these various domains, indicating that the items within each domain are highly correlated and measure the same underlying construct (143). Additionally, the CMNI has exhibited good test-retest reliability, suggesting that it can produce stable and consistent results over time. Test-retest reliability is assessed by administering the same test to the same group of people at two different points in time and calculating the correlation between the two sets of scores. The CMNI was originally developed and validated primarily focusing on young adult men. This population was chosen because young adult men are at a developmental stage where adherence to masculine norms is particularly salient and can impact their behavior and mental health (143).

The original CMNI consists of 94 items. Despite being comprehensive, the 94 items can be time-consuming to administers and demanding for respondents. The Conformity to Masculine Norms Inventory-22 (CMNI-22) was developed to be used in clinical and research settings (144). The CMNI-22 was designed to cover the same dimensions as the original CMNI. This includes dimensions like Winning, Emotional Control, Risk-Taking, Violence, Dominance, Playboy, Self-Reliance, Primacy of Work, Power over Women, Disdain for Homosexuals, and Pursuit of Status. Each dimension is represented by 2 questions from the original tool. To identify the 2 items that would be included in the CMNI-22, item-total correlations were calculated and items with higher item-total correlation were chosen, where respondents who scored high (or low) on the dimension also scored high (or low) on that particular item. Items with higher item-total correlations are considered better representatives because they contribute more to the internal consistency and reliability of the dimension (145). Items with higher factor loadings were selected because they are stronger indicators of the construct, meaning they accurately represent the dimension being measured. These items have a high correlation with the underlying domain being assessed, making them better at reflecting the true nature of the construct (144). After selecting the items, the CMNI-22 underwent psychometric testing to ensure its reliability and validity. The CMNI-22 consists of 22 items, each representing different dimensions of traditional masculine norms. These items are scored using a Likert scale, typically ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). To ensure that higher scores consistently indicate greater conformity to masculine norms, some items are reverse scored. This means that for these specific items, the scoring is flipped (i.e., 1 becomes 4, 2 becomes 3, 3 becomes 2, and 4

becomes 1) to maintain consistency in the interpretation of the results. The total CMNI-22 score is obtained by summing the scores of all 22 items. This total score represents the overall level of conformity to masculine norms. Higher scores indicate greater conformity to traditional masculine norms, while lower scores indicate lower conformity to traditional masculine norms or adherence to more progressive or flexible views on masculinity (144).

1.4.6 Use of the Conformity to Masculine Norms Inventory in Clinical Studies

The CMNI is widely used in clinical studies to understand how adherence to these norms impacts men's health behaviors, attitudes, and outcomes. Several studies have explored the relationship between conformity to masculine norms and mental health. High conformity to masculine norms has been linked to increased levels of psychological distress, depression, and anxiety. This is partly because traditional masculine norms discourage the expression of vulnerability and seeking help, leading to poor mental health outcomes (146, 147). Masculine norms often include self-reliance and the avoidance of negative emotions, which can lead to increased mental health issues, including depression (148). While CMNI scores tend to decrease with age, the relationship between masculine norms and depression strengthens with age (146). Men who conform strongly to masculine norms are also more likely to engage in risky behaviors, including substance use. This includes higher rates of alcohol consumption, smoking, and drug use, often as a means to assert masculinity or cope with stress (149).

Conformity to masculine norms influences preventive health behaviors, such as seeking medical advice, undergoing regular check-ups, and adhering to treatment

regimens. Men with high conformity to masculine norms are less likely to engage in preventive health behaviors, which can lead to delayed diagnoses and poorer health outcomes (150).

1.4.7 Specific Conformity to Masculine Norms Inventory Domains and their Relation to Clinical Outcomes

The different domains of the CMNI explore different facets of masculinity. Scores on these domains can vary depending on several factors. There are variations in the domain scores associated with different race & ethnicities. Overall, among older African American men, for example, masculinity often negatively impacts health-related behaviors (139). Avoidance of medical appointments was frequently mentioned, and other positive health behaviors, such as walking for exercise and healthy eating, were often perceived as unmanly and therefore not adopted. When comparing CMNI domain scores between White and Asian American college students, Asian Americans scored higher on Heterosexual Self-Presentation, Power Over Women, Primacy of Work than White individuals (151). Similarly, when using CMNI domains to analyze adherence to specific masculine norms, younger persons tend to score higher on factors related to Violence, Risk-Taking, and Winning. On the other hand, middle-aged and older persons score higher in domains pertaining to Emotional Regulation and Self-Reliance (152).

A study examining the engagement in yoga among men and women found variations in how masculine norms influence participation. While men were more likely to participate in yoga as a supplementary activity to other sports or physical activities, women were more motivated by mind-body integration, health and positive affect. The study highlighted that men who adhered more strongly to traditional masculine norms

were less likely to participate in yoga, viewing it as a feminine activity. These male yoga participants scored higher on domains such as Emotional Control and Heterosexual Self-Presentation compared to female participants.

By studying variations in domain scores, we can identify at-risk behaviors and develop targeted effective prevention and treatment strategies to better health outcomes.

CHAPTER 2: RATIONALE & OBJECTIVES

2.1 Study Rationale

Although more frequent in women, men suffer one-third of all osteoporosis-related fractures in the world (51). Currently, the literature on osteoporosis management self-efficacy focuses almost exclusively eon postmenopausal women. Qualitative studies on the experiences of men with skeletal fragility are limited. Men report a gap in the clinical expertise surrounding the management of their osteoporosis (53). Sex- and gender-biased assessments influence healthcare professionals' perception and expertise in the prevention and management of fragility fractures in men (70). These gendered views can impact the adherence to intervention programs, as they directly reflect on the levels of perceived self-efficacy one may have towards the betterment of their lifestyle (93). Differences in osteoporosis self-efficacy between men and women have been reported (99). A better understanding of these differences can inform the development of targeted interventions for men at risk of fractures.

Reducing fall risk and managing bone health starts with understanding men's perceptions surrounding this aspect of their health to develop interventions that impact outcomes that are important to them. No study has evaluated the influence of gender identity and levels of conformity to societal masculine norms in older men on their view of self-efficacy in exercise initiation and osteoporosis management to prevent falls and fractures.

2.2 Study Objectives

We posed the following research question: How does conformity to societal masculine norms in older men at high risk for fractures impact their perception of self-efficacy in osteoporosis management, exercise, and fall prevention?

Our hypothesis was that men who exhibited higher conformity to societal masculine norms would perceive lower osteoporosis management self-efficacy.

Our primary objectives were to:

1. Describe men's perception of self-efficacy in osteoporosis management, specifically in exercise participation, dietary calcium intake and fall prevention, and compare those with high conformity to societal masculine norms to those with low conformity to societal masculine norms;
2. Determine the association between levels of conformity to societal masculine norms and the perception of self-efficacy in osteoporosis management, specifically in exercise participation, dietary calcium intake and fall prevention in the study population

Exploratory secondary objectives were to:

1. Explore whether habitual exercise participation modifies the association between levels of conformity to societal masculine norms and the perception of self-efficacy in osteoporosis management;
2. Explore whether the presence of depressive symptoms modifies the association between levels of conformity to societal masculine norms and the perception of self-efficacy in osteoporosis management.

CHAPTER 3: METHODOLOGY & RESULTS

3.1 Methods

We conducted a cross-sectional survey among Canadian men 60 years and older at high risk of fracture.

3.1.1. Survey Design

The survey instrument, comprising 66 close-ended questions, was collaboratively created by a multidisciplinary team, encompassing clinicians, patient partners, and researchers with specialized knowledge in bone health, physical exercise, and adherence to health interventions. We created our survey to obtain demographic information, gender identity, adherence to masculinity norms, participants' self-perceived efficacy in managing osteoporosis, self-efficacy in preventing falls, and mood-related symptoms. To ensure the validity of the survey we incorporated previously developed and validated questionnaires (153). The survey was tested in a pilot phase with patient partners. Validated tools were included such as the Osteoporosis Self-efficacy scale (OSES) (97), the Short-Form Falls Efficacy Scale-International (FES-I) (118), the Godin Leisure-Time Exercise scale (GLTEQ) (154), the Patient Health Questionnaire-8 scale (PHQ-8) (155), and the Conformity to Masculine Norms-22 (CMNI-22) (143) (Table 1).

This self-administered survey was developed in both English and French, to allow for a wider spectrum of participants. To minimize robotic manipulation (robots answering the questionnaire or manipulating the answers), we did not offer a reward (monetary or prize) for participation and ensured to have at least one open-ended question and inserted questions where answer patterns were reversed (156).

Table 1 Validated questionnaires in survey

Validated Tools	Nº of Items	Scale Type	Measure
Sex at birth & Gender Identity (157)	2	Sex at birth question options: male, female Gender identity question options: male, female, indigenous or other cultural identity, other	Gender and sex-based differences in osteoporosis and self-efficacy outcomes
Conformity to Masculine Norms Inventory-Short Version (CMNI) (144)	22	Level of adherence to societal masculine behaviours 4-pt Likert scale 0=strongly disagree to 3=strongly agree Range: 0-66 points	Gender role beliefs
Godin Leisure-Time Exercise questionnaire (GLTEQ) (154)	3	Weekly frequency of engaging in three types of physical activities Total Weekly Leisure Activity Score = (9×Strenuous) + (5×Moderate) + (3×Mild) Range: 0-119 pts Threshold for moderate activity ≥ 14	Self-reported leisure-time physical activity
Patient Health Questionnaire-8 (PHQ-8) (155)	8	Bi-weekly frequency of depressive symptoms 4-pt Likert scale 0=not at all to 3=nearly every day Range: 0-24 pts Threshold for major depression ≥ 10: Threshold for severe major depression ≥ 20	Depression levels in research and clinical settings
Osteoporosis Self-Efficacy Scale (OSES) (97)	12	Confidence to perform osteoporosis management related behaviours 0-100 scale 0=not at all confident to 100=very confident Range: 0-1200 pts Threshold for high OSES efficacy ≥858	Levels of self-efficacy for exercise and calcium intake
Short-Form Falls Efficacy Scale (FES-I) (118)	7	Confidence in avoiding falls while performing daily activities 4-pt Likert scale 1=not at all concerned to 4=very concerned Range: 7-28pts Threshold for high concern about falling ≥14	Fear of falling in community-dwelling older adults

3.1.1.1 Pilot testing

The initial survey instrument, consisting of 70 items, was subjected to a pilot testing procedure. This process engaged five patient partners whose demographic profiles corresponded closely with the target study population. An online meeting was convened to introduce the project's objectives. The patient partners were tasked with evaluating the survey's clarity, the time required for completion, respondent burden, and overall comfort with the content. Pilot participants' individual responses to the survey items were not recorded. We estimated the average completion time to range between 12 and 15 minutes. The participants reported concerns about the Unité de Soutien SSA Québec's "Sex and Gender and Sexual Orientation" questionnaire (158), which we had initially incorporated in the survey. This tool thoroughly explores sex, gender identity, sexual identity, including femininity-related questions. Concerns were raised regarding the potential discomfort participants might experience when responding to this section of the survey. Following feedback from the participants, we made substantial adjustments. We replaced the "Sex and Gender and Sexual Orientation" questionnaire with two questions on gender orientation and sex at birth (157) to address the concerns raised. Moreover, additional introductory sentences were added to certain questions to provide participants with the required background information and explain the reasoning for their inclusion in the survey. After another round of feedback, to which positive answers were received, the survey was finalized to consist of 66 questions (see survey, Appendix B p.104).

3.1.2 Study Population & Sample

The target population for the survey was men 60 years of age and older who lived in the community and were at a high risk for fracture (see screening criteria, Appendix A, p.102).

Inclusion criteria:

- Ability to complete the questionnaire in English or French and possess the ability to comprehend and respond to the questions without visual or cognitive impairments.
- And high risk for fracture as defined by a self-report of:
    - having received a diagnosis of osteoporosis OR
    - having experienced 2 falls or more in the previous year OR
    - having experienced a fracture after the age of 40 OR
    - currently taking anti-osteoporosis medication as prescribed by physician

The survey was available between September and November of 2023. We used a multimodal recruitment technique to provide a thorough and inclusive participant selection process. This involved interacting directly with patients in targeted MUHC-affiliated outpatient clinics (orthopedic and osteoporosis clinics), communicating and collaborating with patient organizations (e.g. Osteoporosis Canada, Procure, etc.) for posting on their websites, and making use of social media channels. Participants who agreed to complete the survey were asked to suggest potential participants who might also want to take part. By doing so, we implemented a snowball sampling method to engage our own social networks and gradually built a bigger group of participants as more people kept suggesting others (159). We provided alternate ways to access the survey to engage a diverse cohort, including individuals with limited internet

accessibility. Tablets or a QR code were available to potential participants in a clinic environment so they could complete the survey while waiting for their appointment. The goal of different enrollment techniques was to reduce inequities in access and encourage participation from a range of backgrounds.

The study was approved by the MUHC Research Ethics Board. Completing and submitting the survey was considered to provide informed consent. REDCap Software enabled the study's digital design, allowing participants to enter their data directly in the database (160). This approach maintained the respondents' anonymity while enabling effective data collection and administration.

3.1.3 Variables

3.1.3.1 Conformity to Masculine Norms Inventory-22

The Conformity to Masculine Norms Inventory-22 (CMNI-22) assesses gender role beliefs over 11 separate dimensions: Winning, Emotional control, Risk-taking, Pursuit of status, Primacy of work, Violence, Power over women, Dominance, ‘Playboy’, Self-reliance, and Homophobia (Table 2) to evaluate conformity to societal masculine norms (143). The CMNI-22, consisting of 22 items, measures various aspects of traditional masculine norms using a Likert scale from 1 (Strongly Disagree) to 4 (Strongly Agree). Some items are reverse scored to ensure that higher scores consistently indicate greater conformity to masculine norms. The total score, calculated by summing all item scores, reflects the overall level of adherence to traditional masculine norms. Higher scores mean greater conformity, while lower scores mean lower conformity to societal masculine norms.

Raw CMNI-22 scores were transformed into standardized scores with a mean of 50 and a standard deviation of 10 (146). The conversion from a raw score to a standardized score was achieved through the following formula:

$$standardized\ score = 50 + 10 \times \left(\frac{X - \mu}{\sigma}\right)$$

Here, X represents the raw score to be transformed, μ is the mean of the raw scores, and σ is the standard deviation of the raw scores (161).

Table 2 Short-Form Conformity to Masculine Norms Inventory domains (144)

Domains	Description	Example
Winning	The importance placed on competition and achieving success	In general, I will do anything to win.
Emotional Control	The degree to which men are expected to suppress emotions and avoid emotional expression	I would feel embarrassed if I had to cry in front of other people.
Risk-Taking	The tendency to engage in behaviors that involve risk or danger	I enjoy taking risks.
Violence	The acceptance of aggression and physical force as a means of solving problems	I believe that violence is sometimes necessary.
Dominance	The expectation for men to assert control and authority over others	In general, I prefer being in charge of a group.
Playboy	The endorsement of a promiscuous and sexually dominant lifestyle	I would feel good about having casual sex with different partners.
Self-Reliance	The belief in being independent and self-sufficient	I tend to do things myself rather than ask for help.
Primacy of Work	The prioritization of career and work-related success over other aspects of life	My work is the most important part of my life.
Power over Women	The belief in male superiority and dominance over women	I believe that men should be the primary decision-makers in relationships.
Disdain for Homosexuals	Negative attitudes and behaviors towards homosexual individuals	I would be uncomfortable if someone thought I was gay.
Pursuit of Status	The drive to achieve social status and recognition	I want to be seen as a high-status person.

3.1.3.2 Primary outcome variables ascertainment

The Osteoporosis Self-Efficacy Scale (OSES) (97) was utilized to evaluate participants' confidence in managing their osteoporosis, specifically their ability to engage in behaviors that prevent the loss of bone density. The OSES consists of two subscales that assess different dimensions of osteoporosis management: exercise and calcium intake. The exercise subscale measures confidence in participants' ability to maintain regular physical activity that is beneficial for bone health. Participants are asked to rate their confidence on a scale where higher scores indicate greater self-efficacy in performing osteoporosis-preventive exercises. The dietary calcium intake subscale measures confidence in managing dietary habits to ensure sufficient calcium intake, which is important for bone health. Like the exercise subscale, participants respond to items that assess their self-assuredness in making dietary choices that prevent osteoporosis. Participants respond to each item on a 10-point scale, where 1 indicates no confidence and 10 indicates complete confidence. The total score for each subscale is calculated by summing the responses with a cut-off of 858 on the total scale defining participants’ levels of overall osteoporosis management self-efficacy, with scores lower than this cut-off indicating low osteoporosis self-efficacy while scores higher than this cut-off indicates high osteoporosis self-efficacy. The OSES has been validated in various populations, including older men, and is used in studies assessing the self-management capabilities of individuals with osteoporosis (99). The inclusion of the OSES in this study allows for an assessment of the perceived self-efficacy of osteoporosis management among participants. (99).

The Short-Form Falls Efficacy Scale International (FES-I) (118) was employed to assess participants' fear of falling, which is an important measure in understanding confidence in performing daily activities without falling. This abbreviated version of the original FES-I consists of seven items that reflect activities such as walking around the house, navigating stairs, and moving on uneven surfaces outdoors. Participants rate their concern about falling during each activity on a four-point Likert scale ranging from 1 ('Not at all concerned') to 4 ('Very concerned'). The scores from each item are summed, yielding a total score between 7 and 28, where higher scores indicate a greater fear of falling. The FES-I has been extensively validated across various settings and populations, including older men. (162, 163, 164).

3.1.3.3 Other variables

General demographic variables (age, province of residence) were obtained. Gender identity was ascertained by combining sex at birth and gender identity questions (157).

