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Associations between Calcium Intake, Osteoporosis Knowledge and Osteoporosis Health Beliefs among young adult women in the Lower North Island, New Zealand.

A thesis presented in partial fulfilment of the requirements for the degree

of

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in

Human Nutrition

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ABSTRACT

***Background/Aim*:** Osteoporosis is becoming the most prevalent bone disease in the world nowadays. While osteoporosis is often regarded as a disease of the elderly, however, maximising peak bone mass (PBM) during the adolescent and young adults' stages is crucial to prevent or delay osteoporosis later in life. Osteoporosis is a preventable disease and making lifestyle changes or following health recommendations such as consuming adequate calcium is essential to prevent or delay osteoporosis. The first three decades of life is a crucial time to act, as it is the period to achieve optimal peak bone mass (PBM). Understanding an individual's osteoporosis knowledge and health beliefs and factors influencing calcium intake may help to prevent osteoporosis. Therefore, this study aimed to examine the associations between calcium intake, osteoporosis knowledge and health beliefs among young female adults in the lower North Island in New Zealand. It also aimed to state the level of osteoporosis knowledge, osteoporosis health beliefs, calcium intake and validation of the food frequency questionnaire (FFQ).

***Study design*:** This was a secondary data analysis of 130 females (university students) between 18-25 years of age who voluntarily participated. Participant's knowledge and health beliefs on osteoporosis were measured using the osteoporosis knowledge test (OKT) and osteoporosis health belief scale (OHBS). A FFQ was completed to estimate the calcium intake. Descriptive analysis, bivariate correlation and multiple regression were used to analyse the data of osteoporosis knowledge, health beliefs and associations with calcium intake. Validity was evaluated using the Spearman correlation coefficient (SCC), Wilcoxon signed rank test, Cross-classification, Weighted kappa statistics and Bland Altman analysis.

***Result*:** Findings show osteoporosis knowledge was significantly associated with calcium intake, susceptibility, calcium barriers, health motivation and one of the predictors of calcium intake as with perceived severity. In general, the university students had moderate mean knowledge on osteoporosis (16.9±3.7) and perceived moderate median susceptibility (15) and severity (19) to osteoporosis. The students perceived many benefits of taking calcium intake with lower calcium barriers and they were highly health motivated. Median daily calcium intake of 692mg (462, 10250) was below the estimated average requirement (EAR) of 1050mg (15-18 years old) and 840mg (19-30 years old) with acceptable findings on the validity analysis of the FFQ.

***Conclusion*:** Overall, the findings confirm the HBM theory that some perceptions such as severity and knowledge influence individual's likelihood of engaging in health promoting behaviour (calcium intake) among this study population. Surprisingly most HBM constructs

were not linked to behaviour (calcium intake). This is interesting but may not be causal. The findings show that increasing knowledge or improving awareness of osteoporosis especially related to physical activity, dairy and non-dairy calcium food sources and seriousness of getting osteoporosis may be the recommended preventive intervention for these university students.

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LIST OF ABBREVIATIONS

a BMD	Areal Bone Mineral Density
ANZHFR	Australia & New Zealand Hip Fracture Registry
BHQ	Bone Health Questionnaire
BMD	Bone Mass Density
BMC	Bone Mineral Content
DALYs	Daily Adjustments in Life Years
DEXA	Dual-emission X-ray Absorptiometry
DXA	Dual X-ray Absorptiometry
EAR	Estimated Average Requirement
FFQ	Food Frequency Questionnaire
FR	Food Records
HBM	Health Belief Model
IOF	International Osteoporosis Federation
LTB	Love the Bone Study
NHS	National Health Survey
NZANS	New Zealand Adult Nutrition Survey
NZ	New Zealand
OKAT	Osteoporosis Knowledge Assessment Tool
OKQ	Osteoporosis Knowledge Questionnaire
OKS	Osteoporosis Knowledge Scale
OKT	Osteoporosis Knowledge Test
OHBS	Osteoporosis Health Belief Scale

OPBS	Osteoporosis Preventing Behaviours Survey
OSES	Osteoporosis Self -Efficacy Scale
PTH	Parathyroid Hormone
PBM	Peak Bone Mass
QALYs	Quality Adjusted Life in Years
QUS	Quantitative Ultrasound
RAM	Rapid Assessment Method
RCT	Randomized Controlled Trial
RDA	Recommended Dietary Allowance
RDI	Recommended Dietary Intake
r-OKT	Revised Osteoporosis Knowledge Test
SD	Standard Deviation
USA	United States of America
WHI	Women Health Initiative
WHO	World Health Organization
3DDD	3 Day Diet Diary

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CHAPTER 1: INTRODUCTION

1.1: Background

Osteoporosis is the most prevalent bone disease in the world today. It affects predominantly post-menopausal women. It is also the most preventable bone disease (Fourie, Floyd, & Marshall, 2015). Globally approximately 200 million people are affected with osteoporosis (Al Anouti et al., 2019). Osteoporosis usually progresses asymptomatically and is often diagnosed after a fracture occurs. Among the Western population, particularly in North America, Europe, and Oceania, it has been reported that there has been a substantial increase in the incidence of osteoporosis fractures (Curtis, Moon, Harvey, & Cooper, 2017). The main fracture sites are the hip, spine, wrist, and humerus associated with high morbidity and mortality rates and massive socioeconomic burdens. Hip and spine fractures are the most serious, as higher immobility, morbidity, and mortality rates are related to these fractures (WHO, 2003). About 38% of women aged over 50 years are affected by hip and spine fracture globally (Wade, Strader, Fitzpatrick, Anthony, & O'Malley, 2014). Osteoporosis increases with increased age, so osteoporosis fracture consequences are expected to increase with our aging population (Brown, McNeill, Leung, Radwan, & Willingale, 2011).

Osteoporosis is often referred to as a disease of the elderly however, maximising peak bone mass (PBM) during the stages of adolescence and young adulthood is crucial. Weaver et al. (2016) found that PBM timing varies according to the skeletal site, so skeletal health maintenance is paramount throughout puberty and the stage of young adulthood. Most healthy females attain 92% of their bone mineral content (BMC) at age 18 years and 99% by 26 years of age (Perez-Lopez, Chedraui, & Cuadros-Lopez, 2010). Adequate calcium intake is essential for adolescents and young adults to achieve PBM and maintain bone mineral density (BMD) later in life. Preventing osteoporosis and reducing the risk of osteoporosis can be achieved through nutritional measures, such as increasing calcium and vitamin D intake. It can also be accomplished by engaging in weight-bearing exercise (WBE) and addressing lifestyle behaviours, such as smoking and alcohol drinking. An individual's knowledge and perceptions of their health issues have a significant impact on their lifestyle and their health. Therefore, adequate measures at an early age, such as raising awareness and modifying lifestyle, are crucial to prevent osteoporosis. University/College-age is the time when peak bone mass (PBM) is achieved and lifestyle behaviours are being developed and it is the perfect opportunity for adopting lifestyle changes (Khired et al., 2021).

The Health Belief Model (HBM) has been used to try to help people change their lifestyle. It

consists of these four constructs: susceptibility, severity, benefits and barriers, which suggest a person's perceptions towards a health problem (Rosenstock, Strecher, & Becker, 1988). For instance, susceptibility measures an individual's perception on their risk of developing a health concern or its existence while severity measures the consequences of having that health concern. The HBM was later adapted as the Osteoporosis Health Belief Scale (OHBS) to measure an individual's or people's perceptions on these constructs: susceptibility, severity, benefits and barriers of health behaviours (calcium intake and physical activity) to related to osteoporosis (Edmonds, Turner, & Usdan, 2012).

In 2007, New Zealand, recorded 70,631 people were diagnosed with osteoporosis which incurred a cost of $330 million (Brown, McNeill, Radwan, & Willingale, 2007). Ninety percent of them were females, and 28% of the cases were diagnosed following a fracture. The National Health Survey 2006/07 reported that osteoporosis prevalence increases with age and was higher among European females (Ministry of Health, 2008). Brown et al. (2007), further emphasised that osteoporosis is more common than breast and prostate cancers and is usually accompanied by fractures and premature deaths. It was highlighted as well that fractures caused by osteoporosis would increase from 84,000 in 2007 to nearly 100,000 in 2013 and 116,000 in 2020. 4906 hip fractures alone were reported in the Australian and New Zealand Hip fracture registry (ANZHFR) 2018 annual report (ANZHFR, 2018). Sadly, an increased rate of osteoporosis fractures is expected in the future. Hence, an increase in health and socioeconomic burdens is expected that had an estimated increased health cost of NZ 458 million in 2020 (Brown et al., 2011).

Statistics show low calcium intake existed among females of all ages in the 1997 National Nutrition Survey (NNS) and 2008/09 New Zealand Adult Nutrition Survey (NZANS). In the NZANS 2008/09, the intake in the age groups 15-18 years (682mg) and 19-30 years (704mg) was below the estimated average requirement (EAR) for the respective age groups (1050mg and 840mg). Having calcium intake below EAR is of great concern as a risk factor for osteoporosis. Furthermore, a previous study, von Hurst and Wham (2007) found moderate osteoporosis knowledge (16.4 out of 26) among females aged 20-49 years living in Auckland. Having insufficient knowledge of osteoporosis risk and prevention behaviours, such as nutrition (calcium and vitamin D intake) or having these behaviours without knowing that they help bone health may limit preventive measures. Additionally, responses to the osteoporosis heath belief questionnaire von Hurst and Wham (2007) showed females perceived they had a low susceptibility to the severity of osteoporosis, thus osteoporosis is not regarded as a threat. A low perception of the barriers to calcium intake was noted, but the belief that calcium-rich

foods are high in cholesterol (fat) was regarded as a barrier to calcium intake by 75% of the study population. Similar barriers were found in previous studies in the early 2000s in New Zealand (Gulliver & Horwath, 2001; Wham & Worsley, 2003). In contrast, less than a fifth of 102 South Asian females living in Auckland agreed with the idea that calcium-rich foods are high in fats (Tsai, 2008). Tsai (2008) also found there was a low perception regarding the susceptibility and severity of osteoporosis and the barriers to calcium intake. A lack of osteoporosis knowledge and inadequate calcium intake among the study population was highlighted as well.

Moreover, a review of the literature revealed that young adults from six countries (Canada, Iran, Nigeria, Pakistan, Sri Lanka, and Syria) had low osteoporosis knowledge and viewed osteoporosis as a disease of old age (Chan, Mohamed, Ima-Nirwana, & Chin, 2018). Also, low perceived susceptibility, low perceived severity, and not engaging in osteoporosis behaviours were highlighted in this population. Chan et al. (2018) also found that lack of knowledge and misconception greatly influenced behaviours to prevent osteoporosis. On the other hand, other researchers found knowledge or increased osteoporosis knowledge does not influence or alter behaviours (Althobiti, Naqshbandi &Mohamed, 2020). Therefore, further investigation on osteoporosis in terms of the knowledge, health beliefs, and calcium intake among young females is needed.

1.2: Purpose of the study

The two studies (Tsai, 2008; von Hurst and Wham, 2008) previously conducted among women in New Zealand had a low proportion of young adults; therefore, this study will focus on only young female adults. To my knowledge, this will be the first study to assess knowledge, health beliefs regarding osteoporosis, and dietary calcium intake among young female adults or university-age females. The information will be valuable for responsible ministry, agency, and stakeholders to develop appropriate and effective interventions for the young adult population. Additionally, the findings will confirm or refute the previous findings and whether the implemented recommendations, such as education or the awareness of low-fat products was effective. The study's research questions, aim and objectives are listed below.