Physical activity is an important determinant of overall health and well-being, playing a role in the prevention and management of various health conditions, including osteoporosis. Regular exercise can enhance self-efficacy by improving physical fitness, reducing symptoms, and fostering a sense of control over one's health. The Godin Leisure-Time Exercise questionnaire measures the assessment of self-reported leisure-time physical activity (154). This scale measures the number of times various types of exercise (strenuous, moderate, and mild) is performed in a week, as well as the amount of total leisure activity. Scores range from 0 to and 119, where a total score of 24 units or more indicates an active lifestyle, a score between 14 and 23 units suggests

moderate activity, and a score of 13 units or less indicates inactivity. It is important to consider usual leisure time activity because understanding an individual's exercise habits can help identify patterns that influence confidence and ability to engage in health-promoting behaviors.

Mental health is a key factor in overall well-being and can influence the management of various health conditions. Depression can negatively impact self-efficacy by diminishing motivation, energy levels, and the perceived ability to manage one's health (165). The Patient Health Questionnaire-8 (PHQ-8) is an eight-item screening tool which uses a Likert scale to determine depression levels in research and clinical settings (155). Scores range between 0 to 24, where a score of 10 or greater indicates major depression and a score of 20 or greater indicates severe major depression. Understanding an individual's mental health through the PHQ-8 can help identify challenges that may hinder their confidence and ability to engage in health-promoting behaviors.

Individuals with higher education levels may have better access to information about osteoporosis management and prevention strategies, thereby potentially increasing their self-efficacy in managing the disease (93). Education level is an important determinant of health literacy, which is substantial for understanding and effectively managing diseases such as osteoporosis. Higher education levels might enable individuals to better comprehend and utilize health information, impacting their confidence and abilities to make informed health decisions (166). Education can influence personal beliefs and perceptions, including those related to gender roles and health behaviors. Individuals with higher education may have different views on

masculinity norms and their personal health responsibilities, which could affect their self-efficacy in managing osteoporosis (167). We measured and categorized levels of education into the following categories: completion of less than a high school diploma, possession of a high school diploma, possession of a trade certificate or vocational school or apprenticeship training, possession of a non-university certificate or diploma from a community college or CEGEP, possession of a university Bachelor's Degree, possession of a university Graduate Degree (such as a Master's or Doctorate), or other.

Cultural differences can influence how individuals interpret and embody masculine norms, and consequently, how they manage their health, including practices related to osteoporosis prevention and management (17, 18). There are disparities in health outcomes and access to healthcare services among different racial and ethnic groups, which can affect a wide range of factors including awareness of a disease, access to preventative care, and treatment options available to individuals all of which can impact health behaviors and outcomes (17, 18). We asked participants to identify their country of birth/origin, and if the answer was not Canada, we asked for the year of their immigration to Canada. We also asked them to identify the cultural and racial background they belong to.

Income level is an important determinant of socioeconomic status, which impacts health outcomes. Individuals with higher income levels typically have better access to healthcare services, including preventive care and treatments relevant to managing osteoporosis (168, 169). This access can influence their self-efficacy regarding osteoporosis management. Higher income often allows for better nutrition, opportunities for physical activity, and access to health education, all of which can enhance an

individual’s self-efficacy in managing health diseases like osteoporosis. Conversely, lower income might restrict access to these resources, potentially lowering self-efficacy (170). We categorized participants’ reported levels of income in the last year into several categories: $0-$9,999, $10,000-$24,999, $25,000-$49,999, $50,000-$74,999, $75,000-$99,999, $100,000-$149,999, $150,000+ and “Prefer not to answer”.

Those diagnosed with osteoporosis may have heightened awareness and potentially more education about osteoporosis management, which can influence their self-efficacy levels. Conversely, those without a diagnosis might not have engaged with healthcare providers about osteoporosis, potentially affecting their self-efficacy differently. Individuals with a diagnosis are more likely to have interacted with healthcare systems, received treatment or advice, and possibly adjusted their lifestyle to manage their disease (171). These interactions can enhance their confidence in managing the disease, thus impacting their self-efficacy scores (107, 172). We asked the participants whether or not they had received a diagnosis of osteoporosis. Subsequently, they were also asked if they were taking anti-osteoporosis medication.

Experiencing falls can influence an individual's perception of their vulnerability and overall physical capabilities (107). Those who have fallen may feel less confident in their ability to prevent future falls and manage their health, particularly concerning illnesses like osteoporosis that are associated with increased fracture risk. Additionally, the physical consequences of previous falls may leave these individuals more prone to future falls, irrespective of how fearful they are of falling. Individuals who have fallen multiple times often reduce their physical activity due to a fear of falling, creating a counterproductive cycle. This restriction in activity, driven by fear, may lead to further

deterioration in their physical abilities. As physical activity diminishes, these individuals can experience muscle weakness, decreased balance, and overall reduced physical fitness, all of which heighten the likelihood of future falls. This cycle is especially detrimental for those with a history of multiple falls since their physical condition may already be weakened. Consequently, any additional decline in their physical capabilities markedly escalates their risk of experiencing more falls (173, 174). We asked the participants whether they had experienced 2 falls or more in the last year or even if they have experienced a fracture after the age of 40.

3.1.4 Statistical Analysis

Descriptive statistics

Descriptive statistical analyses were performed to characterize the survey participants. Histograms and Q-Q plots were generated to graphically examine the distribution of each variable; there were no extreme values. Continuous variables are presented as mean values with their associated standard deviations (SD), or as median values accompanied by the interquartile range (IQR), depending on the distribution of the data. Categorical variables are summarized using frequency counts and percentages.

The cohort was stratified by categorizing the participants into tertiles of standardized CMNI-22 scores where those in the highest tertile (scores = 23.6 to 44.93) were compared with those in the lowest tertile (scores = 54.26 to 79.6). Differences in participants characteristics between the highest and lowest CMNI-22 tertile groups were compared with standard tests (chi-squared test, Student’s t-test, and median test).

Similarly, we contrasted the results of OSES (total and sub-scales) and FES-I between CMNI-22 highest and lowest tertile groups as well as by fracture status (yes, no), by moderate level of physical activity (GLTEQ score ≥ 14) and by presence of depressive symptoms (PHQ-8 score ≥ 10).

Regression analyses

We first examined the associations between the independent variables and the outcomes OSES (total and sub-scales) and FES-I in univariate linear and logistic regression models, respectively. Independent variables considered were: age, PHQ-8, GLTEQ, race/ethnicity, education, marital status, personal income level, diagnosis of osteoporosis, previous falls, previous fractures, anti-osteoporosis medication, province, raw and standardized CMNI-22 score, year of immigration if not born in Canada. This approach allowed for the assessment of the strength and direction of relationships between each independent variable and dependent variables (OSES and FES-I) under study. Participants with missing values on race/ethnicity and/or education level (N = 3) were excluded from regression analyses. The linearity of the continuous variables (age, GLTEQ, PHQ-8) with OSES (total and sub-scales) was verified using scatterplots and with the log-odds of FES-I, using cubic splines. The relationships between GLTEQ scores and OSES (total and exercise sub-scale) were found to be non-linear. To accommodate non-linearity and enhance model fit, a quadratic term ($GLTEQ^2$) was therefore introduced into the regression models for OSES (total and exercise sub-scale).

Variables that were found to be significant predictors of the outcomes OSES and/or FES-I ($p < 0.05$) in the univariate regression models were education,

race/ethnicity, income, osteoporosis diagnosis and falls. There variables were therefore added as co-variables to the multivariable models. Standardized CMNI-22 scores were used in all regression analyses.

Adjusted linear multivariable regression models were developed to examine the associations between standardized CMNI-22 scores as continuous and dichotomous (highest vs lowest tertiles) variables and the OSES outcomes. The first multivariable model was adjusted for age, race/ethnicity, osteoporosis diagnosis, falls, education and income. In the second model, GLTEQ was added to estimate how weekly leisure physical activity impacts the association between CMNI-22 and OSES. In the third model, we further added PHQ-8, to estimate whether the increasing levels of depressive symptoms changed the association between conformity to masculine norms and osteoporosis self-efficacy.

Adjusted logistic regression models were developed to examine the associations between the CMNI-22 scores (continuous and dichotomous) and FES-I outcome. We followed the same adjustment models as for the multiple linear regression analyses, for the logistic regression analyses. However, the sample size was too small to adjust for ethnicity, education, and diagnosis of osteoporosis in the multivariate logistic regression models with the dichotomous CMNI-22 scores variable because including these additional variables would reduce the degrees of freedom and increase the risk of overfitting, leading to unreliable estimates and reduced statistical power.

To examine if the association of OSES & FES-I with CMNI-22 was influenced by varying intensity of depression or habitual exercise, we investigated the presence of an interaction between CMNI-22 and PHQ-8, as well as CMNI-22 and GLTEQ. Hence,

interaction terms between CMNI-22 and PHQ-8 and GLTEQ scores were tested in the fully adjusted models.

To comprehensively understand the specific influence of each aspect of conformity to masculine norms on osteoporosis self-efficacy, separate linear regression models were conducted for each CMNI-22 domain. Analyzing these domains individually allows us to identify which specific aspects of masculinity are most strongly associated with osteoporosis self-efficacy. This distinction is important for developing targeted interventions and understanding the nuanced ways in which different masculine norms impact health behaviors and outcomes. A different linear regression model was done for each CMNI-22 domain. Analyzing these domains separately helps avoid issues of multicollinearity that can occur when multiple correlated predictors are included in the same regression model. This ensures that the estimates for each domain's effect are not distorted by the presence of other domains. Unadjusted and adjusted linear regressions were used to estimate the OSES (total and sub-scales) difference per each increase of 1 unit of a CMNI-22 domain. The regression models were first adjusted for age, education, ethnicity/race, income, falls and diagnosis of osteoporosis. We then further adjusted for GLTEQ (linear and quadratic terms).

Effect size and Minimum Clinically Important Difference

Effect size highlights the clinical relevance of findings. A statistically significant result might not always be considered a clinically important result, but the effect size helps gauge the real-world impact (175). Cohen's d is a measure of effect size that quantifies the standardized difference between two means (176). Also, calculating the effect size is important for conducting power analyses, which are necessary to

determine the appropriate sample size for future studies to detect a true effect (177). A Cohen's statistic of $d = 0.2$ is considered small, $d = 0.5$ is considered medium, and $d \geq 0.8$ is considered large (178).

The Minimum Clinically Important Difference (MCID) represents the smallest change in an outcome that would be recognized as clinically important (179). For example, MCID is important for evaluating whether an intervention has a meaningful impact on patients' health, guiding clinicians in making informed decisions about treatment options. Furthermore, health policies and clinical guidelines often rely on MCID to assess the efficacy of interventions and recommend best practices (180). To calculate the MCID for the OSES total score, as well as the exercise and calcium subscales, we employed a method designed to minimize the influence of outliers and better reflect the central tendency of our data. Specifically, we excluded the lower and upper 5th percentiles (<5% and >95%) of our sample to focus on the central 90%. By analyzing this central 90%, we determined the MCID as 10% of the range within this central portion of the data. This approach ensures that our MCID calculation is robust and representative of the majority of our cohort, while reducing the potential skewing effects of extreme values. This method is consistent with previous literature, which recommends focusing on central data to achieve more reliable and clinically meaningful thresholds for important differences (181, 182).

All statistical analyses were performed using statistical JASP software (Version 0.18). A 2-sided p-value of <0.05 was considered significant.

3.2 RESULTS

Four hundred ninety-six individuals made initial contact with the survey interface, but 129 were excluded because they did not meet the inclusion criteria (age, screening criteria), just opened and closed the survey or did not complete the screening questions. Of the 367 eligible to answer the survey, 16 were excluded for not initiating the survey (even if eligible), and 144 were excluded for not completing the survey in full. Two hundred seven participants were considered as respondents and their information was used in the descriptive analysis (response rate 56%). A total of 204 participants were considered for regression analyses (3 were excluded for missing values on race/ethnicity or education questions) (Figure 1). Of the 207 recruited participants, 90 were recruited from social media (Table 3), 92 (44%) were from Ontario, 63 (31%) from Quebec and the remaining participants from other provinces (Table 4).

Figure 1 Participants flow chart

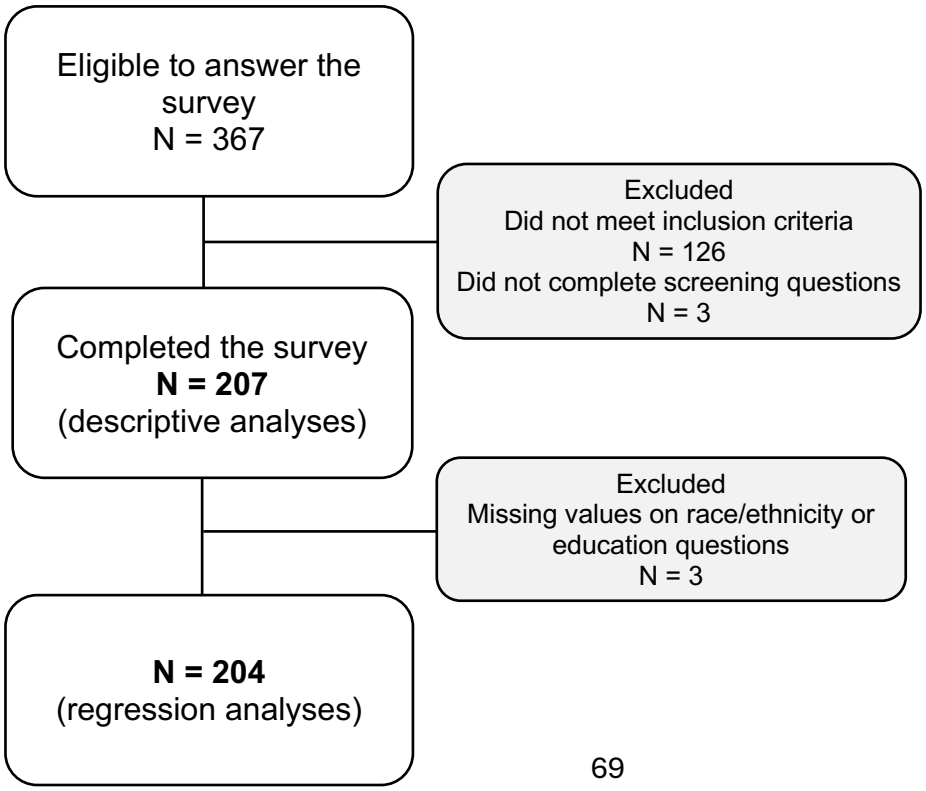


Table 3 Recruitment methods reported by survey participants

Recruitment Method	Total (N = 207)
Social Media, N	90
Friend, Family Member or Acquaintance, N	41
Online Support Group, N	22
Healthcare Professionals, N	13
Outpatient Clinic, N	11
Others, N	30

Table 4 Province of residence reported by survey participants

Province	Total (N = 207)
Ontario, N (%)	92 (44%)
Quebec, N (%)	63 (31%)
Others, N (%) (British Columbia, Alberta, Saskatchewan, Manitoba, New Brunswick, Nova Scotia)	52 (25%)

All participants reported male sex at birth and identified as men; the mean age was 71 (SD=7) years. The majority reported Canada as their country of birth, and 86% self-identified as White. Forty-five (22%) individuals were born in a country other than Canada. The mean number of years since immigration to Canada, for those not born in Canada was 41 (SD = 20) years. When categorizing participants' scores on the CMNI-22 scale into tertiles, a higher proportion of those born in Canada fell into the lowest CMNI tertile compared to the highest tertile. Those born in Canada were significantly also less likely to adhere to masculine norms than those born in another country. Hundred seventy-seven individuals (86%) self-identified as White. Similarly, a higher proportion of White individuals fell into the lowest CMNI tertile compared to the highest tertile. Seventy participants had a personal income level of ≥ $50,000 in the last year. Hundred fifty-one individuals (73%) had responded having completed post-secondary education. A higher proportion of individuals having completed post-secondary education fell into the lowest CMNI tertile compared to the highest tertile. (Table 5).

Over half of the participants had an osteoporosis diagnosis (54%) and most had experienced at least one fracture after the age of 40 (61%). Eighty-nine (43%) reported having experienced 2 falls or more in the past year. Eighty-five (41%) participants reported taking an anti-osteoporosis medication (Table 5).

Overall, participants demonstrated a moderate level of physical activity, as indicated by a median score of 22 (IQR 9-41) on the Godin Leisure-Time Exercise Questionnaire. The median score Patient Health Questionnaire-8 of 4 (IQR 1-7) reflecting absence of depressive symptoms in most respondents. The mean CMNI-22

raw score was 27.8 (SD = 7.5) on a scale of 0-66. After the CMNI-22 scores were transformed on a scale of 0-100, the mean was 49.9 (SD = 10.0) (Table 6).

The mean score on the OSES was 739 (SD = 225) for the entire sample. Participants in the lowest tertile of CMNI-22 scores had a higher mean OSES score (781, SD = 209) compared to those in the highest tertile (689, SD = 261) (p = 0.02). For the exercise subscale, the mean score was 349 (SD = 142), with no significant difference observed between the highest and lowest tertiles. In terms of calcium intake, the mean score on the calcium subscale was 390 (SD = 118). Participants in the lowest tertile of CMNI-22 scores had a higher mean calcium subscale score (415, SD = 113) compared to those in the highest tertile (360, SD = 138) (p = 0.04). The median score on the FES-I was 10 (IQR: 8-14), and no significant difference was observed between tertiles (p = 0.52) (Table 7).

There was no significant difference observed in OSES Total, calcium-subscale, exercise subscale and FES-I scores when stratified between those having experienced a fracture after the age of 40 and those who haven't. Those who were considered moderately active had higher osteoporosis self-efficacy and falls efficacy. Similarly, those who had fewer depressive symptoms had more confidence in exercise participation behaviours related to osteoporosis management (Table 8).