1.3: Research question, Aim and Objectives

1.3.1: Research Questions:

Are osteoporosis knowledge and osteoporosis health beliefs predictors of calcium intake?

1.3.2: Research Aim:

To examine associations between calcium intake, osteoporosis knowledge, and osteoporosis health beliefs (OHB) among young adult females in the lower North Island Region of New Zealand.

1.3.3: Research Objectives:

1. Describe the level of osteoporosis knowledge.
2. Describe the level of osteoporosis health beliefs.
3. Describe calcium intake including validation of a short food frequency questionnaire (FFQ).
4. Examine the associations between calcium intake, osteoporosis knowledge and health beliefs.
5. Examine the association between family history, osteoporosis knowledge and health beliefs.
6. Investigate the predictors of calcium intake.

1.4: Contributions of Researchers

Table: 1.1: Contributions of Researchers

Researcher	**Contribution**
Sarah Fekau MSc (Human Nutrition) Student	Primary author of this thesis who is responsible for developing research questions, aims and objectives; sampling size; data processing, statistical analysing and thesis writing
Dr Janet Weber Academic Supervisor (main supervisor)	Responsible for supervision of the entire research process through final submission. Provide technical and academic assistance in all aspects.
Dr Louise Brough Academic Supervisor (co-supervisor)	Supervised and assisted with all statistical analyses and validation of the food frequency questionnaire (FFQ).
Katie Schraders	Researcher collecting primary data used for this secondary analysis
Elizabeth Reymonds	Researcher collecting primary data used for this secondary analysis

CHAPTER 2: LITERATURE REVIEW

2.1 : Defining Osteoporosis

Osteoporosis is a term derived from two Greek words; osteon' (bone) and 'poros' (little hole), which means "porous bone" (Rachner, Khosla, & Hofbauer, 2011). Osteoporosis is also known as the 'silent disease' or 'silent thief' because it is usually asymptomatic until a fracture occurs (Gass & Dawson-Hughes, 2006; Soleymanian, Niknami, Hajizadeh, Shojaeizadeh, & Montazeri, 2014). The World Health Organization (WHO) defines osteoporosis by bone mineral density (BMD) based on a T-Score from the dual x-ray absorptiometry (DXA) scan. The DXA scan can predict bone strength, fracture risks and is regarded as the gold standard to measure bone mass measurements (Dell, Greene, Anderson, & Williams, 2009).

Osteoporosis has two distinct types: primary or secondary. Primary osteoporosis includes involutional osteoporosis type 1 or postmenopausal osteoporosis and involutional osteoporosis type 2 or senile (aging) osteoporosis (Sozen et al., 2016). Primary osteoporosis is related to hormonal, and aging factors. In contrast, secondary osteoporosis is associated with pre-existing diseases such as diabetes, renal disease, congenital conditions (leukemia), and a drug-induced condition, e.g. hyperthyroidism. Secondary osteoporosis develops following those mentioned diseases, medications, and lifestyle changes (Sozen et al., 2016). Postmenopausal and aging osteoporosis are common due to the natural decline of estrogen levels and increased bone loss with advanced aging (Poole & Compston, 2006).

Osteoporosis is a significant public health issue in developed countries, and the prevalence is expected to increase with the increasing elderly population (Svedbom, Ivergård, Hernlund, Rizzoli, & Kanis, 2014). The health and economic burden of osteoporosis is enormous and causes substantial disability adjustments in life years (DALYs). Studies detail that osteoporosis is preventable if peak bone mass (PBM) is maximised during the skeletal growth period at the adolescent and young adult stage and if the rate of bone loss is slow (NIH, 2001).

2.2 : Understanding Bone Health and Osteoporosis

2.2.1 : Bone Health

Bone is a connective tissue that supports the human body with mechanical support and facilitates muscle action, locomotion, and protects internal organs (Prentice et al., 2003). Bones are made up of collagen and hydroxyapatite (calcium and phosphorus); the minerals are the bone mineral content (BMC).

The bone’s size, thickness and volume are the areal bone mineral density (aBMD). Production and maintenance of bones are functioned by three cells, osteoblasts, osteoclasts, and osteocytes. The osteoclast's role is to remove old bone (resorption) while osteoblasts replace the old bone with new ones (formation or deposition). This process of resorption and deposition is called bone remodeling and is controlled by the osteocytes. The process maintains bone size and strength and regulates bone density and calcium levels in the body (de Villiers, 2009; Nichols, Bonnick, & Sanborn, 2000). Bone remodeling is a continuing process in life, with a gain in bone density in early life followed by a gradual bone loss once PBM is reached. The rate of bone loss increases as people get older and following menopause in women (Nichols et al., 2000). Over time bones gradually become brittle due to low BMD, which increases bone fragility, risk of fracture and later osteoporosis.

2.2.2 : Peak Bone Mass (PBM) and Bone Loss

Bones grow in length and width in the first two decades of life with more bone formation than bone resorption (Ilich & Kerstetter, 2000). During that period, a steady accumulation of bone mass is formed leading to PBM. The rate of bone mass increases at a different rate as per life stages. Teegarden stated that PBM occurs at a different age for different bone sites (Teegarden et al., 1995). Although the timing of achieving PBM is unclear, girls gained 85% of PBM by 18 years of age and boys gain 90% by the age of 20 (Weaver et al., 2016). For instance, Weaver et al. (2016), noted that hip PBM is achieved between age 16 and 19 and between 33 and 40 for the lumbar spine PBM among females. Once PBM is reached, bone loss begins and continues until the end of life (Ilich & Kerstetter, 2013). Gradual bone loss persists throughout adulthood, increases between 5 and 10 years post-menopause in women, and continues with advanced age in both genders.

The evidence showed that a 10% increase in PBM reduces the risk of osteoporotic fractures by 50% and hip fractures by 30% (Bonjour, Chevalley, Ferrari, & Rizzoli, 2009). Therefore, it is crucial to achieve maximum bone mass during PBM attainment (Bono & Einhorn, 2003).

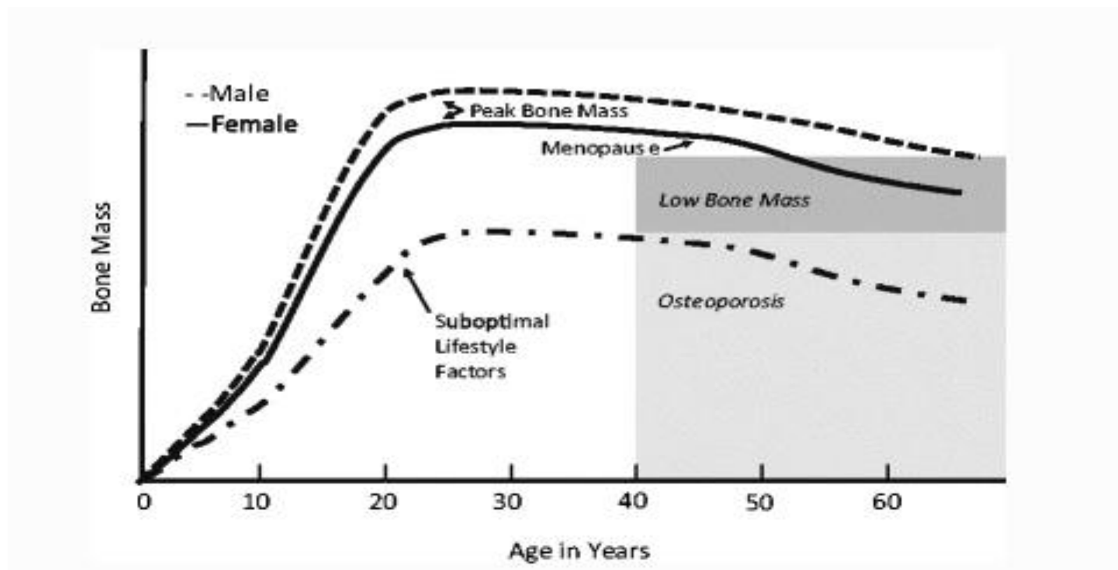

Fig 2.1: Bone mass across the lifespan for male & female (Source: Weaver et al., 2016)

2.3: Risk or Prevention Factors

Even though osteoporosis is often regarded as a disease that affects the elderly, it develops during a person's lifespan (Cech, 2012). The Development of osteoporosis is associated with non-modifiable and modifiable risk factors that influence bone mass gain and bone loss. While factors such as genetics, gender, hormone, and aging are non-modifiable, a person's lifestyle choices that consist of calcium intake, vitamin D, dietary pattern, physical activity, smoking, and alcohol are the modifiable factors. Knowing factors that have an impact on PBM and the rate of bone loss is essential to establish and sustain skeletal health.

Non- Modifiable Factors

2.3.1 : Genetics/Ethnicity/ Family history

Genetics significantly influences bone architecture, bone strength, and PBM; an estimated 60% to 80% of PBM is determined by genetics (WHO, 2003). Twin studies confirm that 80% of the PBM is controlled by genetic predisposition, while the remaining 20% by environmental factors (Sambrook et al.1996). Also, certain ethnicities such as Caucasians, Asians, Europeans, and Hispanics have been reported to have lower BMC, BMD, and bone size compared to African and Pacific people (Bachrach et al. 1999; Bhudhikanok et al.1996; Brown et al. 2013). Evidence also shows that daughters of postmenopausal women with osteoporosis have lower BMC at the lumbar spine and femoral neck than daughters of non-osteoporotic mothers (Percival, 1999; Seeman et al., 1989; WHO, 2003). However, the link can be either heredity or

influenced by family lifestyle as both contribute to bone health.

2.3.2 : Advanced Age

Bone loss is a natural process that happens after PBM is reached and accompanies aging. Bone loses its strength and density as individual ages through the natural changes in bone regulating hormone and calcium metabolism. (Snelling, Crespo, Schaeffer, Smith, & Walbourn, 2001). At age 50 years, loss of bone mass occurs at 0.7-2% yearly for postmenopausal women and 0.5-0.7% for men (Bono & Einhorn, 2003; O'Keefe et al., 2016). International Osteoporosis Foundation (2007), reported that osteoporosis incidence increases by age, with 10% among women at 60 years, 20% at 70 years, 40% at 80 years, and 66% at 90 years. About 90% of hip fractures occur among women at over 50 years of age. Women have a longer life expectancy, so they are more likely to have osteoporosis due to continued bone loss over the years and during their advanced years.

2.3.3 : Gender-Female

Women are prone to have osteoporosis earlier than men, and their chances are three times more over the lifetime (WHO, 2003). Females have less BMC, bone mass and aBMD than males during childhood and adolescence, and usually have rapid bone loss following menopause (Naganathan & Sambrook, 2003; Weaver et al., 2016). Although bone loss occurs in both men and women, women's bone loss occurs at an earlier age and at a faster rate (Alswat, 2017). Alswat (2017), further noted that women also have high bone resorption marker and tend to have fractures five to ten years earlier than men. However, between 60 to 65 years of age, the rate of loss slows down to a similar rate with men. On average, women lose 30% of their bone mass while men between 45 and 75 years of age lose 15 percent.