Table 5 Participants' characteristics, in the total sample and by Lowest Conformity to Masculine Norms Inventory (CMNI) tertile scores and highest CMNI tertile scores

Characteristic	Total (N = 207)	CMNI¶ Tertile Lowest[1] (N = 74)	CMNI¶ Tertile Highest[2] (N = 66)
Age, Mean (SD), years	71 (7)	72 (6)	70 (7)
Sex at Birth = Male, N (%)	207 (100%)	74 (100%)	66 (100%)
Gender Identity = Man, N (%)	207 (100%)	74 (100%)	66 (100%)
Woman, N (%)	0 (0%)	0 (0%)	0 (0%)
Other, N (%)	0 (0%)	0 (0%)	0 (0%)
Country of Birth = Canada, N (%)	162 (78%)	**62 (84%)**	**45 (68%)**
Other Country of Birth, N (%)	45 (22%)	**12 (16%)**	**21 (32%)**
Years Since Immigration, Mean (SD), years	41 (20%)	**51 (14)**	**30 (19)**
Race/Ethnicity = White, N (%)	177 (86%)	**67 (91%)**	**51 (77%)**
Income < 50,000$, N (%)	70 (34%)	28 (38%)	20 (30%)
Income ≥ 50,000$, N (%)	97 (47%)	28 (38%)	32 (49%)
Income = Prefer Not to Say, N (%)	40 (19%)	18 (24%)	14 (21%)
Post-Secondary Education, N (%)	151 (73%)	54 (73%)	44 (67%)
Osteoporosis Diagnosis, N (%)	112 (54%)	**46 (62%)**	**25 (38%)**
≥ 2 Falls in the Previous Year, N (%)	89 (43%)	**30 (41%)**	**38 (58%)**
≥ 1 Fracture After the Age of 40, N (%)	126 (61%)	41(55%)	47 (71%)
Taking Anti-Osteoporosis Medication, N (%)	85 (41%)	**34 (46%)**	**24 (36%)**

In bold: statistically significant differences between lowest and highest tertile group ($p < 0.05$), using Student T test or Chi-square ($\chi 2$) test
¶ Conformity to Masculine Norms Inventory
1. Highest tertile (scores = 23.6 to 44.93)
2. Lowest tertile (scores = 54.26 to 79.6)

Table 6 Participants' responses to CMNI, GLTEQ and PHQ-8 validated questionnaires, in the total sample and by lowest CMNI tertile scores and highest CMNI tertile scores

Characteristic	Total (N = 207)	CMNI¶ Tertile Lowest[1] (N = 74)	CMNI¶ Tertile Highest[2] (N = 66)
CMNI Raw Score (0-66) Mean (SD)	27.8 (7.5)	**20.4 (3.4)**	**36.3 (5.2)**
CMNI Standardized Score (0-100) Mean (SD)	49.9 (10.0)	**40.2 (4.5)**	**61.3 (6.9)**
GLTEQ* (0-119) Median (IQR)	22 (9, 41)	21 (12, 45)	21 (9, 35)
PHQ-8** (0-24) Depression symptoms ≥ 10 Median (IQR)	4 (1, 7)	4 (1, 7)	4 (2, 6)

In bold: statistically significant differences between lowest and highest tertile group ($p < 0.05$), using Student's t-test or Median test
*Godin Leisure-Time Exercise Questionnaire: Moderately active ≥ 14
**Patient Health Questionnaire-8: Depression symptoms ≥ 10
¶ Conformity to Masculine Norms Inventory
1. Highest tertile (scores = 23.6 to 44.93)
2. Lowest tertile (scores = 54.26 to 79.6)

Table 7 Participants' osteoporosis self-efficacy and falls efficacy, by lowest CMNI tertile scores and highest CMNI tertile scores

Characteristic	Total (n = 207)	CMNI¶ Tertile	
		Lowest[1] (N = 74)	Highest[2] (N = 66)
OSES* Scale of 0-1200, Mean (SD)	739 (225)	**781 (208)**	**689 (261)**
Exercise Sub-Scale Scale of 0-600, Mean (SD)	349 (142)	365 (133)	329 (152)
Calcium Sub-Scale Scale of 0-600, Mean (SD)	390 (118)	**415 (113)**	**360 (138)**
FES-I** Scale of 7-28, Median (IQR)	10 (8, 14)	11 (8, 14)	10 (9, 14)

In bold: statistically significant differences between lowest and highest tertile group ($p < 0.05$), using Student's t-test or Median test

* Osteoporosis Self-Efficacy Scale: High efficacy ≥ 858

** Short-form Falls Efficacy Scale-International: High concern of falling ≥ 10

¶ Conformity to Masculine Norms Inventory

1. Highest tertile (scores = 23.6 to 44.93)
2. Lowest tertile (scores = 54.26 to 79.6)

Table 8 Participants' osteoporosis self-efficacy and falls efficacy, by presence of fracture and by weekly leisure activity level

Outcomes		Fracture		GLTEQ¶ ≥ 14		PHQ-8† ≥ 10	
		Yes (N = 126)	No (N = 81)	Yes (N = 143)	No (N = 64)	Yes (N = 34)	No (N = 173)
OSES*	Total	744.7 (228.1)	730.4 (221.5)	**796.7 (210.7)**	**610.3 (203.0)**	671.7 (218.9)	752.3 (224.5)
	Exercise	354.5 (140.1)	340.9 (145.6)	**387.8 (129.6)**	**262.9 (131.2)**	**285.2 (137.6)**	**361.8 (139.9)**
	Calcium	390.1 (118.7)	389.5 (118.6)	**408.9 (113.6)**	**347.4 (118.7)**	386.6 (113.4)	390.6 (119.7)
FES-I**		10 (8, 14)	9 (8, 13)	12 (9, 14)	9 (8, 13)	15 (12, 19)	9 (8, 12)

In bold: statistically significant differences ($p < 0.05$), using Student's t-test or Median test

* Osteoporosis Self-Efficacy Scale: High efficacy ≥ 858

** Short-form Falls Efficacy Scale-International: High concern of falling ≥ 10

¶ Godin Leisure-Time Exercise Questionnaire: Moderately active ≥ 14

† Patient Health Questionnaire-8: Depression symptoms ≥ 10

3.2.1 Conformity to Masculine Norms Inventory and Osteoporosis Management Self-Efficacy

In unadjusted linear regression models, each increase in one unit of CMNI-22 was significantly associated with a decrease in OSES (-5.03; 95% CI [-8.04, -2.02]), exercise intake self-efficacy (-2.55; 95% CI [-4.46, -0.65), and calcium self-efficacy (-2.48; 95% CI [-4.07, -0.88). In multivariate adjusted linear regression models, each increase in one unit of CMNI-22 was significantly associated with a decrease in OSES (-3.22; 95% CI [-5.99, -0.45]) and calcium intake self-efficacy (-1.48; 95% CI [-3.14, -0.18]); but not in exercise self-efficacy (-1.78; 95% CI [-3.41, 0.14]) (Table 9). These results indicate that higher adherence to masculine norms is associated with lower osteoporosis self-efficacy, particularly in the total and calcium subscales, even after adjusting for various demographic and clinical factors. When comparing those in the highest CMNI-22 tertile versus lowest CMNI-22 tertile in multivariate adjusted linear regression analyses, those in the highest tertile demonstrated significantly lower calcium self-efficacy (-46.8; 95% CI [-90.1, -3.5); but not in OSES (-61.9; 95% CI [-136, 12) nor in exercise self-efficacy (-14.9; 95% CI [-58, 28]), compared to those in the lowest tertile (Table 10). These findings indicate that higher adherence to masculine norms is associated with lower osteoporosis self-efficacy, particularly in the total and calcium sub-scales, even after adjusting for various demographic and clinical factors.

3.2.2 Conformity to Masculine Norms Inventory and Falls Self-Efficacy

In multivariate logistic regression models, unadjusted and adjusted odds ratios (OR) with 95% CI were computed to determine the association of CMNI with falls self-efficacy in those with a high for concern of falling, FES-I ≥ 10 versus a low concern for

falling (FES-I < 10). There was no association between CMNI-22 and FES-I whether CMNI-22 was entered in the model as a continuous or a categorized (highest vs lowest tertile) variable (OR 1.00, 95% CI [0.96;1.03] and OR 0.75, 95% CI [0.32; 1.74] respectively) (Table 11,12). These results indicate no significant association between CMNI-22 scores and concern of falling, even after adjusting for various demographic and clinical factors.

3.2.3 Effect Modification Analysis

The interaction between the PHQ-8 with standardized CMNI-22 scores was noted to be statistically significant for our primary outcome OSES (p = 0.01) and for the calcium subscale (p = 0.01); whereby those with lower PHQ-8 and lowest CMNI-22 scores having the highest OSES while those with higher PHQ-8 (above 10) having a lower OSES across the range of CMNI-22 scores (Supplemental Table 1, Appendix C, p. 130). The interaction between the GLTEQ with standardized CMNI-22 scores was noted to not be statistically significant for our primary outcome OSES (p = 0.87) (Supplemental Table 2, Appendix C, p. 131).

3.2.4 Conformity to Masculine Norms Inventory Domains and Osteoporosis Self Efficacy and Falls Efficacy

Unadjusted and adjusted linear regression models were created to determine the impact of each CMNI-22 domain on OSES-Exercise and OSES-Calcium. In univariate analyses, most domains showed statistically significant negative associations with self-efficacy, indicating that higher conformity to masculine norms was linked to lower

exercise self-efficacy. However, the Risk-Taking and Pursuit of Status domains showed positive associations with OSES-Exercise and OSES-Calcium.

In the fully adjusted models (including GLTEQ in addition to variables included in model 1), we noted a reduction in the magnitude of the estimates for OSES-Exercise but not for OSES-Calcium, indicating that leisure-time physical activity partially mediated the relationship between masculine norms and exercise self-efficacy. A closer examination of individual domains reveals significant impacts on self-efficacy.

Self-Reliance, for instance, was consistently associated with lower self-efficacy across all models. In the fully adjusted model, it showed significant negative associations with OSES-Total (-29.2; 95% CI [-49.5, -9.0]), OSES-Exercise (-14.7; 95% CI [-27.0, -2.4]), and OSES-Calcium (-14.5; 95% CI [-26.5, -2.5]). This indicates that higher adherence to self-reliance as a masculine norm significantly reduces self-efficacy in managing osteoporosis. Similarly, Emotional Control showed significant negative associations, with a notable reduction in self-efficacy in the fully adjusted model (-19.4; 95% CI [-38.3, -0.4]), suggesting that the emphasis on controlling emotions undermines confidence in managing osteoporosis-related activities.

Additionally, Power over Women and Dominance domains showed significant negative associations with OSES-Total and OSES-Calcium in the fully adjusted models, indicating that these aspects of masculine norms are detrimental to self-efficacy. For instance, Power over Women had estimates of -28.5 (95% CI [-51.0, -6.1]) for OSES-Total and -15.4 (95% CI [-28.7, -2.2]) for OSES-Calcium. The Disdain for Homosexuals domain was also significantly associated with lower self-efficacy in fully adjusted models

for both OSES-Total (-13.2; 95% CI [-29.1, 2.8]) and OSES-Calcium (-13.6; 95% CI [-22.8, -4.3]), highlighting that non-inclusive attitudes contribute to lower self-efficacy.

Risk-Taking and Pursuit of Status had positive associations with self-efficacy. Risk-Taking showed a positive relationship with OSES-Exercise in both unadjusted and adjusted models (e.g., 16.1; 95% CI [1.6, 30.5] in Model 1). Pursuit of Status was positively associated with OSES-Exercise across all models (e.g., 19.2; 95% CI [3.4, 35.1] in Model 1). These detailed insights suggest that specific masculine norms, particularly those emphasizing self-reliance, emotional control, power, and dominance, significantly reduce osteoporosis self-efficacy, while traits like risk-taking and the pursuit of status may enhance self-efficacy in exercise-related activities (Supplemental Table 3, a), b), c), Appendix C, p.132).

3.2.5 Effect Size and Minimum Clinically Important Differences

Cohen's d was estimated as d = 0.40 for OSES total, as d = 0.39 for the exercise subscale and d = 0.44 for calcium subscale, consistent with a low to moderate effect of CMNI on OSES and its subscales.

The MCIDs were estimated from our sample to be 74, 47, and 38 for OSES, the exercise subscale and calcium subscale respectively. The only association between CMNI (highest tertile- lowest tertile) and OSES that met the MCID was in the calcium subscale where the adjusted difference between the highest and lowest tertile was 47 (95% CI [-90.1, -3.5) and greater than the calculated MCID of 38 (Table 13).

Table 9 Unadjusted and adjusted estimates with 95% CI for Osteoporosis Self-Efficacy Scale (OSES; Total, Exercise and Calcium) for each increase of 1 unit in standardized CMNI scores

Estimate (95% CI)		Unadjusted	Adjusted Model 1 (Age, Education, Race/Ethnicity, Income, Osteoporosis Diagnosis, Falls)	Adjusted Model 2 (Model 1 + GLTEQ*)	Adjusted Model 3 (Model 2+ PHQ-8**)
OSES§	Total	**-5.03** [-8.04, -2.02]	**-4.29** [-7.37, -1.20]	**-3.02** [-5.79, -0.26]	**-3.22** [-5.99, -0.45]
	Exercise	**-2.55** [-4.46, -0.65]	**-2.09** [-4.00, -0.17]	-1.25 [-2.93, 0.43]	-1.48 [-3.14, 0.18]
	Calcium	**-2.48** [-4.07, -0.88]	**-2.20** [-3.88, -0.52]	**-1.80** [-3.42, -0.169]	**-1.78** [-3.41, -0.14]

In bold: statistically significant differences ($p < 0.05$)
* Godin Leisure-Time Exercise Questionnaire scores. For total and exercise, a quadratic term was added.
** Patient Health Questionnaire-8 scores
§ Osteoporosis Self-Efficacy Scale

Table 10 Unadjusted and adjusted estimates with 95% CI for Osteoporosis Self-Efficacy Scale (OSES; Total, Exercise and Calcium) for highest[1] vs. lowest[2] (146) tertile in standardized CMNI scores

Estimate (95% CI)		Unadjusted	Adjusted Model 1 (Age, Education, Race/Ethnicity, Income, Osteoporosis Diagnosis, Falls)	Adjusted Model 2 (Model 1 + GLTEQ*)	Adjusted Model 3 (Model 2+ PHQ-8**)
OSES[§]	Total	**-92.2** [-171, -14]	**-86.4** [-164, -9]	-58.6 [-132, 14]	-61.9 [-136, 12]
	Exercise	-36.9 [-85, 11]	-29.1 [-76, 17]	-10.5 [-52, 32]	-14.9 [-58, 28]
	Calcium	**-55.3** [-97, 13]	**-57.3** [-101, -14]	**-47.8** [-90.5, -5]	**-46.8** [-90.1, -3.5]

In bold: statistically significant differences ($p < 0.05$)
* Godin Leisure-Time Exercise Questionnaire scores. For total and exercise, a quadratic term was added
** Patient Health Questionnaire-8 scores
§ Osteoporosis Self-Efficacy Scale
1. Highest tertile (scores = 23.6 to 44.93)
2. Lowest tertile (scores = 54.26 to 79.6)

Table 11 Unadjusted and adjusted odds ratios (OR) with 95% CI for concern of falling (FES-I ≥ 10 (N = 110) versus FES-I < 10 (N = 97)) for each increase of 1 unit in standardized CMNI scores

Estimate (95% CI)	Unadjusted	Adjusted Model 1 (Age, Education, Race/Ethnicity, Income, Osteoporosis Diagnosis, Falls)	Adjusted Model 2 (Model 1 + GLTEQ*)	Adjusted Model 3 (Model 2+ PHQ-8**)
FES-I§	1.01 [0.98; 1.03]	1.00 [0.97; 1.03]	0.99 [0.96; 1.03]	1.00 [0.96; 1.03]

* Godin Leisure-Time Exercise Questionnaire scores
** Patient Health Questionnaire-8 scores
§ Short-form Falls Efficacy Scale-International

Table 12 Unadjusted and adjusted odds ratios (OR) with 95% CI for concern of falling (FES-I ≥ 10 (N = 110) versus FES-I < 10 (N = 97)) by levels of standardized CMNI Scores (highest[1] vs. lowest tertile[2])

Estimate (95% CI)	Unadjusted	Adjusted Model 1 (Age, Income, Falls)	Adjusted Model 2 (Model 1 + GLTEQ*)	Adjusted Model 3 (Model 2+ PHQ-8**)
FES-I§	0.93 [0.47; 1.82]	0.86 [0.41; 1.84]	0.67 [0.30; 1.49]	0.75 [0.32; 1.74]

* Godin Leisure-Time Exercise Questionnaire scores
** Patient Health Questionnaire-8 scores
§ Short-form Falls Efficacy Scale-International
1. Highest tertile (scores = 23.6 to 44.93)
2. Lowest tertile (scores = 54.26 to 79.6)

Table 13 Minimum clinically important differences (MCID) for participants' osteoporosis self-efficacy and falls efficacy

Outcomes		MCID (estimated from our cohort)	Adjusted Difference between Highest and Lowest CMNI tertiles
	Total	74	62
OSES*	Exercise	47	15
	Calcium	38	47
FES-I**		1.2	N/A

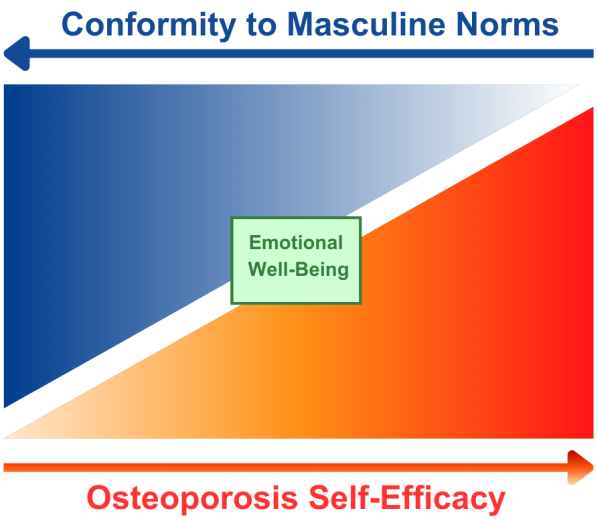
* Osteoporosis Self-Efficacy Scale
** Short-form Falls Efficacy Scale-International

CHAPTER 4: DISCUSSION

4.1. General Discussion

Based on these results, we conclude that there is a small to moderate association between CMNI and Osteoporosis Management perceived self-efficacy in men at high risk for fracture, where those with the highest conformity to masculine societal norms report less self-efficacy. This association was statistically significant for total OSES and for calcium intake self-efficacy, even when adjusting for important variables such as race/ethnicity, income and education. In addition, this finding was found to be of clinical relevance (MCID) in calcium intake self-efficacy. In the unadjusted or adjusted models, there was no significant association between CMNI and perceived FES-I. Finally, we also documented an interaction between the presence of depressive symptoms and CMNI on OSES, whereby the associations noted previously between CMNI and OSES varied across levels of PHQ-8. Indeed, in those with a higher burden of depressive symptoms, the association between CMNI and OSES disappeared (Figure 2).

Figure 2 Association between OSES and CMNI



There is a substantial difference in osteoporosis management between men and women. Osteoporosis is often seen as a female disease due to its higher prevalence among postmenopausal women, leading to a focus on women in research and clinical guidelines (69). Healthcare providers may lack awareness about the presence of osteoporosis in men. Men are less likely to undergo bone density testing, resulting in delayed diagnosis and treatment (150). Studies also show that men are less likely to receive treatment after a fracture, despite having similar or higher fracture risks compared to women (53). In contrast, osteoporosis management in women is well-studied, with established guidelines and interventions leading to better outcomes. Men often do not associate fractures with osteoporosis and rarely discuss bone health with primary care providers. Our findings align with research underlining American men's reluctance to seek medical help and adhere to preventive health behaviors, largely due to traditional masculine norms (183). For instance, our study showed that higher conformity to masculine norms such as self-reliance, power over women, emotional control, and dominance were significantly associated with lower self-efficacy in managing osteoporosis (OSES-Total, OSES-Exercise, and OSES-Calcium). Similarly, White American college men who had high levels of self-reliance, emotional control, violence, dominance, risk-taking, and power over women had negative attitudes toward seeking professional psychological help (184). Our findings also align with the results of a study on sex differences in osteoporosis self-efficacy among community-residing older adults presenting for DXA (101). Using OSES as the measure of self-efficacy, the authors documented those men generally exhibited higher self-efficacy regarding exercise participation, while women demonstrate higher self-efficacy in dietary calcium

intake. These differences were attributed to societal constructs, where physical activity aligns more closely with masculine norms and dietary behaviors are seen as less masculine. As we consider that men with low CMNI-22 scores exhibit characteristics more commonly associated with femininity, our study results align with these findings. Overall, men conforming less to masculine norms reported higher overall osteoporosis and calcium intake self-efficacy compared to those with conforming more to these norms, with physical activity having a differential mediating effect on these relationships. On the other hand, men who conform more strongly to traditional masculine norms, such as risk-taking, self-reliance, emotional control, and pursuit of status, and exhibit characteristics typically associated with masculinity, have self-efficacy levels similar to men in general regarding exercise participation behaviours. This suggests that traits like risk-taking and a desire for social status may enhance men's confidence in engaging in physical activities, aligning with societal expectations that glorify physical strength and athleticism as masculine attributes.

Our finding is also supported by a study on the relationship between masculine norms, media internalization, and body image concerns among Australian men, which highlighted that risk-taking men are less likely to engage in health behaviours and more likely to engage in harmful practices to achieve leanness (185, 186).

Lastly, similarly to our findings, another study on men and women at the university level highlighted that men have reported more barriers to dietary calcium intake than women and reported higher exercise self-efficacy than women (187). Consequently, both the pursuit of status and tendency of risk-taking are significant motivators of such enhanced exercise self-efficacy, leading individuals to believe in their

capacity to successfully engage in and adhere to exercise routines, thereby boosting their exercise self-efficacy.

Interventions targeting osteoporosis management in men should hence aim to highlight and put forward positive aspects of masculinity, such as pursuit of status or risk-taking, to promote exercise while simultaneously addressing the negative impact of norms that discourage dietary calcium intake and help-seeking behaviors.

Our findings that men in the highest CMNI tertile had a higher incidence of fractures and falls and lower rates of medication use support the notion that traditional masculine norms negatively impact health outcomes. These men may engage in riskier behaviors and be less likely to adopt preventive health measures, leading to worse osteoporosis management outcomes.

It is interesting to note that although there was a significant difference in conformity to masculine norms levels, our population of men overall scored on the lower end of the scale. These lower scores may indicate that our sample is more open to health interventions, which is valuable for designing targeted health interventions. It could also reflect the unique characteristics of our sample, such as higher health consciousness or education levels.

Our study indicates that cultural factors, immigration status, income, and education influence adherence to masculine norms and, consequently, osteoporosis self-efficacy. Men born in Canada were less likely to adhere to traditional masculine norms, which improved their self-efficacy in managing osteoporosis. Specifically, those conforming less strongly to masculine norms were more likely to be born in Canada compared to those adhering less to these norms, suggesting that cultural factors

associated with being born and raised in Canada may promote more flexible views on masculinity. Similarly, immigrants conforming less strongly to masculine norms had a longer mean duration of residence in Canada compared to those in the lowest tertile, indicating that longer exposure to Canadian cultural norms may lead to reduced adherence to traditional masculine norms, thereby enhancing self-efficacy in osteoporosis management among immigrant men. Higher income levels and education were associated with lower adherence to masculine norms, likely because these individuals may have greater access to resources and information that challenge traditional masculine norms. A multi-center population study highlighted that urban Shanghai men and women over the age of 40 with higher education levels are more proficient at obtaining and understanding knowledge, showing increased confidence and awareness in practicing health behaviors (188). Higher education provides men with the knowledge to critically evaluate and challenge traditional masculine norms, leading to higher self-efficacy in osteoporosis management.

Significant differences were found in total OSES, calcium subscale, and exercise subscale scores based on weekly leisure activity levels, indicating that active individuals have higher self-efficacy in managing osteoporosis. Our group, being moderately active, did not show a significant impact on OSES exercise scores in adjusted analyses. This is likely because the moderate activity level did not vary enough to show a strong association in the adjusted models. However, descriptive statistics reveal that individuals with higher exercise levels had better OSES scores, suggesting that more engagement in physical activity could enhance self-efficacy.

Mental health also plays a crucial role in self-efficacy. Depressive symptoms can undermine an individual's confidence in managing chronic conditions, including osteoporosis. Adherence to traditional masculine norms often involves suppressing emotions and avoiding seeking help, leading to increased psychological stress and depressive symptoms (189). These symptoms, in turn, negatively impact an individual's confidence in managing their health, thereby reducing their overall self-efficacy, including osteoporosis self-efficacy. When depressive symptoms are present, they can explain a significant portion of the negative impact of traditional masculine norms on osteoporosis self-efficacy. Previous research also has shown that depressive symptoms are associated with lower self-efficacy across various other health conditions, such as diabetes and cardiovascular disease (190, 191). Also, studies found similar associations between mental health and self-efficacy in chronic disease management (86, 192). In the context of osteoporosis, our findings align with these studies, indicating that mental health significantly impacts self-efficacy, specifically in exercise self-efficacy. By documenting mental health status, healthcare providers can better tailor interventions to improve self-efficacy and, ultimately, health outcomes for individuals with osteoporosis.

Gender Differences in Health Perceptions and Behaviors

The findings of our study also align with other existing literature on gender differences in health perceptions and behaviors. For instance, O'Brien et al. found that while some men view maintaining good health as integral to fulfilling their roles as strong and capable providers, the overall adherence to traditional masculine norms often leads to neglecting preventive health measures (193, 194). When studying how adult male and female yoga participants from various regions differ in their motives for

yoga participation and conformity to certain masculine norms, it was highlighted that significant gender differences in participation motives and conformity to masculine norms existed. For instance, females were more motivated by positive affect, health/fitness, mind–body integration, and coping/stress management, whereas males were more motivated by supplementary activity and competition/social recognition (195). In a parallel manner, our study recognized that men who felt confident in exercise participation were driven by domains such as risk-taking and a desire for social status. Research has shown that men adhering strongly to traditional masculine norms are also less likely to visit doctors, participate in health screenings, or follow medical advice (143). Similarly, another study indicated that men view seeking medical help as a threat to their masculinity and independence, often leading to delayed diagnoses and poorer health outcomes (196). Gerdes & Levant also explored the complex relationships between masculine norms and various health and well-being outcomes and found that positive associations were observed between pursuit of status and health-promoting behaviors. This indicates that those who prioritize status also engage in activities beneficial to their health, such as exercise. This finding is consistent with our study's results, which suggest that individuals who prioritize status may be more inclined to participate in health-promoting activities, such as regular exercise, to enhance their physical fitness and overall well-being (197).

Gender biases in medical research has led to substantial disparities in the diagnosis and treatment of various diseases. Historically, cardiology has predominantly focused on men, resulting in significant under-recognition and treatment of heart disease in women (198, 199). This gender bias in research and clinical practice has led

to poorer outcomes in women with cardiovascular diseases. Much like osteoporosis in men, where men are often undertreated and overlooked, cardiovascular research studies have primarily involved male participants, and the findings have been generalized to women without accounting for sex-specific differences in disease presentation, progression, and response to treatment (198). Women with heart disease often present with atypical symptoms compared to men, which leads to misdiagnosis or delayed diagnosis. Additionally, women are less likely to receive important treatments for heart disease compared to men (199). These disparities have called for efforts from the scientific community to address gender bias in cardiology, in parallel to the need for similar efforts in osteoporosis management for men.

To address gender bias in cardiology, one of the key strategies has been the initiation of gender-specific research. This involves conducting studies that focus specifically on women to understand the aspects of cardiovascular disease in this population. Gender-specific research aims to fill this gap by exploring sex- and gender-specific differences in disease presentation, risk factors, and treatment outcomes in cardiovascular diseases (200). These studies help identify unique markers and symptoms of heart disease in women, enabling the development of more accurate diagnostic tools and effective treatments tailored to women's needs (201).

Public health campaigns have been launched to raise awareness about heart disease in women. Campaigns such as the Go Red for Women (202, 203) from the American Heart Association aim to educate the public about the atypical symptoms of heart disease that women often experience, such as fatigue, shortness of breath, and nausea, which can differ significantly from the classic chest pain which is more

commonly reported by men. By increasing awareness, these campaigns encourage women to seek timely medical help and advocate for their health (203). These awareness campaigns also aim to challenge and change the misconception that heart disease is primarily a male issue, highlighting the importance of cardiovascular health for women (204). Another strategy is to provide healthcare professionals with more comprehensive training on gender differences in cardiovascular disease, which focuses on improving the understanding of how heart disease manifests differently in women and the importance of considering these differences in diagnosis and treatment. Improved training allows for clinicians to be better equipped to recognize, diagnose, and treat cardiovascular disease in women, ultimately leading to improved patient outcomes (205, 206). Lastly, updating clinical guidelines to include sex-specific recommendations has been an important way to address gender bias in cardiology. Traditional guidelines often lacked specific considerations for women, which contributed to the under-treatment and mismanagement of heart disease in this population (207). Modern guideline updates incorporate the latest evidence from gender-specific research, providing unique tailored recommendations for the prevention, diagnosis, and treatment of cardiovascular disease in women (208). By including sex-specific information, clinical guidelines ensure that healthcare providers are equipped with the knowledge to deliver equitable care to both men and women.

To address the highlighted gender bias in osteoporosis management, similar strategies should be adopted. Some of which is being done currently such as the conduct of men-specific research studies, MrOs cohort studies (209), osteoporosis drug efficacy studies in men, complex intervention clinical trials in men (MisterFIT-

NCT05927623) and clinical guidelines that provide men-specific recommendations (210, 211). Furthermore, patient support organizations for the management of osteoporosis (such as Osteoporosis Canada) have developed educational tools specifically for men (osteoporosis.ca) and men's group activities (Bones 'n Beer) to discuss skeletal health in a space they appreciate.

Strengths and limitations

Our study has strengths and limitations. This is the first study to analyse the effect of conformity to masculine norms and its impact on perceived self-efficacy in men who suffer a female-associated disease. The information gained through this study is very valuable when considering the development of osteoporosis management strategies in men. The survey was developed in collaboration with patient partners and underwent piloting to ensure its feasibility and relevance. Validated surveys were utilized for key variables, enhancing the reliability of our data collection methods. These tools which have been tested for consistency and accuracy ensured precise the measurement of our variables such as osteoporosis self-efficacy and adherence to masculine norms. This strategy minimized measurement errors and allowed us to compare our findings with other studies. Additionally, the survey was made widely accessible through social media and other channels to accommodate participants without internet access. We also made deliberate efforts and succeeded in recruiting participants from diverse racial and ethnic backgrounds, contributing to the inclusivity and representativeness of our sample. We successfully overcame recruitment barriers by using targeted outreach strategies and efforts to address misconceptions particularly among older men who may not perceive themselves at high risk for fractures.

Limitations associated to the study design include potential biases. There could have been a self-selection bias, since men who are more health-conscious or have a personal interest in osteoporosis may have been more likely to respond, which could have led to an overestimation of osteoporosis awareness and management behaviors in the general male population (212). Another limitation is social desirability bias. Men might underreport behaviors that are perceived as less masculine or overreport behaviors that align with societal expectations of masculinity and health perceptions. This could have led to the inaccurate reporting of their health behaviors, self-efficacy, and adherence to masculine norms (213). Selection bias is always a concern with survey studies. Certain groups of men, e.g., those having completed post-secondary education, are overrepresented, so the results may not be generalizable to the broader male population (212). Although the survey was available in French and English, individuals not fluent in these languages would not have participated. This limitation could have also led to the underrepresentation of certain populations, such as recent immigrants or individuals from non-English and non-French speaking communities (214). Finally the cross-sectional nature of the survey prevents the assessment of the changes in our variables over time (215).

4.2 Future Work And Perspectives

The first step toward optimized osteoporosis care and reducing its burden is to understand the specific challenges faced by older men at high risk for fractures, particularly in the context of masculine norms. Our findings indicate that high conformity to masculine norms is associated with low self-efficacy in osteoporosis management in

general and specifically calcium intake, which is an important aspect of osteoporosis management.

Tailored educational programs are important to address the perceptions and barriers men face regarding osteoporosis management. Men often perceive health issues as less serious or delay seeking treatment due to traditional masculine norms (131). Some strategies for tailored support and education include developing educational materials that specifically address men's health preferences, identifying and addressing common barriers men face in managing osteoporosis. Offering interactive workshops that engage men in discussions about osteoporosis, encouraging family and friends to provide additional motivation and accountability to these men in their disease management journey and implementing follow-up programs to reinforce the importance of osteoporosis management to keep men engaged and informed about their health are all strategies that can be implemented.

To highlight the benefits of exercise and appropriate nutrition in preserving muscle mass, bone strength, and overall physical capability, we can reframe osteoporosis self-management in terms of maintaining physical strength and independence. We can encourage men to take control of their health by adopting a proactive approach to osteoporosis management, by emphasizing the concept of taking charge which can align with traditional masculine values that those with low self-efficacy identify with. Male-specific support groups where men can share their experiences and strategies for managing osteoporosis can provide a sense of collaboration and mutual support and make them feel more comfortable discussing their health issues. Strategies, such as motivational interviewing, peer support groups, and personalized

health coaching, should be developed and implemented, to address the psychological and social barriers men with high CMNI face regarding dietary management. Using male public figures who can advocate for osteoporosis awareness and using illustrations highlighting men following treatment plans can help reduce the stigma and encourage men to take action. Lastly, since domains like pursuit of status and risk-taking are valued in men who may feel less self-efficient, incorporating physical challenges into intervention programs, such as step challenges or fitness tracking, can motivate men who value competitive environments to participate actively in osteoporosis management.

Another strategy, similar to how gender biases in cardiology are addressed, would be to provide healthcare professionals with training on the specific aspects of osteoporosis in men, including the importance of screening, recognizing risk factors, and providing appropriate management. Educating clinicians about the specific needs of men with osteoporosis can improve diagnosis and treatment. And, updating clinical guidelines to include specific recommendations for the diagnosis and treatment of osteoporosis in men will allow healthcare providers to address the challenges and needs of men, ensuring they receive the same level of care and attention as women in managing this condition.

The significant differences in osteoporosis self-efficacy based on demographic factors such as immigration status, race/ethnicity, and income levels highlight the need for culturally sensitive healthcare interventions. We should focus on developing and testing culturally tailored educational materials and support programs. These programs must address the unique needs and barriers faced by men from diverse educational,

ethnic and socioeconomic backgrounds, to ensure that interventions are relevant and effective across these different demographic groups. The cross-sectional nature of our study limits the ability to analyze changes in perceived self-efficacy over time. Hence, future research should involve longitudinal studies to track self-efficacy changes and health behaviors in men with osteoporosis, to provide insights on the long-term impact of tailored interventions.

Our study identified an interaction between depressive symptoms and CMNI on osteoporosis self-efficacy, which emphasizes the importance of integrating mental health screening into osteoporosis care. Future research should investigate treatment plans that include mental health screenings and interventions alongside osteoporosis management. These integrated approaches can address the psychological factors that impede effective disease management, especially in men who conform highly to traditional masculine norms.