2.3.4 : Reproductive and Hormonal Status

Women tend to lose bone mass rapidly 5-10 years postmenopausal due to estrogen decline. As estrogen production declines, the estrogen level in the blood level also decreases and changes the bone remodeling cycle. As a result, less bone formation and greater bone resorption lead to bone loss. The timing of menarche is another determinant of BMD and BMC among females. Chang et al. (2017) found the age of menarche had a weak negative association with BMD on the lumbar spine among Korean females aged 20-50 years. Significant associations were found with those who had menarche at an older age (16-18 years) with BMD. BMD of those who had menarche at an older age (16-18 years) was lower compared to those who had menarche < 12 years, even after controlling for confounding factors such as age, family history, body mass

index (BMI), parity, and lifestyle behaviours (smoking, alcohol, and exercise). However, no associations of BMD with the age of menarche were found in the femur and femur neck regions among this study population of 5032 women. The authors also found taking oral contraceptives had a negative association with BMD. However, the findings contradict the other findings in which higher doses of contraceptives had positive associations with BMD (Hagemans et al., 2004) and no significant difference was found with the age of menarche (Sioka et al., 2010). Also, other factors like the number of pregnancies, breastfeeding, duration of fertility and early menopause influence BMD (Grizzo et al., 2020; Sioka et al., 2010).

Modifiable Factors

Dietary and lifestyle behaviours strongly influence PBM and the rate of bone loss (Compston, 2004; Percival, 1999; WHO, 2003). A recent review concluded that about 20-40% of adult PBM is influenced by nutritional and lifestyle factors (Weaver et al., 2016). The authors developed a four-grade (A-D) system to assess evidence-based studies. Factors with robust evidence are graded as A, moderate evidence as grade B, limited evidence as grade C, and inadequate evidence as grade D. Based on the grading system, lifestyle factors are graded as follow: grade A calcium intake and physical activity; grade B- vitamin D and dairy foods (food pattern); grade C- fiber, fruits, and vegetable intake, smoking (detrimental), coco-cola and caffeine beverages (detrimental) and grade D- alcohol and oral contraceptives (detrimental). The grading system is based on evidence on the influences of each factor on PBM or overall bone health. The mentioned factors will be discussed according to nutritional and lifestyle behavioural factors.

Nutritional Factors

2.3.5 : *Calcium Intake*

A recent systematic review reported that adequate calcium intake is essential during the human lifespan to ensure maximum PBM, maintain BMD, and reduce bone loss later in life (Weaver et al., 2016). About 99% of the calcium in the human body is found in bone in the form of hydroxyapatite (Ilich & Kerstetter, 2013). Calcium intake is crucial during skeletal growth to attain a higher PBM. In general, calcium intake, calcium absorption, and calcium excretion determine the calcium balance, impacting bone mass imbalance and bone loss. Bonjo et al., (1997) conducted a randomized control trial (RTC) on pre-pubertal girls for one year. The girls were given calcium enriched food and drinks equivalent to 850 mg of calcium intake per day for a year; BMD gains on all sites were noted in both placebo (similar food and drinks but not

fortified with calcium) and calcium groups but were higher among the calcium supplemented group. Significant positive effects of calcium on bone accrual and reduced bone loss were noted in a systematic review among premenopausal women. Of the six prospective studies, five showed additional calcium intake of 600mg-1500mg either from dietary sources or supplements provided bone mass maintenance and prevented bone loss (Anderson & Rondano, 1996). The review has confirmed that adequate calcium intake is associated with the accrual of bone mass and reduced bone loss.

2.3.6 : Vitamin D

Vitamin D is a nutrient that functions as a steroid hormone essential for developing and maintaining bone health, serum calcium, neuromuscular function, and metabolic processes (Holick, 2007). The primary source of vitamin D is synthesis during exposure to sunlight, but it can also be found in a few natural and fortified foods. A deficiency of vitamin D will decrease intestinal calcium absorption, which increases the secretion of parathyroid hormone (PTH). Increased PTH triggers bone resorption by releasing calcium from bone, leading to a decline of BMD.

Vitamin D given with a calcium supplement, was found to positively affect bone density in the Women's Health Initiative (WHI) study among women between 50 and 79 years of age. A dose of 400 IU vitamin D and 1000 mg calcium per day increased the hip bone density by 1.06% after seven years and delayed bone mass loss further compared to those on placebo (Brunner et al., 2008; Holick, 2007). A further sub-analysis of the WHI participants also reported that a 29% reduction of hip fracture was found among women who consumed at least 80% of calcium and vitamin D doses during the study period compared to non-compliant women. Also, reduction of fracture risk by 26% and 32% was found among participants with high doses of vitamin D at 700 and 800IU/day compared to those taking 400IU/day in a meta -analysis (Bischoff-Ferrari et al., 2004).

Vitamin D deficiency also leads to muscle pain, muscle weakness, and wasting, as one of vitamin D's roles is to maintain neuromuscular function (Binkley, 2012). Muscle weakness and muscle loss have been associated with increased risk of falls. Falls are more prevalent among older people 65 years of age and above. Binkley (2012) reported falls are the leading cause of fractures, especially hip fractures which were 90% fall related. A meta-analysis of 5 RCTs found that vitamin D supplementation does reduce the risk of falls by 22% among 1237 elderly between 65 and 92 years of age (Bischoff-Ferrari et al., 2004).

2.3.7 : Dietary Pattern

Although individual nutrients play an essential role in bone health and osteoporosis prevention, the overall diet or dietary pattern is also worth considering. Nutrients are obtained from foods and food groups in combination, not foods eaten alone, so they are better regarded as overall diet or dietary patterns. Studies on dietary patterns found associations with high and low BMD. Dietary patterns rich in fruits, vegetables, nutrient-dense, and Mediterranean characteristics are associated with higher BMD and reduced risk of fracture (Kontogianni et al., 2009; Tucker et al., 2002). The studies also note that lower BMD was associated with a high confectionary and energy-dense pattern dietary pattern. Similar findings of negative associations were found with dietary patterns high in processed foods among Australian women (McNaughton, Wattanapenpaiboon, Wark, & Nowson, 2011). Women with the dietary pattern of Mediterranean characteristics showed positive associations with a higher BMD at the hip (0.2%), spine (0.3%), and total body BMC (0.6%) compared to women with a high consumption of processed foods. The associations remained even after adjustment of confounding factors such as age, smoking status, and physical activity.

Lifestyle Behavioural Factors

2.3.8 : Physical Activity

Physical activity influences bone accrual during childhood and adolescence and helps reduce bone loss and the risk of falls and fracture (Kohrt, Bloomfield, Little, Nelson, & Yingling, 2004). Confirmation of positive association of physical activity and BMD was highlighted in a recent review, whereby 90% of the 20 longitudinal studies reviewed found a statistically significant higher BMD among the physically active than the physically inactive cohort (Weaver et al., 2016).

Regular physical activity of more than 60 minutes with moderate – vigorous-intensity physical activity 3-5 times per week helps promote healthy and stronger bones (Carter & Hinton, 2014). Baxter-Jones, Kontulainen, Faulkner, and Bailey (2008) reported an increase of 1-5% of BMC and BMD among athletes engaged in weight bearing exercise (WBE) during training from seven months to two years. WBE are recommended and reported to be more beneficial to BMD than non- WBE. A comparison study of WBE and non-WBE in a cross-sectional study among young adults found higher BMD of athletes who participated in high-intensity forces, such as gymnastics, weightlifting, and bodybuilding compared to swimming athletes (Kohrt et al., 2004).

2.3.9 : Smoking

Although the association varied between studies, with some showing decreases and others not, a meta-analysis of the data (94 prospective and cross-sectional studies) found current smokers' bone mass was 10% lower than non- smokers in all bone sites (lumbar, spine, hip and forearm). (Ward & Klesges, 2001). Additionally, smoking is associated with fracture risk in all sites, but a greater risk in the hip site with men at higher risk. In all, smoking was found to be inversely associated with low bone mass and an increase in fracture risks.

Similarly, a recent review by Weaver et al. (2016), confirmed smoking is associated with low BMD at specific skeletal sites, and smokers are prone to stress fractures among young adults. These findings were based on 13 studies comprised of prospective (6) and cross-sectional (7) studies published since 2000. Other risk behaviours, such as inadequate dietary calcium intake, physical activity, and heavy alcohol consumption, were noted common among smokers. These behavioural factors are confounding factors which were not adjusted in some of the studies in the review.

2.3.10 : Alcohol consumption

Another proposed risk factor for osteoporosis is alcohol consumption and it has been shown to have both positive and negative effects on BMD. In a meta-analysis and systematic review, the findings showed the consumption of a 0.5-1 standard drink of alcohol had lower fracture risk while a higher fracture risk for the consumption of 2 or more standard drinks as compared to abstainers (Berg et al., 2008). Also, positive association between alcohol consumption and BMD was noted however, evidence of level of alcohol consumption (moderate & heavy) was not sufficient to compare. Apart from fracture risks, associations between alcohol intake and osteoporosis risk were found in a recent systematic review. Cheraghi et al. (2019) found that the relative risk of developing osteoporosis varies among alcohol consumers as compared to abstainers. Those consuming 0.5-1 standard drink per day have 1.38 times risk of developing osteoporosis, 1.34 risk times for 1-2 standard drinks and 1.63 times for 2 or more standard drinks per day. The risk is higher among consumers who consume 2 or more standard drinks per day. There is a positive relationship between alcohol intake and osteoporosis regardless of the amount consumed however, risk is much higher with higher intake (≥ 2 standard drinks).

2.3.11 : Summary of Risk Factors

Even though osteoporosis is a severe disease it is preventable as well. Certain risk factors such as genetics/family history/race, advanced age, gender, hormonal changes are non-modifiable which does influence bone especially in the attainment of PBM and bone loss. Other risk factors are modifiable which can be controlled such as adequate intake of calcium vitamin D, a nutrient-dense dietary pattern, engaging in WBE, taking alcohol in moderation, and if possible, it helps to quit smoking.

2.4 : Epidemiology and Burden of Osteoporosis

2.4.1 : Prevalence - globally

Osteoporosis is a growing public health issue worldwide but is more prevalent in the following regions: North America, Europe, South-east Asia, and Oceania (Australia & New Zealand). In 2010, 10.3 million adults in the United States of America (USA) had osteoporosis, while 43.3 million had low bone mass. About 54% of the adult population ≥50 years had osteoporosis or osteopenia (Wright et al. 2014). The majority with osteoporosis were non-Hispanic White, followed by Mexican American and non-Hispanic Black. High osteoporosis prevalence has been reported from 27 countries in Europe. Almost 28 million osteoporosis cases were documented in 2010 among men and women between the ages of 50 and 84 in European countries where 80% of the cases were women (Hernlund et al., 2013).

In the Asian region, approximately 70 million adults (≥50years) had osteoporosis, and 50% were women in China. Despite recording high numbers, the actual cases were underreported due to under-diagnosis (IOF, 2003). For the Oceania region, in year 2001, 2 million people were reported with osteoporosis in Australia and 4.7 million in 2012 (IOF, 2007; Tatangelo et al., 2018). An estimated 652,500 people over age 50 years reported being diagnosed with osteoporosis between 2011 and 2012 in Australia, and 88% were women. Tatangelo et al. (2018) also highlight an issue with under-diagnosis, which does not reflect the real picture of the actual osteoporosis prevalence rate and its burden in Australia. In terms of predicting the incidence of osteoporosis, an increase of 31% is predicted for 2022 in Australia.