Our findings highlight the need for policy changes to support osteoporosis screening and management in men. We should focus on the advocacy of health policies to ensure timely and appropriate care for men at high risk for fractures, including promoting research funding for studies on men's bone health and improving access in remote areas. By launching public health campaigns targeted at men to raise awareness about osteoporosis, emphasizing early detection, lifestyle modifications, and treatment adherence, we can challenge the misconception that osteoporosis is only a women's disease.

By implementing these strategies, the gender bias in osteoporosis management and in other healthcare disparities can be addressed, leading to better outcomes for men and ensuring equitable care for all patients.

4.3 Conclusion

In conclusion, our study found that men adhering strongly to traditional masculine norms exhibit lower self-efficacy in managing osteoporosis, particularly in dietary calcium intake. Our findings underline the need to address masculine norms in osteoporosis management interventions to improving health outcomes for men. Addressing these norms through tailored interventions, culturally sensitive care, and integrated mental health support can improve osteoporosis outcomes and quality of life for older men at high risk for fractures. Collaboration among researchers, healthcare providers, policymakers, and the community is essential to create a more inclusive and effective approach to osteoporosis management in men. By implementing these strategies, the gender bias in osteoporosis management and other healthcare disparities can be addressed, leading to better outcomes for men and ensuring equitable care for all patients. Future work should build on these findings to develop and implement interventions addressing the unique challenges faced by older men at high risk for fractures.

CHAPTER 5: REFERENCES & APPENDICES

5.1 References

1. Sözen T, Özışık L, Başaran N. An overview and management of osteoporosis. Eur J Rheumatol. 2017;4(1):46-56.
2. Coughlan T, Dockery F. Osteoporosis and fracture risk in older people. Clinical medicine. 2014;14(2):187.
3. Canada PHAo. Osteoporosis and Related Fractures in Canada: Report from the Canadian Chronic Disease Surveillance System. Canadian Chronic Disease Surveillance System Ottawa, ON; 2020.
4. Foundation NO. Clinician's guide to prevention and treatment of osteoporosis. National Osteoporosis Foundation. 2010.
5. Sözen T, Özışık L, Başaran NÇ. An overview and management of osteoporosis. European journal of rheumatology. 2017;4(1):46.
6. Papaioannou A, Morin S, Cheung AM, Atkinson S, Brown JP, Feldman S, et al. 2010 clinical practice guidelines for the diagnosis and management of osteoporosis in Canada: summary. Canadian Medical Association Journal. 2010;182(17):1864-73.
7. Ensrud KE, Ewing SK, Taylor BC, Fink HA, Stone KL, Cauley JA, et al. Frailty and Risk of Falls, Fracture, and Mortality in Older Women: The Study of Osteoporotic Fractures. The Journals of Gerontology: Series A. 2007;62(7):744-51.
8. Papaioannou A, Wiktorowicz M, Adachi JD, Goeree R, Papadimitropoulos E, Bédard M, et al. Mortality, independence in living, and re-fracture, one year following hip fracture in Canadians. Journal SOGC. 2000;22(8):591-7.
9. Hopkins RB, Burke N, Von Keyserlingk C, Leslie WD, Morin SN, Adachi JD, et al. The current economic burden of illness of osteoporosis in Canada. Osteoporos Int. 2016;27(10):3023-32.
10. Hopkins R, Burke N, Von Keyserlingk C, Leslie W, Morin S, Adachi J, et al. The current economic burden of illness of osteoporosis in Canada. Osteoporosis International. 2016;27:3023-32.
11. Tarride J-E, Hopkins R, Leslie W, Morin S, Adachi J, Papaioannou A, et al. The burden of illness of osteoporosis in Canada. Osteoporosis International. 2012;23:2591-600.
12. Leslie WD. Ethnic Differences in Bone Mass—Clinical Implications. The Journal of Clinical Endocrinology & Metabolism. 2012;97(12):4329-40.
13. Bao Y, Xu Y, Li Z, Wu Q. Racial and ethnic difference in the risk of fractures in the United States: a systematic review and meta-analysis. Sci Rep. 2023;13(1):9481.
14. Singer B, McLauchlan G, Robinson C, Christie J. Epidemiology of fractures in 15 000 adults: the influence of age and gender. The Journal of Bone & Joint Surgery British Volume. 1998;80(2):243-8.
15. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. J Bone Miner Res. 2007;22(3):465-75.

16. Wright NC, Chen L, Saag KG, Brown CJ, Shikany JM, Curtis JR. Racial Disparities Exist in Outcomes After Major Fragility Fractures. J Am Geriatr Soc. 2020;68(8):1803-10.
17. Noel SE, Santos MP, Wright NC. Racial and ethnic disparities in bone health and outcomes in the United States. Journal of Bone and Mineral Research. 2020;36(10):1881-905.
18. Cauley JA, Palermo L, Vogt M, Ensrud KE, Ewing S, Hochberg M, et al. Prevalent vertebral fractures in black women and white women. Journal of Bone and Mineral Research. 2008;23(9):1458-67.
19. Gough Courtney M, Roberts J, Godde K. Structural Inequity and Socioeconomic Status Link to Osteoporosis Diagnosis in a Population-Based Cohort of Middle-Older-Age Americans. Inquiry. 2023;60:469580231155719.
20. Kim J, Lee J, Shin JY, Park BJ. Socioeconomic disparities in osteoporosis prevalence: different results in the overall Korean adult population and single-person households. J Prev Med Public Health. 2015;48(2):84-93.
21. Du Y, Zhao LJ, Xu Q, Wu KH, Deng HW. Socioeconomic status and bone mineral density in adults by race/ethnicity and gender: the Louisiana osteoporosis study. Osteoporos Int. 2017;28(5):1699-709.
22. Marshall K, Teo L, Shanahan C, Legette L, Mitmesser SH. Inadequate calcium and vitamin D intake and osteoporosis risk in older Americans living in poverty with food insecurities. PLoS One. 2020;15(7):e0235042.
23. Rawal LB, Smith BJ, Quach H, Renzaho AMN. Physical Activity among Adults with Low Socioeconomic Status Living in Industrialized Countries: A Meta-Ethnographic Approach to Understanding Socioecological Complexities. J Environ Public Health. 2020;2020:4283027.
24. Puth M-T, Klaschik M, Schmid M, Weckbecker K, Münster E. Prevalence and comorbidity of osteoporosis– a cross-sectional analysis on 10,660 adults aged 50 years and older in Germany. BMC Musculoskeletal Disorders. 2018;19(1):144.
25. Romero-Díaz C, Duarte-Montero D, Gutiérrez-Romero SA, Mendivil CO. Diabetes and Bone Fragility. Diabetes Ther. 2021;12(1):71-86.
26. Ashai S, Harvey NC. Rheumatoid arthritis and bone health. Clin Med (Lond). 2020;20(6):565-7.
27. Merlotti D, Mingiano C, Valenti R, Cavati G, Calabrese M, Pirrotta F, et al. Bone Fragility in Gastrointestinal Disorders. Int J Mol Sci. 2022;23(5).
28. Delitala AP, Scuteri A, Doria C. Thyroid Hormone Diseases and Osteoporosis. J Clin Med. 2020;9(4).
29. Sheu A, Diamond T. Bone mineral density: testing for osteoporosis. Aust Prescr. 2016;39(2):35-9.
30. Morin SN, Feldman S, Funnell L, Giangregorio L, Kim S, McDonald-Blumer H, et al. Clinical practice guideline for management of osteoporosis and fracture prevention in Canada: 2023 update. CMAJ. 2023;195(39):E1333-E48.
31. Unnanuntana A, Gladnick BP, Donnelly E, Lane JM. The assessment of fracture risk. J Bone Joint Surg Am. 2010;92(3):743-53.

32. Kanis JA, Harvey NC, Johansson H, Odén A, Leslie WD, McCloskey EV. FRAX Update. J Clin Densitom. 2017;20(3):360-7.
33. Kanis J, Johansson H, Harvey N, McCloskey E. A brief history of FRAX. Arch Osteoporos 13: 118. 2018.
34. Kanis JA, Cooper C, Rizzoli R, Abrahamsen B, Al-Daghri NM, Brandi ML, et al. Identification and management of patients at increased risk of osteoporotic fracture: outcomes of an ESCEO expert consensus meeting. Osteoporos Int. 2017;28(7):2023-34.
35. Dawson-Hughes B, Committee NOFG. A revised clinician's guide to the prevention and treatment of osteoporosis. The Journal of Clinical Endocrinology & Metabolism. 2008;93(7):2463-5.
36. Fraenkel L, Bathon JM, England BR, St. Clair EW, Arayssi T, Carandang K, et al. 2021 American College of Rheumatology guideline for the treatment of rheumatoid arthritis. Arthritis & Rheumatology. 2021;73(7):1108-23.
37. JA K. European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO). European guidance for the diagnosis and management of osteoporosis in postmenopausal women. Osteoporosis Int. 2008;19:399-428.
38. LeBoff MS, Hawkes WG, Glowacki J, Yu-Yahiro J, Hurwitz S, Magaziner J. Vitamin D-deficiency and post-fracture changes in lower extremity function and falls in women with hip fractures. Osteoporosis International. 2008;19(9):1283-90.
39. Ji J, Hou Y, Li Z, Zhou Y, Xue H, Wen T, et al. Association between physical activity and bone mineral density in postmenopausal women: a cross-sectional study from the NHANES 2007-2018. J Orthop Surg Res. 2023;18(1):501.
40. Varahra A, Rodrigues I, MacDermid J, Bryant D, Birmingham T. Exercise to improve functional outcomes in persons with osteoporosis: a systematic review and meta-analysis. Osteoporosis International. 2018;29:265-86.
41. Sinaki M, Pfeifer M, Preisinger E, Itoi E, Rizzoli R, Boonen S, et al. The Role of Exercise in the Treatment of Osteoporosis. Current Osteoporosis Reports. 2010;8(3):138-44.
42. Gupta A, March L. Treating osteoporosis. Aust Prescr. 2016;39(2):40-6.
43. LeBoff MS, Greenspan SL, Insogna KL, Lewiecki EM, Saag KG, Singer AJ, et al. The clinician's guide to prevention and treatment of osteoporosis. Osteoporos Int. 2022;33(10):2049-102.
44. Qaseem A, Snow V, Shekelle P, Hopkins Jr R, Forciea MA, Owens DK, et al. Pharmacologic treatment of low bone density or osteoporosis to prevent fractures: a clinical practice guideline from the American College of Physicians. Annals of internal medicine. 2008;149(6):404-15.
45. Wright N, Saag K, Dawson-Hughes B, Khosla S, Siris E. The impact of the new National Bone Health Alliance (NBHA) diagnostic criteria on the prevalence of osteoporosis in the USA. Osteoporosis International. 2017;28:1225-32.
46. Compston J, Cooper A, Cooper C, Gittoes N, Gregson C, Harvey N, et al. UK clinical guideline for the prevention and treatment of osteoporosis. Archives of osteoporosis. 2017;12:1-24.

47. Walters S, Khan T, Ong T, Sahota O. Fracture liaison services: improving outcomes for patients with osteoporosis. Clin Interv Aging. 2017;12:117-27.
48. Mitchell PJ. Best Practices in Secondary Fracture Prevention: Fracture Liaison Services. Current Osteoporosis Reports. 2013;11(1):52-60.
49. Foundation NO. America's bone health: the state of osteoporosis and low bone mass in our nation. Washington, DC: National Osteoporosis Foundation;. 2002:1-55.
50. Leslie W, O'donnell S, Lagace C, Walsh P, Bancej C, Jean S, et al. Population-based Canadian hip fracture rates with international comparisons. Osteoporosis international. 2010;21:1317-22.
51. von Friesendorff M, McGuigan FE, Besjakov J, Akesson K. Hip fracture in men-survival and subsequent fractures: a cohort study with 22-year follow-up. J Am Geriatr Soc. 2011;59(5):806-13.
52. Jiang HX, Majumdar SR, Dick DA, Moreau M, Raso J, Otto DD, et al. Development and initial validation of a risk score for predicting in-hospital and 1-year mortality in patients with hip fractures. Journal of Bone and Mineral Research. 2005;20(3):494-500.
53. Papaioannou A, Kennedy CC, Ioannidis G, Gao Y, Sawka A, Goltzman D, et al. The osteoporosis care gap in men with fragility fractures: the Canadian Multicentre Osteoporosis Study. Osteoporosis International. 2008;19:581-7.
54. Morin S, Lix LM, Azimaee M, Metge C, Majumdar SR, Leslie WD. Institutionalization following incident non-traumatic fractures in community-dwelling men and women. Osteoporos Int. 2012;23(9):2381-6.
55. Ackerman KE, Misra M. Bone health and the female athlete triad in adolescent athletes. Phys Sportsmed. 2011;39(1):131-41.
56. Karsenty G. The mutual dependence between bone and gonads. The Journal of endocrinology. 2012;213(2):107-14.
57. Riggs BL, Khosla S, Melton III LJ. Sex steroids and the construction and conservation of the adult skeleton. Endocrine reviews. 2002;23(3):279-302.
58. Lambert JK, Zaidi M, Mechanick JI. Male osteoporosis: epidemiology and the pathogenesis of aging bones. Current osteoporosis reports. 2011;9:229-36.
59. Looker AC, Beck TJ, Orwoll ES. Does body size account for gender differences in femur bone density and geometry? Journal of bone and mineral research. 2001;16(7):1291-9.
60. Zhang Y-W, Lu P-P, Li Y-J, Dai G-C, Chen M-H, Zhao Y-K, et al. Prevalence, characteristics, and associated risk factors of the elderly with hip fractures: a cross-sectional analysis of NHANES 2005–2010. Clinical interventions in aging. 2021:177-85.
61. Rinonapoli G, Ruggiero C, Meccariello L, Bisaccia M, Ceccarini P, Caraffa A. Osteoporosis in men: a review of an underestimated bone condition. International journal of molecular sciences. 2021;22(4):2105.
62. Cauley JA, Chalhoub D, Kassem AM, Fuleihan GE-H. Geographic and ethnic disparities in osteoporotic fractures. Nature Reviews Endocrinology. 2014;10(6):338-51.
63. Orlic ZC, Raisz LG. Causes of secondary osteoporosis. Journal of clinical densitometry. 1999;2(1):79-92.

64. Ebeling PR, Nguyen HH, Aleksova J, Vincent AJ, Wong P, Milat F. Secondary osteoporosis. Endocrine Reviews. 2022;43(2):240-313.
65. Vondracek SF, Hansen LB. Current approaches to the management of osteoporosis in men. American journal of health-system pharmacy. 2004;61(17):1801-11.
66. Ganesan K, Jandu JS, Anastasopoulou C, Ahsun S, Roane D. Secondary osteoporosis. 2017.
67. Schuit SC, van der Klift M, Weel AE, de Laet CE, Burger H, Seeman E, et al. Fracture incidence and association with bone mineral density in elderly men and women: the Rotterdam Study. Bone. 2004;34(1):195-202.
68. Cosman F, de Beur SJ, LeBoff MS, Lewiecki EM, Tanner B, Randall S, et al. Clinician's Guide to Prevention and Treatment of Osteoporosis. Osteoporos Int. 2014;25(10):2359-81.
69. Nielsen DS, Brixen K, Huniche L. Men's Experiences of Living With Osteoporosis: Focus Group Interviews. American Journal of Men's Health. 2011;5(2):166-76.
70. Sale JEM, Ashe MC, Beaton D, Bogoch E, Frankel L. Men's health-seeking behaviours regarding bone health after a fragility fracture: a secondary analysis of qualitative data. Osteoporosis International. 2016;27(10):3113-9.
71. Majumdar SR, Lier DA, Hanley DA, Juby AG, Beaupre LA, for the S-PT. Economic evaluation of a population-based osteoporosis intervention for outpatients with non-traumatic non-hip fractures: the "Catch a Break" 1i [type C] FLS. Osteoporosis International. 2017;28(6):1965-77.
72. Compton M, Mortenson WB, Sale J, Crossman A, Ashe MC. Men's perceptions of living with osteoporosis: a systematic review of qualitative studies. International journal of orthopaedic and trauma nursing. 2019;33:11-7.
73. Raphael H, Gibson B, Walker J, Lathlean J. A grounded theory study of men's perceptions and experience of osteoporosis. Journal of Men's Health. 2009;3(6):229.
74. Rowley J, Johnson F, Sbaffi L. Gender as an influencer of online health information-seeking and evaluation behavior. Journal of the Association for Information Science and Technology. 2017;68(1):36-47.
75. Gaines JM, Marx KA. Older men's knowledge about osteoporosis and educational interventions to increase osteoporosis knowledge in older men: a systematic review. Maturitas. 2011;68(1):5-12.
76. Bandura A, Wessels S. Self-efficacy. 1994.
77. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Advances in behaviour research and therapy. 1978;1(4):139-61.
78. Bandura A. Regulation of cognitive processes through perceived self-efficacy. Developmental psychology. 1989;25(5):729.
79. Schwarzer R, Warner LM. Perceived self-efficacy and its relationship to resilience. Resilience in children, adolescents, and adults: Translating research into practice: Springer; 2012. p. 139-50.
80. Tahmassian K, Jalali Moghadam N. Relationship between self-efficacy and symptoms of anxiety, depression, worry and social avoidance in a normal sample of students. Iran J Psychiatry Behav Sci. 2011;5(2):91-8.

81. Kvarnström K, Westerholm A, Airaksinen M, Liira H. Factors Contributing to Medication Adherence in Patients with a Chronic Condition: A Scoping Review of Qualitative Research. Pharmaceutics. 2021;13(7).
82. Yao J, Wang H, Yin X, Yin J, Guo X, Sun Q. The association between self-efficacy and self-management behaviors among Chinese patients with type 2 diabetes. PLoS One. 2019;14(11):e0224869.
83. Strecher VJ, McEvoy DeVellis B, Becker MH, Rosenstock IM. The Role of Self-Efficacy in Achieving Health Behavior Change. Health Education Quarterly. 1986;13(1):73-92.
84. Tan F, Oka P, Dambha-Miller H, Tan NC. The association between self-efficacy and self-care in essential hypertension: a systematic review. BMC Fam Pract. 2021;22(1):44.
85. Teixeira PJ, Carraça EV, Markland D, Silva MN, Ryan RM. Exercise, physical activity, and self-determination theory: A systematic review. International Journal of Behavioral Nutrition and Physical Activity. 2012;9(1):78.
86. Chan SW. Chronic Disease Management, Self-Efficacy and Quality of Life. J Nurs Res. 2021;29(1):e129.
87. Marks R, Allegrante JP. A Review and Synthesis of Research Evidence for Self-Efficacy-Enhancing Interventions for Reducing Chronic Disability: Implications for Health Education Practice (Part II). Health Promotion Practice. 2005;6(2):148-56.
88. Schwarzer R, Jerusalem M. Generalized self-efficacy scale. J Weinman, S Wright, & M Johnston, Measures in health psychology: A user's portfolio Causal and control beliefs. 1995;35(37):82-003.
89. Freund T, Gensichen J, Goetz K, Szecsenyi J, Mahler C. Evaluating self-efficacy for managing chronic disease: psychometric properties of the six-item Self-Efficacy Scale in Germany. Journal of Evaluation in Clinical Practice. 2013;19(1):39-43.
90. Chen G, Gully SM, Eden D. Validation of a new general self-efficacy scale. Organizational research methods. 2001;4(1):62-83.
91. İncirkuş K, Nahcivan N. Validity and reliability study of the Turkish version of the self-efficacy for managing chronic disease 6-item scale. Turkish journal of medical sciences. 2020;50(5):1254-61.
92. Bailey S, Lin J. The association of osteoporosis knowledge and beliefs with preventive behaviors in postmenopausal breast cancer survivors. BMC Womens Health. 2021;21(1):297.
93. Park KS, Yoo JI, Kim HY, Jang S, Park Y, Ha YC. Education and exercise program improves osteoporosis knowledge and changes calcium and vitamin D dietary intake in community dwelling elderly. BMC Public Health. 2017;17(1):966.
94. Kim MJ, Kim KW. Nutrition knowledge, outcome expectations, self-efficacy, and eating behaviors by calcium intake level in Korean female college students. Nutr Res Pract. 2015;9(5):530-8.
95. Janiszewska M, Kulik T, Żołnierczuk-Kieliszek D, Drop B, Firlej E, Gajewska I. General self-efficacy level and health behaviours in women over the age of 45 years who have undergone osteoporosis treatment. Prz Menopauzalny. 2017;16(3):86-95.

96. Hsieh E, Fraenkel L, Bradley EH, Xia W, Insogna KL, Cui Q, et al. Osteoporosis knowledge, self-efficacy, and health beliefs among Chinese individuals with HIV. Arch Osteoporos. 2014;9(1):201.
97. Horan ML, Kim KK, Gendler P, Froman RD, Patel MD. Development and evaluation of the osteoporosis self-efficacy scale. Research in nursing & health. 1998;21(5):395-403.
98. Sahib MN. Validation and Assessment of Osteoporosis Self-Efficacy Among Iraqi General Population. Open Nurs J. 2018;12:76-85.
99. McLeod KM, Johnson CS. A systematic review of osteoporosis health beliefs in adult men and women. J Osteoporos. 2011;2011:197454.
100. Abdulameer SA, Syed Sulaiman SA, Hassali MA, Subramaniam K, Sahib MN. Psychometric properties and osteoprotective behaviors among type 2 diabetic patients: osteoporosis self-efficacy scale Malay version (OSES-M). Osteoporosis International. 2013;24(3):929-40.
101. Solimeo SL, Nguyen VTT, Edmonds SW, Lou Y, Roblin DW, Saag KG, et al. Sex differences in osteoporosis self-efficacy among community-residing older adults presenting for DXA. Osteoporosis International. 2019;30(5):1033-41.
102. Vaishya R, Vaish A. Falls in older adults are serious. Indian journal of orthopaedics. 2020;54:69-74.
103. Meyer F, König HH, Hajek A. Osteoporosis, Fear of Falling, and Restrictions in Daily Living. Evidence From a Nationally Representative Sample of Community-Dwelling Older Adults. Front Endocrinol (Lausanne). 2019;10:646.
104. Smulders E, van Lankveld W, Laan R, Duysens J, Weerdesteyn V. Does osteoporosis predispose falls? a study on obstacle avoidance and balance confidence. BMC Musculoskeletal Disorders. 2011;12(1):1.
105. Paolucci T, Saraceni VM, Piccinini G. Management of chronic pain in osteoporosis: challenges and solutions. J Pain Res. 2016;9:177-86.
106. Hsu W-L, Chen C-Y, Tsauo J-Y, Yang R-S. Balance control in elderly people with osteoporosis. Journal of the Formosan Medical Association. 2014;113(6):334-9.
107. Resnick B, Nahm ES, Zhu S, Brown C, An M, Park B, et al. The impact of osteoporosis, falls, fear of falling, and efficacy expectations on exercise among community-dwelling older adults. Orthop Nurs. 2014;33(5):277-86; quiz 87-8.
108. Lee D, Tak SH. A concept analysis of fear of falling in older adults: insights from qualitative research studies. BMC Geriatr. 2023;23(1):651.
109. Kumar A, Carpenter H, Morris R, Iliffe S, Kendrick D. Which factors are associated with fear of falling in community-dwelling older people? Age and Ageing. 2014;43(1):76-84.
110. Soh SL-H, Tan C-W, Thomas JI, Tan G, Xu T, Ng YL, et al. Falls efficacy: Extending the understanding of self-efficacy in older adults towards managing falls. Journal of frailty, sarcopenia and falls. 2021;6(3):131.
111. Clemson L, Stark S, Pighills AC, Fairhall NJ, Lamb SE, Ali J, et al. Environmental interventions for preventing falls in older people living in the community. Cochrane database of systematic reviews. 2023(3).

112. Sadaqa M, Németh Z, Makai A, Prémusz V, Hock M. Effectiveness of exercise interventions on fall prevention in ambulatory community-dwelling older adults: a systematic review with narrative synthesis. Front Public Health. 2023;11:1209319.
113. Li F, Fisher KJ, Harmer P, McAuley E. Falls self-efficacy as a mediator of fear of falling in an exercise intervention for older adults. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2005;60(1):P34-P40.
114. Aminzadeh F, Edwards N. Exploring seniors' views on the use of assistive devices in fall prevention. Public health nursing. 1998;15(4):297-304.
115. Garcia A, Marciniak D, McCune L, Smith E, Ramsey R. Promoting fall self-efficacy and fall risk awareness in older adults. Physical & Occupational Therapy in Geriatrics. 2012;30(2):165-75.
116. Camicioli R, Morris ME, Pieruccini-Faria F, Montero-Odasso M, Son S, Buzaglo D, et al. Prevention of Falls in Parkinson's Disease: Guidelines and Gaps. Mov Disord Clin Pract. 2023;10(10):1459-69.
117. Yardley L, Beyer N, Hauer K, Kempen G, Piot-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). Age and Ageing. 2005;34(6):614-9.
118. Kempen GI, Yardley L, Van Haastregt JC, Zijlstra GR, Beyer N, Hauer K, et al. The Short FES-I: a shortened version of the falls efficacy scale-international to assess fear of falling. Age and ageing. 2008;37(1):45-50.
119. McCambridge J, Kalaitzaki E, White IR, Khadjesari Z, Murray E, Linke S, et al. Impact of length or relevance of questionnaires on attrition in online trials: randomized controlled trial. Journal of medical Internet research. 2011;13(4):e1733.
120. Schnebly RA. Biological sex and gender in the United States. Arizona State University. School of Life Sciences. Center for Biology and ...; 2022.
121. Morgenroth T, Ryan MK. Gender trouble in social psychology: How can Butler's work inform experimental social psychologists' conceptualization of gender? Frontiers in Psychology. 2018;9:1320.
122. Lindqvist A, Sendén MG, Renström EA. What is gender, anyway: a review of the options for operationalising gender. Psychology & sexuality. 2021;12(4):332-44.
123. Reisner SL, Conron KJ, Scout, Baker K, Herman JL, Lombardi E, et al. "Counting" transgender and gender-nonconforming adults in health research: Recommendations from the gender identity in US surveillance group. Transgender Studies Quarterly. 2015;2(1):34-57.
124. Camilleri M, Murray K. Barriers to accessing health care among transgender individuals. Ontario HIV Treatment Network. 2017.
125. Vlassoff C. Gender differences in determinants and consequences of health and illness. J Health Popul Nutr. 2007;25(1):47-61.
126. Mahalik JR, Burns SM, Syzdek M. Masculinity and perceived normative health behaviors as predictors of men's health behaviors. Social science & medicine. 2007;64(11):2201-9.

127. Nusselder WJ, Cambois EM, Wapperom D, Meslé F, Looman CWN, Yokota RTC, et al. Women's excess unhealthy life years: disentangling the unhealthy life years gap. Eur J Public Health. 2019;29(5):914-9.
128. Crimmins EM, Shim H, Zhang YS, Kim JK. Differences between Men and Women in Mortality and the Health Dimensions of the Morbidity Process. Clin Chem. 2019;65(1):135-45.
129. Thompson AE, Anisimowicz Y, Miedema B, Hogg W, Wodchis WP, Aubrey-Bassler K. The influence of gender and other patient characteristics on health care-seeking behaviour: a QUALICOPC study. BMC Fam Pract. 2016;17:38.
130. Mahalik JR, Levi-Minzi M, Walker G. Masculinity and health behaviors in Australian men. Psychology of Men & Masculinity. 2007;8(4):240-9.
131. Novak JR, Peak T, Gast J, Arnell M. Associations Between Masculine Norms and Health-Care Utilization in Highly Religious, Heterosexual Men. Am J Mens Health. 2019;13(3):1557988319856739.
132. Palefsky JM. Human papillomavirus-related disease in men: not just a women's issue. Journal of Adolescent Health. 2010;46(4):S12-S9.
133. Farrimond H. Beyond the caveman: Rethinking masculinity in relation to men's help-seeking. Health:. 2012;16(2):208-25.
134. Möller-Leimkühler AM. Barriers to help-seeking by men: a review of sociocultural and clinical literature with particular reference to depression. Journal of affective disorders. 2002;71(1-3):1-9.
135. McKenzie SK, Oliffe JL, Black A, Collings S. Men's Experiences of Mental Illness Stigma Across the Lifespan: A Scoping Review. Am J Mens Health. 2022;16(1):15579883221074789.
136. Palmer R, Smith BJ, Kite J, Phongsavan P. The socio-ecological determinants of help-seeking practices and healthcare access among young men: a systematic review. Health Promot Int. 2024;39(2).
137. Fabiano PM, Perkins HW, Berkowitz A, Linkenbach J, Stark C. Engaging men as social justice allies in ending violence against women: evidence for a social norms approach. J Am Coll Health. 2003;52(3):105-12.
138. Tyler RE, Williams S. Masculinity in young men's health: Exploring health, help-seeking and health service use in an online environment. Journal of Health Psychology. 2014;19(4):457-70.
139. Hooker SP, Wilcox S, Burroughs EL, Rheaume CE, Courtenay W. The potential influence of masculine identity on health-improving behavior in midlife and older African American men. J Mens Health. 2012;9(2):79-88.
140. Courtenay WH. College men's health: An overview and a call to action. Journal of American college health. 1998;46(6):279-90.
141. Rivera A, Scholar J. Traditional masculinity: a review of toxicity rooted in social norms and gender socialization. Advances in Nursing Science. 2020;43(1):E1-E10.
142. Gast J, Peak T. "It used to be that if it weren't broken and bleeding profusely, I would never go to the doctor": men, masculinity, and health. American journal of men's health. 2011;5(4):318-31.

143. Mahalik JR, Locke BD, Ludlow LH, Diemer MA, Scott RP, Gottfried M, et al. Development of the conformity to masculine norms inventory. Psychology of men & masculinity. 2003;4(1):3.
144. Burns SM, Mahalik JR. Conformity to masculine norms inventory--22 items. American Journal of Men's Health. 2008.
145. Zijlmans EA, Tijmstra J, Van der Ark LA, Sijtsma K. Item-score reliability as a selection tool in test construction. Frontiers in psychology. 2019;9:2298.
146. Herreen D, Rice S, Currier D, Schlichthorst M, Zajac I. Associations between conformity to masculine norms and depression: age effects from a population study of Australian men. BMC Psychology. 2021;9(1):32.
147. Milner A, Shields M, King T. The influence of masculine norms and mental health on health literacy among men: Evidence from the ten to men study. American journal of men's health. 2019;13(5):1557988319873532.
148. Sileo KM, Kershaw TS. Dimensions of Masculine Norms, Depression, and Mental Health Service Utilization: Results From a Prospective Cohort Study Among Emerging Adult Men in the United States. Am J Mens Health. 2020;14(1):1557988320906980.
149. Iwamoto DK, Smiler AP. Alcohol makes you macho and helps you make friends: the role of masculine norms and peer pressure in adolescent boys' and girls' alcohol use. Subst Use Misuse. 2013;48(5):371-8.
150. Davis B, Honomichl R, Sullivan AB. Effects of Conformity to Masculine Norms and Coping on Health Behaviors in Men With Multiple Sclerosis. Int J MS Care. 2022;24(4):162-8.
151. Hsu K, Iwamoto DK. Testing for Measurement Invariance in the Conformity to Masculine Norms-46 Across White and Asian American College Men: Development and Validity of the CMNI-29. Psychol Men Masc. 2014;15(4):397-406.
152. Smiler AP. Conforming to Masculine Norms: Evidence for Validity among Adult Men and Women. Sex Roles. 2006;54(11):767-75.
153. Hyman L, Lamb J, Bulmer M, editors. The use of pre-existing survey questions: Implications for data quality. Proceedings of the European Conference on Quality in Survey Statistics; 2006: Cardiff Wales, UK.
154. Godin G. The Godin-Shephard leisure-time physical activity questionnaire. The Health & Fitness Journal of Canada. 2011;4(1):18-22.
155. Yuan C, Yong G, Wang X, Xie T, Wang C, Yuan Y, et al. Developing the Patient Health Questionnaire-8 for a greater impact on the quality of life of patients with functional dyspepsia compared to Somatic Symptom Scale-8. BMC Gastroenterology. 2020;20(1):359.
156. Storozuk A, Ashley M, Delage V, Maloney EA. Got bots? Practical recommendations to protect online survey data from bot attacks. The Quantitative Methods for Psychology. 2020;16(5):472-81.
157. Bauer GR, Braimoh J, Scheim AI, Dharma C. Transgender-inclusive measures of sex/gender for population surveys: Mixed-methods evaluation and recommendations. PloS one. 2017;12(5):e0178043.

158. Cipriani E, Giguère C-E, Samson-Daoust E, Cotocea I, Juster R-P. Mesurer le genre en recherche sur les humains, un nouveau questionnaire adapté.
159. Parker C, Scott S, Geddes A. Snowball sampling. SAGE research methods foundations. 2019.
160. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. Journal of biomedical informatics. 2009;42(2):377-81.
161. Mahalik JR, Talmadge WT, Locke BD, Scott RP. Using the Conformity to Masculine Norms Inventory to work with men in a clinical setting. Journal of clinical psychology. 2005;61(6):661-74.
162. Visschedijk JH, Terwee CB, Caljouw MA, Spruit-van Eijk M, van Balen R, Achterberg WP. Reliability and validity of the Falls Efficacy Scale-International after hip fracture in patients aged≥ 65 years. Disability and rehabilitation. 2015;37(23):2225-32.
163. van Vliet R, Hoang P, Lord S, Gandevia S, Delbaere K. Falls efficacy scale-international: a cross-sectional validation in people with multiple sclerosis. Archives of physical medicine and rehabilitation. 2013;94(5):883-9.
164. Morgan MT, Friscia LA, Whitney SL, Furman JM, Sparto PJ. Reliability and validity of the Falls Efficacy Scale–International (FES-I) in individuals with dizziness and imbalance. Otology & Neurotology. 2013;34(6):1104-8.
165. Fürtjes S, Voss C, Rückert F, Peschel SK, Kische H, Ollmann TM, et al. Self-efficacy, stress, and symptoms of depression and anxiety in adolescents: An epidemiological cohort study with ecological momentary assessment. Journal of Mood & Anxiety Disorders. 2023;4:100039.
166. Etemadifar MR, Nourian SM, Fereidan-Esfahani M, Shemshaki H, Nourbakhsh M, Zarezadeh A. Relationship of knowledge about osteoporosis with education level and life habits. World J Orthop. 2013;4(3):139-43.
167. Piao HH, He J, Zhang K, Tang Z. A cross-sectional study to estimate associations between education level and osteoporosis in a Chinese postmenopausal women sample. Int J Clin Exp Med. 2015;8(11):21014-23.
168. Choi MH, Yang JH, Seo JS, Kim YJ, Kang SW. Prevalence and diagnosis experience of osteoporosis in postmenopausal women over 50: Focusing on socioeconomic factors. PLoS One. 2021;16(3):e0248020.
169. Tsai AJ. Disparities in osteoporosis by race/ethnicity, education, work status, immigrant status, and economic status in the United States. European journal of internal medicine. 2019;64:85-9.
170. Whitley MD, Herman PM, Aliyev GR, Sherbourne CD, Ryan GW, Coulter ID. Income as a predictor of self-efficacy for managing pain and for coping with symptoms among patients with chronic low back pain. Journal of manipulative and physiological therapeutics. 2021;44(6):433-44.
171. Nayak S, Roberts MS, Chang CC, Greenspan SL. Health Beliefs about Osteoporosis and Osteoporosis Screening in Older Women and Men. Health Educ J. 2010;69(3):267-76.