According to the New Zealand National Health Survey (2002/03), the osteoporosis prevalence rate was 2.4%, meaning 1 in 42 adults had osteoporosis. Osteoporosis was more prevalent among females and the non-Maori population. In 2007, 70,631cases were reported based on the NZ survey 2002/03 and NZ census among adults aged 50+ years, and 90% of the patients

were women (Brown et al., 2007). Reported cases were diagnosed either by fractures or from a DXA scan. It was noted that cases were underdiagnosed and underestimated due to the diagnostic process and costing. Public health funding does not cover asymptomatic diagnosis and preventative treatment and the cost of the diagnosis is not reimbursed (Brown et al. 2011). Hence, the real prevalence is expected to be much higher as elderly population increases.

2.4.2 : Incidences of Fractures and impacts on morbidity, mortality, and quality of life

Fracture is one of the utmost consequences of osteoporosis as it increases morbidity and mortality risk (WHO, 2003). The most common osteoporotic fracture sites are the hip, vertebrae, and forearm (Poole & Compston, 2006). These osteoporotic fractures impose massive burdens on a country's health and economy. Hip fracture is the most serious one as it is so painful and requires extended hospitalization and care (WHO, 2003). Furthermore, it comes with a higher degree of immobility, morbidity, and mortality, creating huge health burdens. Statistics show a trend of 20% of patients with hip fractures died within a year following fracture (Harvey, Dennison & Cooper, 2010). In general, fractures affect an individual physically and psychologically in terms of the subsequent loss of mobility, ability to make daily activities, loss of productivity, loss of independence, and reduced quality of life (Harvey, Dennison, & Cooper, 2010).

IOF (2007) reported approximately 9 million fractures in the year 2000 globally, with hip fracture the highest at 1.6million, followed by forearms at 1.7million and 1.4 million vertebral fractures. These osteoporotic fractures occurred more frequently among women (1 in 3) than men (1in 5) of adults over 50 years. Globally, an osteoporotic fracture occurs every 3 seconds, and incidence rates are projected to increase 2-3-fold by 2050**.** Burge et al. (2017) reported more than 2 million osteoporotic fractures in the USA in 2005 with a prediction of a 50% increase in fractures that is expected by the year 2025. Similarly, a prediction of an increase of 4.8 million fractures by 2025 was made for Europe (IOF, 2003). The increasing trend of fractures was also reported in China and Australia, with a high incidence of hip fracture. China reported 68,700 annually while 20 000 were reported in Australia (IOF, 2003). An increase incidence of hip fractures (411,000) was later reported in 2015 for China (Si, Winzenberg, Jiang, Chen, & Palmer, 2015). No new record for Australia was reported in the IOF page however, 18,424 hip fractures were reported in 2017 from hospital registrations following the establishment of the ANZHFR in 2015 (ANZHFR, 2018).

In New Zealand, more than 84,000 osteoporotic fractures were reported in year 2007 and an estimated increase of 37% between 2007 and 2020 is predicted. Two-thirds of the osteoporotic

fractures reported in 2007 occurred among women, as expected. The most frequent fractures were vertebral (33%), rib (25%), forearm (14%), and hip (5%). Although hip fractures were only 5% of the total fractures, they require more attentive care with higher costs. Fractures come with quality adjustment in life years (QALY) losses and huge health and economic burdens. Brown et al. (2007), estimated nearly 11250 QALYs lost in 2007 to osteoporotic fractures and predicted an increase to 15100 in 2020. Health costs were estimated at more than NZ 211 million per year for fracture treatment. As expected, vertebral and hip fractures incurred more expenses, with NZ 55 million costs for fracture care and rehabilitation and NZ 330 million for treatment and management were incurred**.** In total, approximately NZ 330 million per annum has been spent on osteoporosis-related costs in 2007 with an expected increase in the future. High predictions of the prevalence, incidences, osteoporotic fractures, and the loss of QALYs with an increase of NZ 458 million for health cost is predicted for the year 2020 and beyond.

2.5 : Prevention of Osteoporosis with Tools used to assess Osteoporosis Knowledge, Health Beliefs and Calcium Intake

Failure to reach optimal PBM before skeletal maturity and excessive bone loss after PBM contributes to the development of osteoporosis. By 30 years of age, PBM is achieved; thus, identifying controllable factors, such as calcium intake and exercise in the first three decades of life is essential to reduce osteoporosis later in life (Gammage, Gasparotto, Diane, Mack & Klentrou, 2012). Although the science of reducing risk is relatively straightforward, it is not being followed as the high rates of osteoporosis show. Therefore, understanding why and developing strategies to promote bone health behaviours and reduce risky behaviours among young adult females are essential. Specific tools, such as the health belief model (HBM), osteoporosis knowledge test (OKT), osteoporosis health belief scale (OHBS) and osteoporosis self-efficacy scale (OSES) have been developed and validated to assess and understand the level of osteoporosis knowledge, predict osteoporosis health behaviours and to determine an individual's level of confidence to take action.

2.5.1 : Health Belief Model (HBM)

The Health Belief Model (HBM) was developed by a group of social psychologists to understand people's failures to participate in the early detection and prevention of diseases (Hochbaum, Rosenstock, & Kegels, 1952). This model was derived from the psychological and behavioural theory that believes health-related actions are stimulated by the following factors: the existence of health concern, vulnerability to serious health conditions, and having high

health benefits that outweigh barriers to health actions (Rosenstock, Strecher, & Becker, 1988). These factors are expressed in five dimensions as below:

1. Perceived susceptibility- refers to an individual's feelings of risk or vulnerability to contracting a disease.
2. Perceived severity- refers to an individual's feelings of seriousness on the implications of the disease or consequences of the disease.
3. Perceived benefits- refers to an individual's belief in particular behaviours that are effective in reducing the threat of a disease.
4. Barriers- refers to individuals' belief in potential obstacles that impede undertaking recommended behaviours to prevent or minimize disease.
5. Cue of Actions- a trigger necessary to promote engagement in preventive behaviours.

2.5.2 : Osteoporosis Health Belief Scale (OHBS)

The Osteoporosis health belief scale (OHBS) was developed following the HBM concept to assess health beliefs about osteoporosis and identify the relationship between health beliefs and preventive behaviours (Kim, Horan, Gendler, & Patel, 1991). The two most critical preventive behaviours are calcium intake and exercise, which are incorporated in the OHBS. Knowing and understanding their benefits and barriers is the key to address the prevention and delaying of osteoporosis. This OHBS has been tested for reliability and validity among 150 elderly participants and used in various countries and age populations. The OHBS has seven constructs based on the HBM, emphasizing the benefits and barriers of exercise and calcium intake behaviours.

1. Perceived Susceptibility- refers to an individual's vulnerability to developing osteoporosis.
2. Perceived severity (seriousness) - refers to an individual's beliefs of the harmful effects or consequences of developing osteoporosis.
3. Perceived Exercise Benefits- individual's beliefs of the benefits of exercise to prevent and minimize the threat of osteoporosis.
4. Perceived Calcium Benefits- individual's beliefs of the benefits of calcium intake to prevent and minimize the threat of osteoporosis.

5. Perceived Exercise Barriers- refers to the individual's barriers that hinder one's ability to do exercise.
6. Perceived Calcium Barriers- refers to an individual's barriers to having adequate calcium intake.
7. Perceived Health Motivation- refers to one's ability to seek and take health-related actions concerning osteoporosis.

Each subscale has six statements with Likert-scale responses as strongly disagree (1); disagree (2); neutral (3); agree (4) and strongly agree (5). The total range of scores for each subscale is 6-30 and 35-210 for the overall score of the OHBS. High perceived susceptibility and severity indicate a threat to physical health, social life, and daily activities that typically stimulate health behaviours. Other positive triggers to behavioural change are the high perceived benefits of exercise and calcium intake behaviours and positive health motivation. In contrast, high perceived barriers are expected to hinder behavioural change.

2.5.3 : Osteoporosis Self-Efficacy Scale (OSES)

Following the OHBS, the osteoporosis self-efficacy scale (OSES) was developed to measure the confidence level in actioning behavioural change in exercise and calcium intake (Horan, Kim, Gendler, Froman, & Patel, 1998). This self-efficacy concept was derived from Bandura's social cognitive theory based on two factors that motivate actions: favourable outcomes and individuals' confidence level to execute change. OSES, when added with OHBS, is referred to as the expanded OHBS (Gammage & Klentrou, 2011). The OSES has two sets of scales: 21 items and 12 items; either one can be used. Both scales have a confidence scale range from 0-100, with a low score indicating not at all confident and very confident for the high score. The OHBS and OSES were tested for validity and reliability and used among different ethnicities, ages, and gender populations (Horan et al., 1998; McLeod & Johnson, 2011). Each tool can either be used separately or together.

2.5.4 : Osteoporosis Knowledge Test (OKT)

The Osteoporosis knowledge test (OKT) is another tool developed in the early 1990s to measure osteoporosis knowledge among studied populations (Kim, Horan, & Gendler, 1991). Having knowledge on osteoporosis (risk factors and preventions) is important to make informed choices about the prevention of osteoporosis. Although knowledge is essential it is believed to be mediated by health beliefs to influence behaviour change (Piaseu, Schepp, &

Belza, 2002). Supporting findings were found and confirmed by Chang (2008) and Sedlak, Doheny, and Jones (2000) that osteoporosis knowledge alone does not influence behavioural change, but it will along with health beliefs and self-efficacy.

The OKT is comprised of three domains: osteoporosis risks, calcium food sources, and exercises to prevent osteoporosis. The OKT consists of 24 items: 9 on osteoporosis risks, 7 on exercise, and 8 on calcium intake. The OKT was validated and used in various countries (China, United States of America, Thailand, and New Zealand). It has been used with modifications such as translation, food choices and wordings to accommodate the study population (Chen, Liu & Cai, 2005; Doheny, Sedlak, Estok & Zellar, 2007; von Hurst & Wham, 2007). The OKT was revised in 2011 due to new evidence on bone health, such as bone accretion, bone remodeling, the role of vitamin D, and other associated risk factors (C. Gendler, Martin, Kim, Von Hurst, 2011). The revised OKT (r-OKT) included an extra domain labelled as general consisting of three questions: one each on peak bone mass (PBM), diagnosis, and treatment. Additionally, five risk factors (elderly, smoking, alcohol use, overweight & eating disorders) and three vitamin D questions were added in the risk and nutrition domains, respectively. Revision was based on previous studies' evidence and recommendations (Gendler et al., 2015). For instance, the vitamin D questions were added by von Hurst and Wham (2007) in New Zealand and smoking and alcohol were added by Chen, Lui, and Cai (2005) in China. The r-OKT consists of 32 items, of which 14 were retained unchanged from the original OKT. There are 11 risk domain questions, 6 exercise domain questions, 12 nutrition domain questions, and 3 general domain questions. Similar to the original OKT it can be measured as the total OKT score, nutrition subscale and exercise subscale.