172. des Bordes J, Prasad S, Pratt G, Suarez-Almazor ME, Lopez-Olivo MA. Knowledge, beliefs, and concerns about bone health from a systematic review and metasynthesis of qualitative studies. PLoS One. 2020;15(1):e0227765.
173. Asai T, Oshima K, Fukumoto Y, Yonezawa Y, Matsuo A, Misu S. The association between fear of falling and occurrence of falls: a one-year cohort study. BMC Geriatrics. 2022;22(1):393.
174. Scheffer AC, Schuurmans MJ, Van Dijk N, Van Der Hooft T, De Rooij SE. Fear of falling: measurement strategy, prevalence, risk factors and consequences among older persons. Age and ageing. 2008;37(1):19-24.
175. Sharma H. Statistical significance or clinical significance? A researcher's dilemma for appropriate interpretation of research results. Saudi J Anaesth. 2021;15(4):431-4.
176. Fritz CO, Morris PE, Richler JJ. Effect size estimates: current use, calculations, and interpretation. Journal of experimental psychology: General. 2012;141(1):2.
177. Serdar CC, Cihan M, Yücel D, Serdar MA. Sample size, power and effect size revisited: simplified and practical approaches in pre-clinical, clinical and laboratory studies. Biochem Med (Zagreb). 2021;31(1):010502.
178. Sullivan GM, Feinn R. Using effect size—or why the P value is not enough. Journal of graduate medical education. 2012;4(3):279-82.
179. Vetter TR, Chou R. Clinical trial design methodology for pain outcome studies. Practical Management of Pain: Fifth Edition: Elsevier Inc.; 2013. p. 1057-65.
180. Cook CE. Clinimetrics Corner: The Minimal Clinically Important Change Score (MCID): A Necessary Pretense. J Man Manip Ther. 2008;16(4):E82-3.
181. Mayo NE, Anderson S, Barclay R, Cameron JI, Desrosiers J, Eng JJ, et al. Getting on with the rest of your life following stroke: a randomized trial of a complex intervention aimed at enhancing life participation post stroke. Clin Rehabil. 2015;29(12):1198-211.
182. Osoba D, Bezjak A, Brundage M, Zee B, Tu D, Pater J, et al. Analysis and interpretation of health-related quality-of-life data from clinical trials: basic approach of The National Cancer Institute of Canada Clinical Trials Group. European journal of cancer. 2005;41(2):280-7.
183. Courtenay WH. Constructions of masculinity and their influence on men's well-being: a theory of gender and health. Soc Sci Med. 2000;50(10):1385-401.
184. Wong YJ, Ho M-HR, Wang S-Y, Miller I. Meta-analyses of the relationship between conformity to masculine norms and mental health-related outcomes. Journal of counseling psychology. 2017;64(1):80.
185. De Jesus AY, Ricciardelli LA, Frisén A, Smolak L, Yager Z, Fuller-Tyszkiewicz M, et al. Media internalization and conformity to traditional masculine norms in relation to body image concerns among men. Eating behaviors. 2015;18:137-42.
186. Dawson N, Hammer JH. No pain, no gains: Conformity to masculine norms, body dissatisfaction, and exercise dependence. Psychology of Men & Masculinities. 2020;21(3):430.
187. Gammage KL, Gasparotto J, Mack DE, Klentrou P. Gender Differences in Osteoporosis Health Beliefs and Knowledge and Their Relation to Vigorous Physical Activity in University Students. Journal of American College Health. 2012;60(1):58-64.

188. Wang Y, Li C, Chang R, Qiao Y, Cai Y, Shen T. Predicting osteoporosis preventive behaviors in middle-aged and older urban Shanghai residents: a health belief model-based path analysis in a multi-center population study. Front Public Health. 2023;11:1235251.
189. Kim S, Yu S. Men's mental health and interventions tailored to masculinity: A scoping review. The Journal of Men's Health. 2023;19(11):1-10.
190. Cherrington A, Wallston KA, Rothman RL. Exploring the relationship between diabetes self-efficacy, depressive symptoms, and glycemic control among men and women with type 2 diabetes. J Behav Med. 2010;33(1):81-9.
191. Zhou Y, Huo Q, Du S, Shi X, Shi Q, Cui S, et al. Social Support and Self-Efficacy as Mediating Factors Affecting the Association Between Depression and Medication Adherence in Older Patients with Coronary Heart Disease: A Multiple Mediator Model with a Cross-Sectional Study. Patient Prefer Adherence. 2022;16:285-95.
192. Melin J, Fors A, Jakobsson S, Krabbe D, Björkman I. Self-Efficacy to Manage Chronic Disease (SEMCD) scale: translation and evaluation of measurement properties for a swedish version. Archives of Public Health. 2023;81(1):2.
193. O'brien R, Hunt K, Hart G. 'It's caveman stuff, but that is to a certain extent how guys still operate': men's accounts of masculinity and help seeking. Social science & medicine. 2005;61(3):503-16.
194. Oliffe JL, Rice S, Kelly MT, Ogrodniczuk JS, Broom A, Robertson S, et al. A mixed-methods study of the health-related masculine values among young Canadian men. Psychology of Men & Masculinities. 2019;20(3):310.
195. Cagas JY, Biddle SJ, Vergeer I. For exercise, relaxation, or spirituality: Exploring participation motives and conformity to masculine norms among male and female Yoga participants. International Journal of Environmental Research and Public Health. 2022;19(2):770.
196. Smith DT, Mouzon DM, Elliott M. Reviewing the Assumptions About Men's Mental Health: An Exploration of the Gender Binary. American Journal of Men's Health. 2018;12(1):78-89.
197. Gerdes ZT, Levant RF. Complex relationships among masculine norms and health/well-being outcomes: Correlation patterns of the Conformity to Masculine Norms Inventory subscales. American journal of men's health. 2018;12(2):229-40.
198. Maas AH, Appelman YE. Gender differences in coronary heart disease. Neth Heart J. 2010;18(12):598-602.
199. Keteepe-Arachi T, Sharma S. Cardiovascular Disease in Women: Understanding Symptoms and Risk Factors. Eur Cardiol. 2017;12(1):10-3.
200. Parvand M, Ghadiri S, Théberge E, Comber L, Mullen K-A, Bhalla NP, et al. Sex, gender, and women's heart health: How women's heart programs address the knowledge gap. CJC open. 2023.
201. Adedinsewo DA, Pollak AW, Phillips SD, Smith TL, Svatikova A, Hayes SN, et al. Cardiovascular disease screening in women: leveraging artificial intelligence and digital tools. Circulation research. 2022;130(4):673-90.

202. Suero-Abreu GA, Barajas-Ochoa A, Perez-Peralta A, Rojas E, Berkowitz R. Assessment of the effect of the Go Red for Women campaign on search engine queries for cardiovascular disease in women. Cardiology research. 2020;11(5):348.
203. Hsu ARC, Wong ND. Cardiovascular health awareness and promotion in women: AHA's life's simple 7™ and go red for women™. Current Cardiovascular Risk Reports. 2017;11:1-8.
204. Mosca L, Ferris A, Fabunmi R, Robertson RM. Tracking women's awareness of heart disease: an American Heart Association national study. Circulation. 2004;109(5):573-9.
205. Bosomworth J, Khan Z. Analysis of Gender-Based Inequality in Cardiovascular Health: An Umbrella Review. Cureus. 2023;15(8).
206. Adreak N, Mackay MH, Pike A, O'Neill C, Sterling E, Randhawa V, et al. Integration of Women's Cardiovascular Health Content Into Healthcare Provider Education: Results of a Rapid Review and National Survey. CJC Open. 2024;6(2Part B):463-72.
207. Tannenbaum C, Norris CM, McMurtry MS. Sex-specific considerations in guidelines generation and application. Canadian Journal of Cardiology. 2019;35(5):598-605.
208. Lundberg GP, Mehta LS, Sanghani RM, Patel HN, Aggarwal NR, Aggarwal NT, et al. Heart centers for women: historical perspective on formation and future strategies to reduce cardiovascular disease. Circulation. 2018;138(11):1155-65.
209. Barrett-Connor E, Nielson CM, Orwoll E, Bauer DC, Cauley JA. Epidemiology of rib fractures in older men: Osteoporotic Fractures in Men (MrOS) prospective cohort study. Bmj. 2010;340.
210. Watts NB, Adler RA, Bilezikian JP, Drake MT, Eastell R, Orwoll ES, et al. Osteoporosis in Men: An Endocrine Society Clinical Practice Guideline. The Journal of Clinical Endocrinology & Metabolism. 2012;97(6):1802-22.
211. Fuggle NR, Beaudart C, Bruyère O, Abrahamsen B, Al-Daghri N, Burlet N, et al. Evidence-Based Guideline for the management of osteoporosis in men. Nature Reviews Rheumatology. 2024;20(4):241-51.
212. Elston DM. Participation bias, self-selection bias, and response bias. Journal of the American Academy of Dermatology. 2021.
213. Chung J, Monroe GS. Exploring social desirability bias. Journal of Business Ethics. 2003;44:291-302.
214. Kappelhof J. Survey research and the quality of survey data among ethnic minorities. Total survey error in practice. 2017:235-52.
215. Solem RC. Limitation of a cross-sectional study. American Journal of Orthodontics and Dentofacial Orthopedics. 2015;148(2):205.

5.2 APPENDIX A: SCREENING CRITERIA

A Survey of Men on the Management of Bone Health and Fall Prevention

Dear Participant,

You are invited to take part in a research survey about your perception of bone health management and fall prevention. Your answers will help the research team better understand how men perceive their bone health and their risk for falls. We hope to use our findings to create exercise programs specifically for men to keep their bones and muscles healthy and prevent falls.

This survey should take approximately 12-15 minutes to complete.

This survey is completely anonymous. We do not ask your name, and there are no questions that allow you to be identified by your answers.

Completing this survey indicates that:

- You live in Canada;
- You are a man;
- You are 60 years of age or older;
- You must demonstrate at least one of the following conditions:

☐ Have a diagnosis of osteoporosis OR

☐ Have suffered 2 falls or more in the previous year OR

☐ Have suffered a fracture after the age of 40 years OR

☐ Are currently taking an anti-osteoporosis medication prescribed by your physician.

- You declare your consent to participate in this project.

Your answers will be kept strictly confidential. The results of the survey may be published or shared during scientific meetings; however, it will not be possible to identify you. By completing and submitting this survey you are consenting to have your answers included in our study. Your participation in this survey is completely voluntary. You can refuse to participate or stop completing the survey, at any time, without explanation. However, because the survey is anonymous, it will not be possible for you to ask that your answers be withdrawn once the survey is submitted.

The McGill University Health Centre Research Ethics Board reviewed this survey and is responsible for monitoring it at all participating institutions in the health and social services network in Quebec.

For any question concerning your rights as a research participant taking part in this survey or if you have comments, or wish to file a complaint, you may communicate with:

The Patient Ombudsman of the McGill University Health Centre at the following phone number: 514 934-1934, ext. 44285.

To determine if you are eligible to participate in this survey, please answer the following 4 questions. If you are eligible, the survey will start after you click on the “Submit” button.

1. Do you have a diagnosis of osteoporosis
   ☐ Yes
   ☐ No

2. Have you suffered two falls or more in the previous year?
   ☐ Yes
   ☐ No

3. Have you suffered a fracture after the age of 40?
   ☐ Yes
   ☐ No

4. Are you currently taking any anti-osteoporosis medication prescribed by your physician?
   ☐ Yes
   ☐ No

5.3 APPENDIX B: SURVEY QUESTIONNAIRE

The following questions are about physical activities that you generally participate in. Please answer each question even if you do not consider yourself to be an active person.

During a typical 7-Day period (a week), how many times on the average do you do the following kinds of exercise for more than 15 minutes during your free time (write on each line the appropriate number).

5. During a typical 7-Day period (a week), how many times on the average do you do the following kinds of exercise for more than 15 minutes during your free time (write on each line the appropriate number).

a) STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling)

_____ times per week

b) MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

_____ times per week

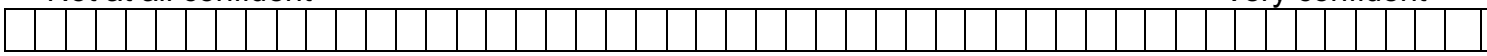
c) MILD/LIGHT EXERCISE (MINIMAL EFFORT) (e.g., yoga, archery, fishing from riverbank, bowling, horseshoes, golf, snow-mobiling, easy walking)

_____ times per week

The following questions are about your perception of bone health and fall prevention. We are interested in learning how confident you feel about doing the following activities. Everyone has different experiences which will make each person more or less confident in doing the following things. Thus, there are no right or wrong answers to this questionnaire. It is your opinion that is important. In this questionnaire, exercise means activities such as walking, swimming, golfing, biking, aerobic dancing. If it were recommended that you do any of the following THIS WEEK, how confident or certain would you be that you could:

6. Begin a new or different exercise program

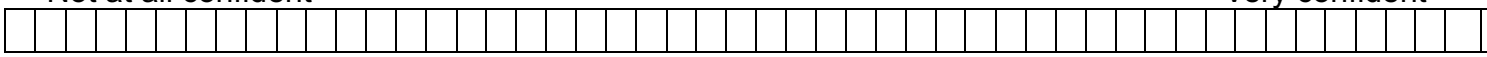
Not at all confident Very confident



(Place an X mark on the scale above)

7. Change your exercise habits

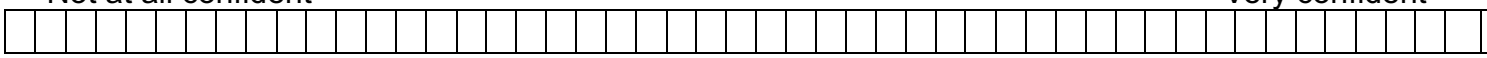
Not at all confident Very confident



(Place an X mark on the scale above)

8. Put forth the effort required to exercise

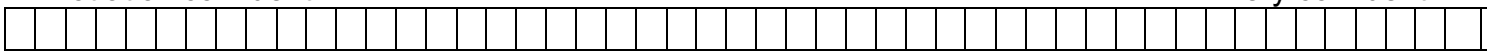
Not at all confident Very confident



(Place an X mark on the scale above)

9. Do exercises even if they are difficult

Not at all confident Very confident



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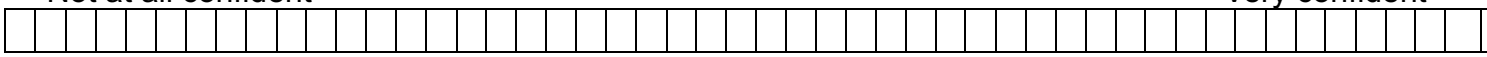
10. Exercise for the appropriate length of time

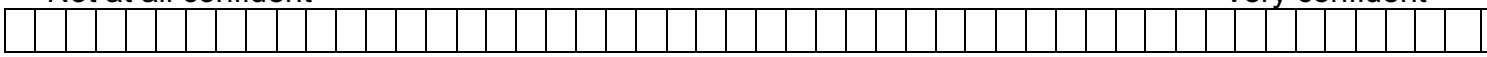
Not at all confident Very confident



(Place an X mark on the scale above)

11. Do the type of exercises that you are supposed to do

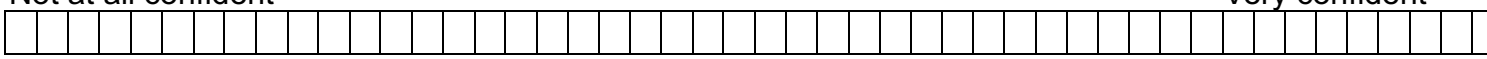
Not at all confident Very confident



(Place an X mark on the scale above)

12. Increase your calcium intake

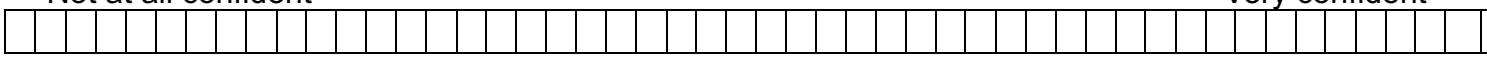
Not at all confident Very confident



(Place an X mark on the scale above)

13. Change your diet to include more calcium rich food

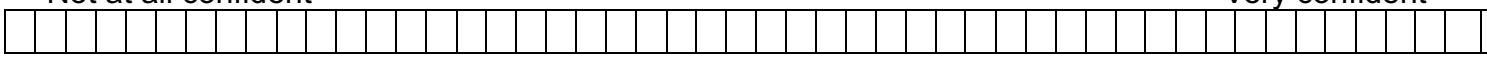
Not at all confident Very confident



(Place an X mark on the scale above)

14. Eat calcium rich foods as often as you are supposed to do

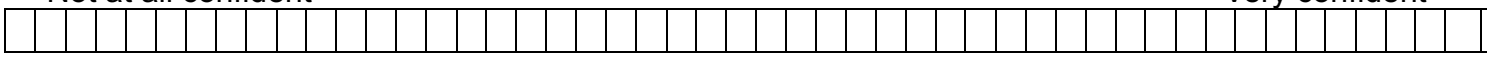
Not at all confident Very confident



(Place an X mark on the scale above)

15. Select appropriate foods to increase your calcium intake

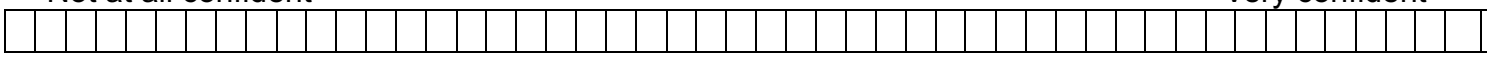
Not at all confident Very confident



(Place an X mark on the scale above)

16. Stick to a diet which gives you an adequate amount of calcium

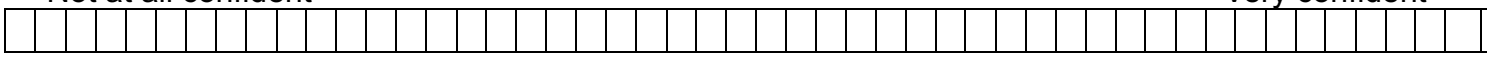
Not at all confident Very confident



(Place an X mark on the scale above)

17. Obtain foods that give an adequate amount of calcium even when they are not readily available

Not at all confident Very confident



(Place an X mark on the scale above)

Now we would like to ask some questions about how concerned you are about the possibility of falling. Please reply thinking about how you usually do the activities mentioned below. If you currently don't do the activity, please answer to show whether you think you would be concerned about falling IF you did that activity. For each of the following activities, please tick the box which is closest to your own opinion to show how concerned you are that you might fall if you did this activity.