This r-OKT has been tested for reliability and validity among a group of adults of both genders of white people. Gendler et al., (2015) stated that the r-OKT has more strengths as compared to the other knowledge questionnaires such as the osteoporosis knowledge assessment tool (OKAT), facts on osteoporosis quiz (FOOQ), and osteoporosis knowledge questionnaire (OKQ) as it incorporates evidence-based changes and offers ‘don't know’ responses which help to avoid guessing. However, an evaluation of its effectiveness adapting or modifying to suit different cultures and language translation is encouraged.

2.5.5 : Calcium Intake Tool

A variety of tools have been used to measure calcium intake among study populations. Calcium-specific food frequency questionnaires (FFQ), food records and rapid assessment

method (RAM) for calcium intake are the common dietary tools used to measure estimated calcium intake. The calcium specific FFQ is a shorter version of the FFQ, where only food items with a significant amount of calcium are included. There are many versions of a calcium specific FFQ depending on the numbers of calcium food items included. The calcium specific FFQ can be either short, medium, or long. Frequency of consumption of food item as per serving are asked in daily, weekly, monthly, yearly, and never/infrequently**.** The number of serve(s) and frequency are calculated to estimate calcium intake per day**.**

The food record is a record where all foods and drinks consumed throughout the day are recorded with serving sizes. In the food record, the serving sizes are recorded based on actual or estimated food item consumed. While the number of days of a record can vary, it is mostly between 3-4 days. Other specific information such as food brands, serving sizes, ingredients and recipes are also recorded alongside the meal and time. Estimated calcium intake is calculated based on all food and drink items or meals consumed unlike the FFQ, only from calcium rich foods. Nutrient intake estimation is more accurate and less biased with a food record compared to using FFQ (Park et al., 2018).

Another tool used is the RAM method which consists of 4-6 food categories to measure calcium estimates. The food categories are milk-cheese-yoghurt; fruits-vegetables; bread-cereals-rice-pasta; meat-fish-poultry-dry nuts/seeds; calcium enriched orange juice and calcium supplements with fixed serving sizes (Gammage & Klentrou, 2011; Wallace, 2002). Respondents are asked about the number of times food items are consumed per day or week and to answer yes or no for calcium supplements. The number of servings is then converted into calcium intake and reported as the number of servings per day or week. The RAM tool is less time consuming and quick to gather information in terms of a larger-scale study.

Comparison of the calcium estimates from the three tools show that RAM has the tendency to over-estimate calcium intake and not appropriate for young adult population as most would not be taking calcium supplements (Gammage & Klentrou, 2011; Moore, Braid, Falk, & Klentrou, 2007). A previous study using RAM has found only 10% of young adults took calcium supplements (Edmonds, 2009). While FFQ has been known to overestimate/underestimate nutrients intakes compared to a food record, it is beneficial to detect longer consumption habits (Narruz-Varli, Kose, Tatar, Arslan & Koksal, 2018). FFQ usually underestimates calcium intake estimates as compared to food records (Ong et al., 2017; Söderberg et al., 2017). Regardless of its limitations, FFQ is quick and less expensive to use in a large-scale study.

2.6.0 : Current Osteoporosis Knowledge, Health Beliefs, and Behaviours (Calcium intake)

A recent systematic review reported poor knowledge about osteoporosis among adolescents and young adults (Chan et al., 2018). Thirty-four articles published from 2008 to May 2018 which studied college and university students were analyzed in the review. This is used/referred to in the following paragraphs plus older/newer studies in New Zealand and in other countries. Articles using OKT and OHBS are summarized in Table 1.

2.6.1 : Level of Osteoporosis Knowledge

The review aimed to provide findings on osteoporosis knowledge, beliefs, and practices among young adults on bone health. Of the thirty-four articles, thirteen measured osteoporosis knowledge, whereby nine reported having poor knowledge while four with good knowledge scores based on knowledge score's percentage. While all studies used a cross-sectional study design, different tools including an osteoporosis knowledge questionnaire (OKQ), OKT, r-OKT, osteoporosis knowledge scale (OKS), osteoporosis knowledge assessment tool (OKAT) were used to measure the knowledge. The review also found osteoporosis knowledge varies among age groups, gender, and education level but may not be comparable as different knowledge questionnaires were used.

Of the 13 studies that measured osteoporosis knowledge, only 4 had used OKT and r-OKT as tools to measure osteoporosis knowledge. These four will be examined further to compare their level of osteoporosis. Amre, Safadi, Jarrah, Al-Amer, and Froelicher (2008) found a poor level of osteoporosis knowledge (12.5 out of 23) among 85 nursing students in Jordon. The inadequate knowledge was found throughout the domains of the modified OKT used. Surprisingly these final year nursing students had limited osteoporosis knowledge which was not expected. Similarly, Gammage, Gasparotto, Mack, and Klentrou (2012) found generally poor osteoporosis knowledge among Canadian College students, but women have better knowledge than men. Low-moderate osteoporosis knowledge was reported in a comparable study with 408 American and 409 Chinese college students in separate countries (Ford, Bass, Zhao, Bai, & Zhao, 2011). American students (14.5 out of 24 or 60%) have better osteoporosis knowledge than the Chinese students (11.8 out of 24 or 49%). Interestingly Nguyen and Wang (2012) found higher osteoporosis knowledge among healthcare students in Colombia which was different from the Jordanian nursing students. The r-OKT was used in this study with a

total score of 32. Nguyen and Wang found a higher mean of 24 out of 32 (76%). Findings from the four studies were inconsistent as two studies reported low knowledge, one with moderate and another with high osteoporosis knowledge were found among University or College students from China, United States of America (USA), Canada and Colombia.

Similar results on moderate osteoporosis knowledge were reported in two New Zealand Studies. von Hurst and Wham (2007) used a modified OKT (26) among women aged 20-49 years living in Auckland. Two additional vitamin D questions were included in the questionnaire; the total score was 26. The participants were selected through snowballing sampling whereby six hundred and twenty- two women participated. Younger women (20-29 years) had the lowest total mean score of 15.8 or 58% compared to 17.3 (67%) in the 40-49 years' group. The researchers also found older women had good knowledge of the risk and nutrition domains as compared to young adult women. Likewise, a moderate level of osteoporosis knowledge was found among 102 South Asian women between 20 and 49 years of age who were living in Auckland, with a mean score of 15.1 out of 26 or 58% even though the women were highly educated (Tsai, 2008). The same modified OKT tool used above was also used.

2.6.2: *Level of Osteoporosis Health Beliefs*

2.6.2.1: Perceived Susceptibility and Severity

The osteoporosis health belief scale (OHBS) was used in six of the studies reviewed by Chan et al. (2018). According to the HBM, high perceived susceptibility and severity indicate a threat that increases the likelihood of action. Findings from the six studies found low perceptions of susceptibility and severity is common among young adult population. In a comparison study conducted among American and Chinese students found both study population perceived low susceptibility to osteoporosis using the original OHBS (Ford et al., 2011). Each study population has a mean score of 13.4 out of 30 (45%) and 12.9 out of 30 (43%), respectively. Similarly, low mean perceived severity scores were reported, both groups measured 14.4 out of 30 or 48 percent. These findings confirm that college students from both countries perceived low susceptibility and severity to osteoporosis. Comparable findings were found among 353 nursing students in Damascus in a cross-sectional study. Again, the original OHBS was used in this study with a mean score of 13.4 out of 30 (45%) for low susceptibility of osteoporosis and 17.1 out of 30 (57%) showing moderate perception of severity of osteoporosis (Sayed-Hassan, Bashour, & Koudsi, 2013).

Findings similar to Sayed-Hassan et al. (2013) were found among Canadian university students however, a modified OHBS was used (Gammage et al., 2012). Each subscale or construct has 5 items instead of 6 with different scoring from the original OHBS. Participants, both males (1.7 out of 5 or 34%) and females (2.4 out of 5 or 48%), reported having low perceptions of the susceptibility of osteoporosis. Despite having low perceptions of susceptibility, these participants perceived moderate severity of osteoporosis. Males have a mean score of 3 out of 5 or 60% for severity and 3.4 out of 5 or 68% for females. Comparable findings were found in another study conducted in Canada among women and men, between 18 and 25 years of age, between 30 and 50 years of age and 50+ years of age, also using a modified OHBS (Shanthi Johnson, McLeod, Kennedy, & McLeod, 2008). Young adults (18-25 years old) had low perceived susceptibility, with scores of 10.9 out of 25 (44%) and 8.6 out of 25 or 34% for females and males respectively. Both young males and females have moderate mean scores of severities; 15.6 out of 25 (62%) and 13.8 out of 25 (55%), respectively. Further, the other two studies (Bilal et al., 2017; de Silva et al., 2014) in the review did report low perceived susceptibility of osteoporosis among medical students in Pakistan and Sri Lanka from the modified OHBS. Unfortunately, as both studies did not report the mean score of severity, so they cannot be compared.

In addition to articles in the review, other studies among university and college students also found related findings to the above studies. Edmonds, Turner, and Usdan (2012) found low perceived susceptibility and moderate perceived severity among 792 college students between 17 and 31 years of age in the USA using OHBS. A similar finding of low perceived susceptibility was found among university students in Malaysia (Chiang, 2020). Although students perceived low susceptibility, osteoporosis was perceived as a serious disease with a severity mean score of 20. In contrast, Mostafa, Mohtasham, Sakineh, and Mona (2016) reported moderate mean scores of both susceptibility (15.1 out of 30) and severity (18.2 out of 30) among university students in Iran.

On the same note, two studies in New Zealand, one reported low perceptions of susceptibility and moderate perceptions of osteoporosis severity among women between 20 and 49 years of age living in Auckland while the other perceived moderate susceptibility and severity (Tsai, 2008; von Hurst & Wham, 2007). In all, the studies found common findings as young adults perceived low susceptibility and moderate severity to osteoporosis.

2.6.2.2: Perceived Benefits and Barriers of Calcium Intake

Benefits and barriers to calcium intake are hypothesized to influence and predict the intake of calcium foods. Tsai (2008) reported perceived high benefits (23.5 out of 30) of calcium intake and low barriers (13.4 out of 30) of calcium intake among South Asian women in New Zealand. Although von Hurst and Wham (2007) did not report mean scores, 91% of the participants agreed that "taking enough calcium prevents problems with osteoporosis," and 77% agreed with "calcium-rich foods have too much cholesterol." These statements highlight the benefits and barriers of calcium intake among the study population. They found older women (40-49years) are more likely to agree with the statement of calcium barriers than younger women.

Among the European population the benefits of high perceptions of calcium intake were reported (Edmonds et al., 2012; Ford et al., 2011; Gammage et al., 2012). Two USA studies reported having high perceptions of calcium benefits at 22.3 out of 30 (74%) (Edmonds et al., 2012) and 23.2 out of 30 (77%) (Ford et al., 2011). Similar high perceptions of benefits were found among Canadian university students (4.2 out of 5) (Gammage et al., 2012). Studies of young women in two Asian countries also reported participants having high perception scores on the benefits of calcium intake. A study conducted among Medical students between 18 and 40 years of age reported a mean score of 23.1 out of 30 for benefits of calcium intake (Chiang (2020). The study by Aree-Ue and Petlamul (2013) found both younger (between 20 and 35 years of age) and older (≥60 years of age) women perceived high calcium benefits despite living in rural Thailand.