18. Getting dressed or undressed
    - ☐ Not at all concerned
    - ☐ Somewhat concerned
    - ☐ Fairly concerned
    - ☐ Very concerned

19. Taking a bath or shower
    - ☐ Not at all concerned
    - ☐ Somewhat concerned
    - ☐ Fairly concerned
    - ☐ Very concerned

20. Getting in or out of a chair
    - ☐ Not at all concerned
    - ☐ Somewhat concerned
    - ☐ Fairly concerned
    - ☐ Very concerned

21. Going up or down stairs
    - ☐ Not at all concerned
    - ☐ Somewhat concerned
    - ☐ Fairly concerned
    - ☐ Very concerned

22. Reaching for something above your head or on the ground
    - ☐ Not at all concerned
    - ☐ Somewhat concerned
    - ☐ Fairly concerned
    - ☐ Very concerned

23. Walking up or down a slope
    - ☐ Not at all concerned
    - ☐ Somewhat concerned
    - ☐ Fairly concerned
    - ☐ Very concerned

24. Going out to a social event (e.g. religious service, family gathering or club meeting)
    - ☐ Not at all concerned
    - ☐ Somewhat concerned
    - ☐ Fairly concerned
    - ☐ Very concerned

The following questions are about your bone health. Please check the option that best corresponds to your answer.

25. Since the age of 40, has a doctor ever told you that you had a broken bone or fracture?
    - ☐ Yes
    - ☐ No

26. If applicable, which bones have you broken after the age of 40 years old that resulted from a minor fall or low-intensity injury?

	No	Yes, only once	Yes, more than once
Shoulder, upper arm	☐	☐	☐
Elbow, lower arm	☐	☐	☐
Wrist, hand	☐	☐	☐
Hip	☐	☐	☐
Thigh	☐	☐	☐
Knee, lower leg	☐	☐	☐
Ankle, foot	☐	☐	☐
Upper back or upper spine	☐	☐	☐
Lower back or lower spine	☐	☐	☐
Chest (excluding back and spine)	☐	☐	☐
Abdomen or pelvis (excluding back and spine)	☐	☐	☐

The following questions are about your mood and your mood-related symptoms. Over the last 2 weeks, how often have you been bothered by any of the following problems?

27. Little interest or pleasure in doing things
☐ Not at all
☐ Several days
☐ More than half the days
☐ Nearly every day

28. Feeling down, depressed, or hopeless
☐ Not at all
☐ Several days
☐ More than half the days
☐ Nearly every day

29. Trouble falling or staying asleep, or sleeping too much
☐ Not at all
☐ Several days
☐ More than half the days
☐ Nearly every day

30. Feeling tired or having little energy

☐Not at all

☐ Several days

☐ More than half the days

☐ Nearly every day

31. Poor appetite or overeating

☐Not at all

☐ Several days

☐ More than half the days

☐ Nearly every day

32. Feeling bad about yourself – or that you are a failure or have let yourself or your family down

☐ Not at all

☐ Several days

☐ More than half the days

☐ Nearly every day

33. Trouble concentrating on things, such as reading the newspaper or watching television

☐ Not at all

☐ Several days

☐ More than half the days

☐ Nearly every day

34. Moving or speaking so slowly that other people could have noticed? Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual;

☐ Not at all

☐ Several days

☐ More than half the days

☐ Nearly every day

The next few questions ask about sex and gender. Both biological and social differences between women and men contribute to differences in their health. Sex (biological attributes) and gender (socio-cultural factors) can influence things like our risk of developing certain diseases, response to medical treatments, and how often we seek health care.

35. What sex were you assigned at birth, meaning on your original birth certificate?
☐ Male
☐ Female

36. Which best describes your current gender identity?
☐ Male
☐ Female
☐ Indigenous or other cultural gender identity (e.g., two-spirit)
☐ I prefer to use another term (e.g., gender fluid, non-binary): _____

The following statements are about how people might think, feel or behave. The statements are designed to measure attitudes, beliefs, and behaviours associated with both traditional and non-traditional masculine gender roles. Thinking about your own actions, feelings and beliefs, please indicate how much you personally agree or disagree with each statement. There are no correct or wrong answers to this questionnaire. You should give the responses that most accurately describe your personal actions, feelings and beliefs. It is best if you respond with your first impression when answering. If you are not currently employed or are retired, please answer the questions about your work as to how you felt when you were employed.

37. My work is the most important part of my life
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

38. I make sure people do as I say
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

39. In general, I do not like risky situations
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

40. It would be awful if someone thought I was gay
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

41. I love it when men are in charge of women
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

42. I like to talk about my feelings
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

43. I would feel good if I had many sexual partners
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

44. It is important to me that people think I am heterosexual
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

45. I believe that violence is never justified
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

46. I tend to share my feelings
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree
47. I should be in charge
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree
48. I would hate to be important
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

49. Sometimes violent action is necessary
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

50. I don’t like giving all my attention to work
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

51. More often than not, losing does not bother me
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

52. If I could, I would frequently change sexual partners
☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

53. I never do things to be an important person

☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

54. I never ask for help

☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

55. I enjoy taking risks

☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

56. Men and women should respect each other as equals

☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

57. Winning isn't everything, it's the only thing

☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

58. It bothers me when I have to ask for help

☐ Strongly Disagree
☐ Disagree
☐ Agree
☐ Strongly Agree

Please tell us a bit about yourself. These questions allow us to better understand certain background characteristics of our population and to better analyze our results to create tailored exercise programs for individuals of all socio-demographic backgrounds.

59. How did you find out about our survey?

☐ Healthcare professional (physician, physiotherapist, nurse, dietician) or healthcare institution

☐ Outpatient clinic

☐ Social Media (Facebook)

☐ Community center / leisure activity center / religious institution

☐ Online support group

☐ Friend, family member or acquaintance

☐ Others (please specify): _____

60. What is your date of birth (month/year only)

_____

61. What is the highest level of education you have completed?

☐ Less than high school diploma

☐ High school diploma

☐ Trade certificate, vocational school, or apprenticeship training

☐ Non-university certificate or diploma from a community college, CEGEP

☐ University Bachelor's Degree

☐ University Graduate Degree (such as Masters or Doctorate)

☐ Others (please specify): _____

62. What is your current marital/partner status?

☐ Single, never married, or never lived with a partner

☐ Married, living with a partner, or in a common-law relationship

☐ Widowed

☐ Divorced

☐ Separated

63. In what country were you born?

☐ Canada
☐ China
☐ France
☐ Germany
☐ Greece
☐ Guyana
☐ Hong Kong
☐ Hungary
☐ India
☐ Italy
☐ Jamaica
☐ Netherlands/Holland
☐ Philippines
☐ Poland
☐ Portugal
☐ United Kingdom
☐ United States
☐ Vietnam
☐ Sri Lanka
☐ Other (please specify): _____

64. In what year did you first come to Canada to live? (Please estimate if you are unsure of the exact date)

_____

65. People living in Canada come from many different cultural and racial backgrounds. Are you… (please select all that apply):
    - ☐ White
    - ☐ Chinese
    - ☐ South Asian (e.g., East Indian, Pakistani, Sri Lankan)
    - ☐ Black
    - ☐ Filipino
    - ☐ Latin American
    - ☐ Southeast Asian (e.g., Cambodia, Indonesian, Laotian, Vietnamese)
    - ☐ Arab
    - ☐ West Asian (e.g., Afghan, Iranian)
    - ☐ Japanese
    - ☐ Korean
    - ☐ North American Indian
    - ☐ Inuit
    - ☐ Métis
    - ☐ Other (please specify): _____

66. Which province/territory do you currently reside in?
    - ☐ British Columbia
    - ☐ Alberta
    - ☐ Saskatchewan
    - ☐ Manitoba
    - ☐ Ontario
    - ☐ Quebec
    - ☐ New Brunswick
    - ☐ Nova Scotia
    - ☐ Newfoundland & Labrador
    - ☐ Prince Edward Island
    - ☐ Yukon
    - ☐ Northwest Territories
    - ☐ Nunavut

67. Which of the following best describes your personal income last year?

☐ $0-$9,999
☐ $10,000-$24,999
☐ $25,000-$49,999
☐ $50,000-$74,999
☐ $75,000-$99,999
☐ $100,000-$149,999
☐ $150,000+
☐ Prefer not to answer

5.3 APPENDIX C: SUPPLEMENTAL TABLES

Supplemental Table 11 Adjusted** estimates (95% CI) for the OSES (Total, Exercise, Calcium) in models considering interactions of PHQ-8 with standardized CMNI scores

Estimate (95% CI)	OSES[§]		
	Total	Exercise	Calcium
CMNI[¶] (Per 1 Unit)	**-6.60** (-10.37; -2.83)	**-2.86** (-5.14; -0.58)	**-3.80** (-6.02; -1.57)
PHQ-8[†] (Per 1 Unit)	**-42.12** (-72.00; -12.25)	**-20.24** (-38.30; -2.18)	**-22.38** (-40.01; -4.76)
CMNI*PHQ-8 (Per 1 Unit)	**0.79** (0.18; 1.39)	0.32 (-0.05; 0.69)	**0.47** (0.11; 0.83)

In bold: statistically significant differences ($p < 0.05$)
**Adjusted for age, falls, income, race/ethnicity, education, diagnosis of osteoporosis, Godin Leisure-Time Exercise Questionnaire scores (polynomials of 2 degrees for exercise and total).
[¶] Conformity to Masculine Norms Inventory
[†] Patient Health Questionnaire-8
[§] Osteoporosis Self-Efficacy Scale

Supplemental Table 2 Adjusted** estimates (95% CI) for the OSES (Total, Exercise, Calcium) in models considering interactions of PHQ-8 or GLTEQ with standardized CMNI scores

Estimate (95% CI)	OSES[§]		
	Total	Exercise	Calcium
CMNI[¶] (Per 1 Unit)	-3.47 (-7.65; 0.71)	-1.72 (-4.22; 0.78)	-1.91 (-4.36; 0.53)
GLTEQ[†] (Per 1 Unit)	5.92 (-1.66; 13.50)	3.83 (-0.71; 8.37)	1.10 (-2.78; 4.97)
GLTEQ^2 (Per 1 Unit)	-0.03 (-0.06; 0.001)	-0.02 (-0.04; -0.003)	--
CMNI*GLTEQ (Per 1 Unit)	0.01 (-0.13; 0.15)	0.01 (-0.07; 0.09)	0.006 (-0.08; 0.09)

In bold: statistically significant differences ($p < 0.05$)
**Adjusted for age, falls, income, race/ethnicity, education, diagnosis of osteoporosis, Patient Health Questionnaire-8 scores.
¶ Conformity to Masculine Norms Inventory
† Godin Leisure-Time Exercise Questionnaire
§ Osteoporosis Self-Efficacy Scale

Supplemental Table 3 Estimates (95% CI) of OSES-Exercise, OSES-Calcium and OSES-Total in unadjusted and adjusted linear regressions for each increase in one unit of CMNI domain

A) For OSES-Exercise as outcome

CMNI domain (per 1 unit increase)	Unadjusted	Adjusted Model 1 (Age, Education, Race/Ethnicity, Income, Osteoporosis Diagnosis, Falls)	Adjusted Model 2 (Model 1 + GLTEQ*)
Winning	-8.0 (-25.1; 9.1)	-10.4 (-27.1; 6.2)	-4.6 (-19.1; 9.9)
Emotional Control	**-20.5 (-34.3; -6.8)**	**-19.5 (-32.5; -6.4)**	**-15.7 (-27.0; -4.4)**
Risk-Taking	**16.7 (1.7; 31.8)**	**16.1 (1.6; 30.5)**	6.1 (-6.8; 18.9)
Violence	**-15.3 (-28.5; -2.2)**	**-15.0 (-27.7; -2.3)**	-8.8 (-20.0; 2.5)
Power over women	**-25.2 (-40.8; -9.5)**	**-19.0 (-34.5; -3.4)**	-13.1 (-26.8; 0.6)
Dominance	**-19.4 (-33.2; -5.6)**	**-15.9 (-30.1; -1.7)**	-8.3 (-20.8; 4.2)
Playboy	-1.2 (-12.3; 10.0)	-0.6 (-11.3; 10.1)	-1.3 (-10.6; 8.0)
Self-Reliance	**-24.3 (-38.6; -9.9)**	**-18.2 (-32.3; -4.0)**	**-14.7 (-27.0; -2.4)**
Primacy of Work	-10.8 (-26.2; 4.6)	-8.2 (-23.2; 6.9)	-4.7 (-17.8; 8.3)
Disdain for Homosexuals	-10.5 (-21.9; 0.9)	-5.7 (-16.8; 5.3)	0.4 (-9.3; 10.1)
Pursuit of Status	**21.7 (5.3; 38.2)**	**19.2 (3.4; 35.1)**	**18.9 (5.2; 32.5)**

In bold: statistically significant differences ($p < 0.05$)
* Godin Leisure-Time Exercise Questionnaire scores

B) For OSES-Calcium as outcome

CMNI domain (per 1 unit increase)	Unadjusted	Adjusted Model 1 (Age, Education, Race/Ethnicity, Income, Osteoporosis Diagnosis, Falls)	Adjusted Model 2 (Model 1 + GLTEQ*)
Winning	**-19.3 (-33.5; -5.1)**	**-20.5 (-35.0; -6.1)**	**-17.6 (-31.6; -3.6)**
Emotional Control	-6.8 (-18.6; 5.0)	-5.8 (-17.5; 5.9)	-3.7 (-14.9; 7.6)
Risk-Taking	**17.8 (5.2; 30.4)**	**18.1 (5.5; 30.7)**	**13.2 (0.8; 25.7)**
Violence	-5.1 (-16.3; 6.1)	-3.9 (-15.2; 7.5)	-0.1 (-11.2; 10.9)
Power over women	**-20.9 (-34.1; -7.7)**	**-17.8 (-31.4; -4.1)**	**-15.4 (-28.7; -2.2)**
Dominance	**-19.0 (-30.6; -7.5)**	**-16.8 (-29.2; -4.4)**	**-13.3 (-25.4; -1.2)**
Playboy	-4.3 (-13.7; 5.1)	-3.5 (-12.9; 5.9)	-3.6 (-12.7; 5.5)
Self-Reliance	**-20.3 (-32.4; -8.2)**	**-16.4 (-28.8; -3.9)**	**-14.5 (-26.5; -2.5)**
Primacy of Work	-2.9 (-15.9; 10.1)	-0.8 (-14.1; 12.5)	0.8 (-11.9; 13.6)
Disdain for Homosexuals	**-17.6 (-27.0; -8.2)**	**-16.4 (-25.9; -6.9)**	**-13.6 (-22.8; -4.3)**
Pursuit of Status	2.5 (-11.6; 16.6)	1.2 (-12.9; 15.4)	(-12.6; 14.5)

In bold: statistically significant differences ($p < 0.05$)
* Godin Leisure-Time Exercise Questionnaire scores

C) For OSES-Total as outcome

CMNI domain (per 1 unit increase)	Unadjusted	Adjusted Model 1 (Age, Education, Race/Ethnicity, Income, Osteoporosis Diagnosis, Falls)	Adjusted Model 2 (Model 1 + GLTEQ*)
Winning	**-27.4 (-54.5; -0.3)**	**-31.0 (-57.8; -4.2)**	-22.2 (-46.1; 1.7)
Emotional Control	**-27.4 (-49.4; -5.3)**	**-25.3 (-46.5; -4.0)**	**-19.4 (-38.3; -0.4)**
Risk-Taking	**34.5 (10.7; 58.3)**	**34.2 (11.0; 57.4)**	19.3 (-1.9; 40.5)
Violence	-20.5 (-41.6; 0.7)	-18.8 (-39.6; 1.9)	-8.9 (-27.6; 9.8)
Power over women	**-46.1 (-70.8; -21.3)**	**-36.7 (-61.8; -11.7)**	**-28.5 (-51.0; -6.1)**
Dominance	**-38.4 (-60.2; -16.6)**	**-32.7 (-55.5; -9.9)**	**-21.6 (-42.2; -1.0)**
Playboy	-5.5 (-23.3; 12.3)	-4.1 (-21.5; 13.3)	-4.9 (-20.3; 10.5)
Self-Reliance	**-44.6 (-67.3; -21.9)**	**-34.5 (-57.4; -11.7)**	**-29.2 (-49.5; -9.0)**
Primacy of Work	-13.7 (-38.3; 10.9)	-9.0 (-33.5; 15.5)	-3.9 (-25.6; 17.8)
Disdain for Homosexuals	**-28.1 (-46.0; -10.2)**	**-22.1 (-39.8; -4.4)**	-13.2 (-29.1; 2.8)
Pursuit of Status	24.2 (-2.3; 50.6)	20.4 (-5.5; 46.4)	19.8 (-3.1; 42.7)

In bold: statistically significant differences ($p < 0.05$)
* Godin Leisure-Time Exercise Questionnaire scores