Young adults perceived low-moderate barriers to calcium intake as reported by the mean scores of the seven studies mentioned above. According to the responses, these were the common barriers: the high cost of calcium-rich foods, which was reported by Chinese students in (Ford et al., 2011), availability and accessibility reported by Malaysian students (Chiang, 2020), food preferences such as taste, cultural foods, dislike and (Aree-Ue & Petlamul, 2013; Bilal et al., 2017; de Silva et al., 2014) giving up other foods in order to consume calcium foods (Tsai, 2008) and calcium-rich foods are high in cholesterol (von Hurst & Wham, 2007). The findings indicate that barriers to calcium intake vary by countries among young adults.

2.6.2.3. Health Motivation

Heath motivation measures a person's self-motivation to seek or practice health-seeking behaviours. All six studies that measured susceptibility and severity in the review reported having moderate-high perceptions of health motivation (Bilal et al., 2017; de Silva et al., 2014; Ford et al., 2011; Gammage et al., 2012; Sayed-Hassan et al., 2013; Shanthi Johnson et al., 2008). On the same note the other four studies also found similar findings (Chiang, 2020; Edmonds et al., 2012; Mostafa et al., 2016; Tsai, 2008). These findings show young adults are health motivated despite having different nationalities and cultural backgrounds.

2.7: Predictors of Calcium intake (relationship between osteoporosis knowledge, health beliefs and calcium intake)

Osteoporosis knowledge and osteoporosis health beliefs may influence a person's calcium intake, as highlighted earlier in the health belief model. Since not all studies reported on earlier measured the predictors of calcium intake, a few studies will be discussed here. Of the two reported studies in New Zealand, only Tsai's study measured the calcium intake of participants using food records. The participants from Tsai's study had a median calcium intake of 685 mg/day, with calcium barriers and health motivations, reported significant predictors of calcium intake in the multivariate analysis.

Similar findings were reported among college students in the USA between 17 and 31 years of age for both genders (Edmonds et al., 2012). The participants also had inadequate calcium intake with calcium barriers and health motivations as the predictors of calcium intake. In terms of calcium barriers, a consistent finding was found among female university students in Iran. Calcium barriers were the only significant predictors of calcium intake (Mostafa et al., 2016). In contrast, a study conducted among younger females in grades 8-11 in Canada found osteoporosis knowledge and calcium self-efficacy in addition to calcium barriers as predictors of calcium intake from a simultaneous regression (Gammage & Klentrou, 2011).

Osteoporosis knowledge was reported as one predictor of calcium intake along with severity and health motivations among 333 Malaysian university students (Chiang, 2020). Participants had moderate osteoporosis knowledge, moderate susceptibility, severity, calcium barriers, and health motivation scores but perceived high calcium benefits. An inadequate intake of dairy products was reported, as 61.5% did not consume adequate dairy products based on four questions (RAM). The findings revealed the common predictors of calcium intakes were

calcium barriers, health motivation and osteoporosis knowledge. Perceived severity of osteoporosis and calcium self -efficacy were found but were not consistent in the studies.

2.8 : Rationale of this study

Osteoporosis is a growing public health problem around the world and in New Zealand. It is a preventable disease and making lifestyle changes or following health recommendations is essential to prevent or delay osteoporosis. Additionally, the predictions of increasing fractures, health, and socioeconomic burdens of osteoporosis highlight the need for urgent actions. The first three decades of life is a crucial time to act as it is the period to achieve optimal PBM. Understanding young female adults' knowledge and health beliefs on osteoporosis may help to prevent osteoporosis. Previous studies in New Zealand have identified females have moderate knowledge of osteoporosis and a perceived low threat of developing osteoporosis. Also, females between 15 to 30 years of age tend to have low calcium intake below the EAR as reported in surveys in 1997 and 2009 which is the crucial time to attain PBM.

Additionally, the high-fat content of calcium-rich foods was highlighted as a main barrier to the consumption of calcium-rich foods. This study aims to determine the association between calcium intake, osteoporosis knowledge, and osteoporosis health beliefs. The findings of this study will provide insight into the areas to address in terms of preventive behaviours especially for young adults.

Table 2.1: Summary of Studies using OKT, OHBS and Associations between Calcium Intake, OKT, and OHBS

Reference	Study Characteristics	Methodology	Findings
Studies using OKT, OHBS and associations between calcium intake			
KEY: +ve= positive; -ve= negative; ↓=increase/high; ↑= decrease/low			
Amre et al., 2008	85 - Nursing University students Male= 58, Female= 27 Age =19- 32 yrs. Study Country- Jordan	**Objective** To explore baccalaureate nursing student's knowledge of osteoporosis for beginning practice in the community **Tool** Modified version of OKT and OKQ (out of 23)	Overall poor knowledge of osteoporosis – 12.6 out of 23 (54.9%) - graduating student nurses have limited knowledge to perform in community (health promotion and diseases prevention).
(Aree-Ue & Petlamul, 2013)	187 females Age-20-35years &≥60 years Study Country- Thailand	**Objective** To compare knowledge, attitude towards preventive behaviours between younger & older women **Tools** OKT OHBS OSES **Statistical analysis** T-test and bivariate	**Education level**- younger women had formal education & reached a higher level as compared to older women **OKT**- 11.54±3.78 (young); 7.71±3.96 (older). The statistically significant difference that older women had lower knowledge score **OHBS-** - susceptibility – 16.86±4.79 (young); 13.77±6.04(older) Statistically proven young women had greater susceptibility - Severity -22.66±3.89(young);23.34±6.06 (older) - Calcium benefits-23.20±3.75 (young); 22.25±4.34 (older) - **Calcium barriers- 15.29±3.34 (young); 17.63±4.20 (older) - Health motivation-23.21±3.34 (young); 23.69±4.57 (older) **OSES-** calcium intake- 43.35±10.12(young);38.80±14.48 (older)

			Correlation - Knowledge has a positive correlation to osteoporosis preventive behaviours in young women - Positive & significant correlations were found with preventive actions and overall health beliefs in older women - all other relationships not significant
Bilal et al., 2017	400 university female medical students Mean age 19.4 Study Country- Pakistan	**Objective** - To assess osteoporosis knowledge, beliefs & practices among university students **Tools** - OKAT- osteoporosis knowledge - OHBS- osteoporosis health beliefs - FFQ- calcium intake **Statistics Analysis** - Descriptive analysis - Chi Square tests	**Calcium Intake=** average 510mg/day (low calcium intake) -only 29% met calcium RDA **OKAT=** 8% had good knowledge score, 49% average & 43% poor **OHBS** - Susceptibility – believe chances of getting osteoporosis is high (14%) - Severity-osteoporosis would made daily living challenging (81%) - Calcium barriers- calcium food is difficult to eat (30%) - Health Motivation- take steps to improve health (62%)
Chang, 2006	265 women 25-45years old Study country- Taiwan	**Objective** -Examine associations between demographics knowledge (15 questions on risk & prevention), health beliefs, and calcium intake **Tools** **Self-designed questionnaire** **-** Demographics - Knowledge (15 questions on risk & prevention) **-** OHBS (4 subscales- susceptibility, severity, calcium benefits & barriers). **Calcium intake-** based on the authors' previous study & literature **Statistical analysis** - T-test and ANOVA test	**Calcium intake**= 454.7±66 (low calcium intake) **Knowledge** (out of 15) = 12.1±2.8 or 80.6% (high score) **OHBS** (out of 5)**-** - susceptibility=2.8±0.5 (moderate score) - Severity=2.2±0.7 (low score) - calcium benefits=1.9±0.4(low score) - calcium barriers=2.9±0.7 (moderate score) **Correlations between calcium intake & variables** -Women who had high calcium intake are likely to be less knowledgeable, (-0.324) perceived greater susceptibility (0.252), severity (0.292), perceived fewer barriers (-0.293) are older (0.258), have a family history (4.730), graduated from high school (6.210) and self-rated health (0.253)

		- Bivariate correlations Stepwise regression analysis	**Predictors of calcium intake** Knowledge, number of children self -rated health, level of education, body mass index
(Chiang, 2020)	University students Both gender (95males & 238 females) 18-40years old Study country-Malaysia -	**Objective** - Examine the association between osteoporosis knowledge, health beliefs & calcium intake among medical sciences students **Tools** - **OKT** (16 items) - **OHBS** (30 items) - 6-13.9 (low); 14-21.9 (mod); 22-30 (high) - **OPBS-** dietary calcium questions used to measure calcium intake - Calcium servings modified to meet the daily requirement in the local context (Malaysia) - Adequate = ≥7 servings daily - Inadequate= < 7 servings daily **Statistical analysis** - Descriptive - Correlations - Multiple linear regression -	**OKT** (total score of out of 100) - Mean total score=50.4±16.48 (moderate score) - 4.5% (high score); 55.9% (moderate); 39.6% (low) **OHBS** (out of 30) - susceptibility – 14.2±4.02 (moderate score) - severity – 20.4±4.67 (moderate score) - calcium benefits -23.1±3.94 (high score) - calcium barriers- 14.4±3.99 (moderate score) - health motivation -21.6±3.79(moderate score) **Calcium intake** -61.5% had inadequate dairy products **Correlations** -Calcium intake has not significant correlations with OKT and OHBS constructs - Positive correlations between OKT and health motivation(r=0.173), calcium benefits(r=0.127); and negative correlations with calcium barriers (r=-0.208) -Positive correlations between age and OKT (r=0.355) and health motivation (r=0.149) but negative correlations with calcium barriers (r=0.120) **Predictors of dairy products** -OKT (Beta= -0.175) perceived severity (Beta= -0.122) and health motivation (Beta=0.171) are predictors of dairy intake p value <0.001 with R square of 0.060.
de Silva et al., 2014	186 female students medical School entrants - Mean age 20.7	**Objectives** - Determine the knowledge, beliefs, and practice regarding Osteoporosis among young female entering Medical Schools in Sri Lanka	**Calcium Intake** =528mg per day (only 18.5% met RDA) **OKAT**= 51.6% average score, 40.8% poor score (overall lacked knowledge on risk and protective factors

	Study country- Sri Lanka	**Tools** -OKAT- 20 question. - The modified OHBS (3 questions per construct) - FFQ for assessing calcium intake. **Statistical Analysis:** - Descriptive analysis - Pearson Chi-Square	**OHBS** -Susceptibility = low as only 13.9% (n=26) of women agreeing that they had higher chances of getting osteoporosis. - Severity= high as 83.3% felt having osteoporosis would make daily life difficult. Calcium barriers- low as 15% can't tolerate and dislike calcium rich foods Health Motivation- moderate as 59% were motivated to improve health
(Edmonds et al., 2012)	- 792 College students - 17-31 years old - Both gender Study country - the USA	**Objectives** -Examine the relationship between osteoporosis knowledge, health beliefs, and calcium intake **Tools** Osteoporosis knowledge test (OKT) - 24 items (total score is 24) - 1-point score per correct response Osteoporosis health belief scale (OHBS) - 42 items with 7 constructs. - Rated using a Likert scale (1-5) - Each construct has a possible score of 6-30 - High scores indicate high perception except for barriers. Barriers high scores indicate low perceptions Osteoporosis preventing behaviour survey (OPBS) has questions to measure calcium intake - 39 items consisting of questions on exercise, calcium intake, risk factors - Calcium intake is measured based on4 questions of the frequency of consumption of calcium-rich foods & intake of calcium supplements - Food is converted into servings classified as follow - Inadequate - < 4 servings/week - Moderate 5 servings /week or 1 serving/day - Adequate- 2-3 servings/day	Mean age – 20.6 years Female (53.6%), male (46.45) Ethnicity- white (64.5%), remaining others **OKT-** (total score is out of 24) * No mean score of knowledge given but low scores, especially in the risk domain and few calcium questions. Lack of knowledge **OHBS** (total score is out of 30) * susceptibility =13.64 ±5.09 (low score) * severity =17.34± 4.37 (moderate score) * exercise & calcium benefits =23.23± 5.33, 22.26± 4.61 (high scores for both) *exercise & calcium barriers =24.27±4.62, 22.82± 4.57 (low scores for both) * health motivation =19.87±4.34 (high moderate score) **Calcium Intake** * 62.5% had an inadequate calcium intake **Correlations & Multiple Regression** *Significant positive correlation between health motivation & calcium intake (r= 0.204, p=0.000). High calcium intake, high health motivation * No significant correlations with other variables **Predictors**

		Statistical analysis - Descriptive - Bivariate correlation Multiple regression	* Health motivation, perceived barriers (calcium & exercise), age, ethnicity, and physical activity were predictors of calcium intake. All at a significant value ✓ Low calcium barriers yet inadequate calcium intake
Ford et al., 2011	774 university students 408 from the USA & 409 from China Study country- USA & China	**Objective** Investigate differences in osteoporosis knowledge, self-efficacy, and health beliefs among Chinese and American students. **Tools** -OKT -OHBS -OSES (only for exercise so won't be reporting in findings) **Statistics Analysis** Chi-Square Analysis	**OKT** Osteoporosis differences were noted (US=14.52, Chinese=11.82) **OHBS** Susceptibility – low scores for both countries (US=13.4, Chinese= 12.9) Severity- both had mean score of 14- Calcium benefit- high for US (23) and moderate for China (18) Calcium barriers**-** low for US (13) and moderate for China (15)- cost was the main barrier to calcium intake among Chinese students Health Motivation- both had higher mean score of 21 and 20 respectively.
(Gammage & Klentrou, 2011)	- 510 grade 9-12 females - From 8 different schools Study country- Canada	**Objective** To investigate if the expanded health belief model (EHBM) could predict calcium intake & exercise **Tools** - OKT (out of 24) - OHBS (out of 5 for each constructs) - Osteoporosis self-efficacy scale (OSES) 21 items which measure confidence of preventive behaviours (calcium intake & exercise)- 11 (calcium) 10 (exercise) - Rapid assessment method (RAM) for calcium intake- mg /day (6 food categories)	**OKT** (out of 24-total scores) - Mean =11.68±3.51 (low score) **OHBS (out of 5)** susceptibility =2.39±.74 (low score) severity =3.27±.69 (moderate score) calcium benefit =3.56±.58 (high score) calcium barrier =2.24±.68 (low score) exercise benefits =3.56±.59 (high score) exercise barriers =2.61±.70 (moderate score) health motivation =3.51±.68 (high score) **Calcium Intake –** mean = 1315.18±479.18 – adequate, meets recommendation for age group

		- Physical activity questionnaire adolescent (PAQ_A) **Statistical Analysis** - Descriptive - Bivariate correlations Simultaneous regression – calcium intake	**Correlation & Regression** *Calcium intake negative associated with susceptibility, calcium & exercise barriers * Calcium intake positive associated with severity, health motivation, knowledge &self-efficacy (calcium & exercise). *Correlations were in small-medium size ***Predictors of calcium intake** Calcium barriers (-ve), calcium self-efficacy (+ve), and knowledge (+ve)
Gammage et al., 2012	-	**Objectives** Gender differences in osteoporosis-related knowledge and beliefs **Tool** OKT (24)- measured as percentage Modified OHBS (35)- each construct out of 5 OSES (10 calcium intake & 11 exercise) **Statistical Analysis** Descriptive analysis Multiple Regression- predictors physical activity	**OKT** Male = 57.7; female =61.4 **OHBS** Susceptibility - Male-=1.69; female=2.42 Severity- Male= 3.07; female=3.4 Calcium benefits -Male= 4.18; female=4.23 Calcium barriers- Male =1.76; female=2.14 Health Motivation-Male=3.93; female=3.77 Females are more susceptible to osteoporosis than males
Nguyen & Wang 2012	206 Nursing students Age 21 to 27 yrs. Majority are female and Caucasian Study country-Colombia	**Objective** Investigated osteoporosis knowledge in students from different health disciplines students **Tools** - Revised OKT (out of 32) **Statistical Analysis** Descriptive analysis	**OKT**= High at 24.4 out of 34 (76.3%) - Osteoporosis knowledge discrepancies were found between students from health disciplines and year of class - Dietetics students have higher scores
(Mostafa et al., 2016)	239 University Female students 18-44years old Mean age 22.17±2.66	**Objective** -to assess the determinants of calcium intake based on the health belief model **Tools** -Self- designed questionnaire consist of	**Calcium intake means=** 945.63±629.19mg/day- below Recommended Daily Allowance (RDA) **OHBS- all scores out of 30.** (Low score in barriers indicate high perception while high for the other)

	91.6% married Study country- Iran	- Demography (9 items) - OHBS (24items- susceptibility, severity, calcium benefits & calcium barrier-6 questions each) - Food frequency-FF (19 items)- mg/day **Statistical analysis** Independent t-test, ANOVA - Pearson's Correlation	- susceptibility 15.19±4.45 (moderate score) - Severity 18.19±4.45 (moderate score) - calcium benefits 13.79±2.72 (low score) - calcium barriers 13.49±3.96 (moderate score) **Correlation-** - Perceived susceptibility (-0.201**) - perceived severity (-0.15*) - perceived barriers (-0.206**) **Multivariate regression** - Calcium barriers the strongest determinant of calcium intake (beta= -0.14, p =0.000)
Sayed-Hassan & Hyam Bashour & Abir Koudsi, 2013	353 nursing students Study Country- Damascus (Syria)	**Objective** Determine the level of osteoporosis knowledge and beliefs among nursing college students in Damascus **Tools** OKAT (out of 20) OHBS **Statistical Analysis** Descriptive Statistics Chi square test ANOVA Univariate linear regression	**OKAT** Mean knowledge score – 7.9 out of 20 (39. 6%) Low osteoporosis knowledge **OHBS** Susceptibility - low score at 13.2 (44%) Seriousness – high score than susceptibility at 17.1 (57%) Health Motivation- high score than susceptibility at 18.4 (61%) **Univariate linear regression** OKAT domain on "knowledge of preventive factors" was a strong predictor of three OHBS subscales namely "benefits of exercise", "benefits of calcium intake," and "barriers to exercises''.
Shanti -Johnson et al 2008	Sample of 300 3 age groups - 18 -25 years - 30 years 50 - 50 plus Both gender (Male & Female) Study country- Canada	**Objective** Compare osteoporosis health beliefs among different age and gender groups. **Tools** Modified OHBS (3)- susceptibility, severity & health motivation **Statistical Analysis** - Descriptive statistics	**OHBS** Mean score by young adult of both gender on susceptibility was lower. Men and Women in the age groups, women had a high score in susceptibility in each group. No significant differences in seriousness and health motivation

		- ANOVA - MANCOVA	scores between the age group and gender.
Tsai 2008	Sample of South Asian women 102 women aged 20-49years old Study Country- New Zealand	**Objective** Determine osteoporosis knowledge, health beliefs & dietary calcium intake among South Asian women **Tool** OKT (out of 26) OHBS (out of 30) Food Record **Statistics Analysis** Descriptive analysis Bivariate Correlation Multiple Regression	**Calcium intake=** 685mg /day – lower than calcium EAR **OKT**- Average knowledge score at 15.1 out of 26 (58%) **OHBS** Susceptibility – low score at 17.0 Severity- high score at 19.3 Calcium Benefits- perceived higher benefits as 3 statements reported having >80% agreed (no mean score) Calcium Barriers- low score at 13.4 Health Motivation- high score at 22.4 **Predictors of calcium Intake** Calcium barriers, health motivation and use of dietary supplements
(von Hurst & Wham, 2007)	622 women 20-49years Study country -New Zealand	**Objective** - determine osteoporosis knowledge & health beliefs & attitude towards preventive behaviours - if age is the predictor factor to knowledge & health beliefs **Tools** - modified OKT (26 items) - OHBS (42 items) **Statistical Analysis** - Descriptive analysis - Univariate linear regression analysis	**OKT-** moderate knowledge in total (16.4 or 63%) - 15.8±3.9 (20-29); 16.4±4.1 (30-39); 17.3±4.0 (40-49) - All fall in the moderate score - young women have the lowest knowledge mean score **OHBS** - susceptibility - low score -no significant difference in all 3 age groups - severity – low and no significant difference found - benefits of calcium & exercise had high scores with no significant difference - high barriers of barriers in young women and least in older women. No difference in scores of calcium barriers. Calcium foods rich in cholesterol (77%) is one of the obstacles to calcium intake - Older women have greater health motivation scores. **Correlations**

			- Significant correlation between knowledge & health motivation - Benefits of exercise & calcium were predictors of health motivation, while barriers were the negative predictors. - No significant relations between susceptibility, severity, and health motivation.
Wallace 2002	273 non -traditional College women Computer class students 17-64 years of age Study country- USA	**Objective** - Examine associations between EHBM & protective behaviours **Tools** - Facts on osteoporosis quiz (FOQ)- 26 items - OHBS - OSES (12 item) - RAM- calcium intake - Adequate calcium >1200mg.day - Inadequate calcium < 1200mg - Weight bearing exercise - Adequate = ≥90min/week - Inadequate =< 90min/week **Statistical analysis** Univariate Pearson correlation Stepwise multiple regression	**Calcium intake** – 66.7% had calcium intake (<1200mg) -25% consumed half of RDA or less. -21.5% used calcium supplements **Knowledge** – 16.83±5.25 (65%)- mod knowledge **OHBS & SE-calcium- univariate** ↓Ca↓Ex ↑Ca↑Ex ↓Ca↑Ex ↑Ca↓Ex Sus-18.26±4.59 17.61±4.56 16.04±4.76 16.32±4.59 Sev -18.80±4.22 20.22±4.23 18.99±4.02 18.37± 4.8 ben - 24.32±3.12 25.53±3.15 25.23±3.01 24.61±3.92 bar -14.42±3.56 10.68 ±4.14 12.03±3.70 12.71 ±3.67 H. Mo- 20.90 ±3.74 23.95± 3.64 23.24±4.14 20.53±4.36 SE - 60.64± 22.18 79.93±18.55 70.55 ±22.09 67.11 ±24.09 **Predictors** - Perceived susceptibility is one of the predictors of the Ca/Ex group.

CHAPTER 3: METHODOLOGY

3.1: Study Design

This study is a secondary analysis of the Love the Bones (LTB) data. The LTB was a longitudinal study conducted among young female adults in 2017. The aim of the original study was to evaluate change on osteoporosis knowledge, beliefs and practices among young women who participated in a novel osteoporosis prevention. The study has two phases with two planned follow-ups at six months and two years. This present analysis focuses on the data collected in phase one and the food frequency questionnaire (FFQ) in phase two three months later. The analysis aimed to determine the association between calcium intake, osteoporosis knowledge, and osteoporosis health beliefs.

3.2: Sample Size

The sample size for this analysis was calculated using G*power version 3.1. The linear multiple regression fixed model was used as a statistical test with A priori as a power analysis. A moderate effect size of 0.15, α err probability of 0.05, power (1-β err prob) of 0.80 and 8 predictors for the regression analysis. The calculated sample size of 109, which was present in the data set.

3.3: Ethical Approval and Consideration

The Massey University Human Ethics Committee granted ethical approval (SOA 17/06) to conduct the study. All participants were given an information sheet, and written consent was obtained before obtaining the data. Identification numbers were assigned to the participants for confidentiality purposes. Furthermore, participation was voluntary, with acceptable withdrawal at any time during the study period. Copies of ethical approval, information sheet, and consent are available in Appendix 1,3 and 4.

3.4: Subject Recruitment

Subjects were recruited through flyers posted on university campuses, social media, and print media and by word of mouth in the lower North Island of New Zealand. Females the age of 18 and 25 were requested to complete a health screening form to check for participation eligibility. Conditions that might affect bone health/density were reasons for exclusions from the study, as stated in the flow chart below and in the screening form (appendix 2).

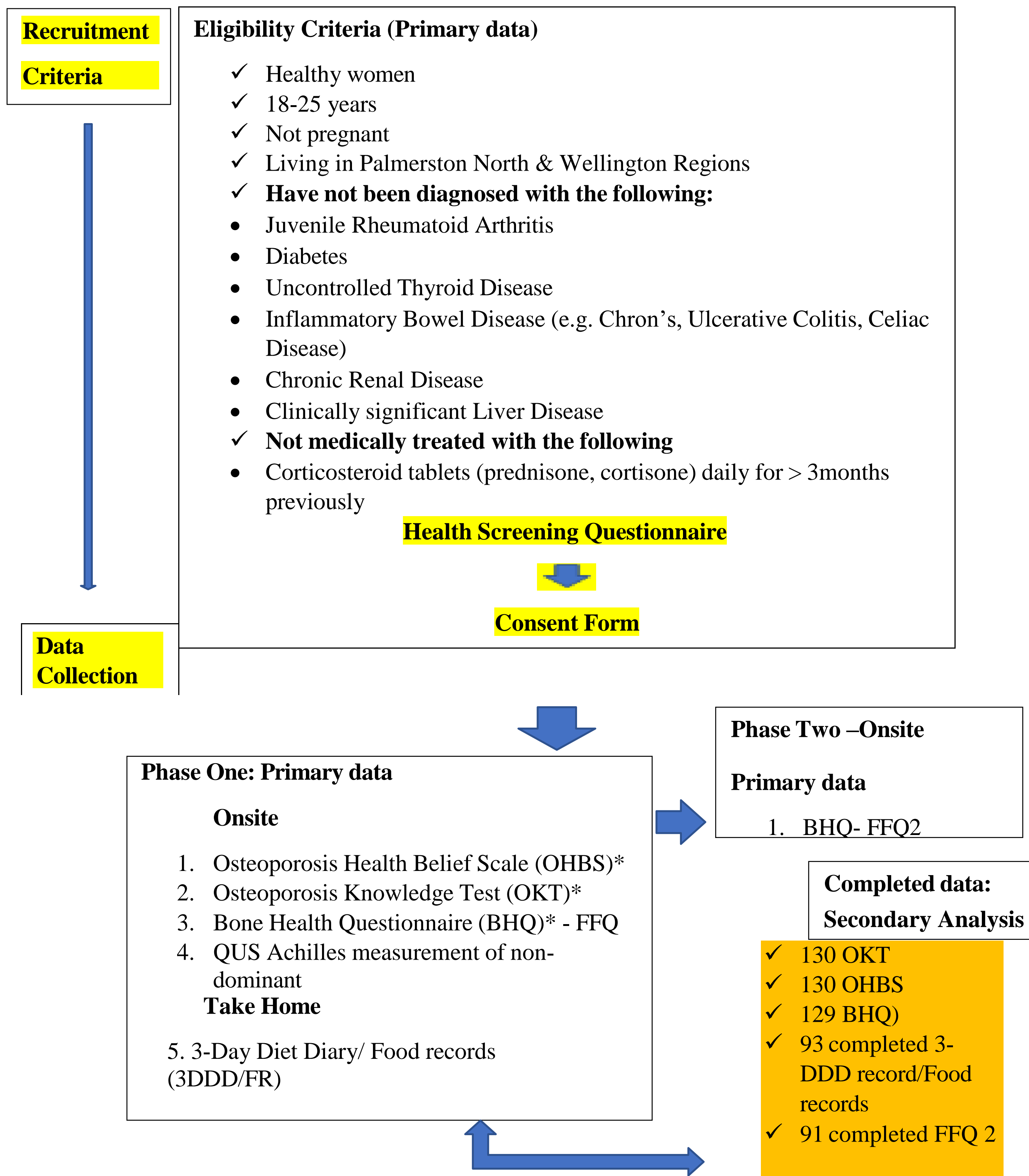

Figure 3.1: Flow diagram of recruitment and data collection for primary data & secondary analysis

3.5 : Data Collection

Participants who met the eligibility criteria were asked to visit the Human Nutrition Research Unit (HNRU) at Massey University, Palmerston North campus. Each participant completed the three Survey Monkey questionnaires via computer on-site. A 3 day-diet diary (3DDD) was provided as a take-home paper booklet with instructions explained verbally by researchers and written instructions on the record sheet. The FFQ 2 was taken from the BHQ during phase two and it was done onsite.

Data Collection Tools

3.5.1 : Revised Osteoporosis Knowledge Test (r-OKT) Questionnaire.

The original Osteoporosis Knowledge test (OKT) was developed by Kim, Horan, and Gendler (1991) and was later revised in the study by Gendler et al., (2015). The revised OKT (r-OKT) has 32 questions with four domains: risk, exercise, nutrition, and general. Following pre-testing of the questionnaire, a modified r-OKT with 29 questions was used in this present study. Three questions were omitted due to difficulty and confusion to answer questions such as Calcium and Vitamin D's recommended daily intake (RDI). Another omitted question is overweight as a risk factor of osteoporosis. The modified 29 questionnaire has 10 risk domain statements on genetic and environmental risk factors for osteoporosis with four choices of response regarding how these factors influence risk (more likely, less likely, neutral, and don't know). The other three domains have multiple choices questions with four possible answers. The exercise domain has six questions, 10 questions for nutrition, and three questions for the general domain. Questions for the exercise domain are on duration and frequency of exercise and the best types of exercise to reduce osteoporosis risk. The nutrition questions are mostly about food sources of calcium, with three about vitamin D. The general domain has three questions, one question each on peak bone mass (PBM), osteoporosis diagnosis, and osteoporosis treatment.

Each correct response scores one, with zero score for incorrect or don't know answers. The scores are reported either as total OKT score or as exercise subscale and nutrition subscale. The maximum score for OKT is 29, with a high score defined as 21-29 (≥72%), moderate from 15-20 (50%-69%), and ≤14 (<50%) as low based on percentage cut-off used by Evenson and Sanders (2016) and Nguyen and Wang (2012). The osteoporosis risk (10) and general (3) items are included in both subscales. This gives the exercise subscale the total score of 19 (13 from risk and general knowledge + 6 exercise) and 23 for the nutrition subscale (13 from risk and general knowledge +

10 nutrition). Permission to reproduce and use the questionnaire was obtained before the study. The questionnaire is included in Appendix 5.

3.5.2 : Osteoporosis Health Belief Scale (OHBS) Questionnaire

The Osteoporosis Health Belief scale (OHBS) questionnaire was developed by Kim, Horan, Gendler, et al. (1991) based on the health belief model (HBM). The OHBS focuses on constructs that are likely to predict behaviours associated with osteoporosis risk. It has been validated and used among various nationalities, age groups, and both genders (Edmonds et al., 2012; Evenson & Sanders, 2016; von Hurst & Wham, 2007; Wallace, 2002). The OHBS consists of 42 items under seven constructs. The seven constructs are

1) Susceptibility
2) Severity (Seriousness)
3) Exercise Benefits
4) Calcium Benefits
5) Exercise Barriers
6) Calcium Barriers
7) Health Motivation

Each construct is measured by six-item 5-point Likert scale. Responses are coded 1-5 with strongly disagree as 1, disagree as 2, neutral as 3, agree as 4, and strongly agree as 5. Each construct has a possible score range from 6-30 and is categorized as low (6-14), moderate (15-20), and high scores of (21-30). The OHBS is the sum of the score from the seven constructs with possible scores of 42-210. The same as the individual construct, the OHBS score is classified as low (<105), moderate (105-146) and high (147-210). Pre-testing of questionnaire was done with no further modification as all questions were well understood. Permission to reproduce and use the questionnaire was obtained before data collection. The questionnaire is shown in Appendix 6.

3.5.3 : Bone Health Questionnaire (BHQ)

The Bone Health questionnaire (BHQ) questionnaire has four sections: medical history, reproductive history, eating and drinking behaviours (past & present), and physical activity. The questionnaire has 66 questions; however, only items from medical history (5) and the food the frequency questionnaire (FFQ) from the past and current eating and drinking behaviours are used

in this analysis. The medical history includes family history, diagnosis of medical conditions (stress fracture, osteopenia & osteoporosis) and medical procedures.

A short FFQ of 20 calcium-specific food items was used to measure calcium intake. Short FFQ with items range from 5, 15, and 30 items have been used to estimate dietary calcium among various populations (Blalock et al., 1998; Magkos, Manios, Babaroutsi, & Sidossis, 2006; Nordblad, Graham, Mughal, & Padidela, 2016). This current calcium-specific FFQ was developed from the calcium-specific 30 food items by Magkos et al. (2006), and the New Zealand Women's Food Frequency Questionnaire (NZWFFQ) (Houston, 2014). Each food item of the FFQ has a stated serving size such as a cup, ½ cup, 1 handful, and 1 tablespoon etc. The frequency of consumption was reported as daily, weekly, monthly, and infrequent/never, where a number is recorded accordingly. For instance, 0-1 for infrequent, 2-3 times per month, 1-6 times per week and 1or more per day. The BHQ was pre-tested with changes made. The medical history and FFQ can be found in appendix 7 as extracts of BHQ.

3.5.4 : 3 Day Diet Diary (3DDD)

The 3-DDD record booklet was given to participants to record all food and drinks consumed over three days (appendix 8). Participants were asked to record two weekdays and a weekend day. Instructions on how to record and describe serving sizes or amounts taken, brand names, and recipes were stated in the instruction on the booklet. A brief reminder not to alter the participant's normal diet during the three days was also emphasised. The diet records were checked upon return by the research assistants to ensure records were complete or to obtain further clarifications. Specific information on quantity, brand, recipe, and food labels were the reasons for the follow-ups.

3.6 : Analysis of Calcium intake from FFQ

Calcium content for each food item in the FFQ was taken from FoodWorks 10- (Xyris software Pty, Brisbane, Australia) based on the New Zealand food files 2016. For food category with a range of items e.g., milk drinks, the average calcium was taken for the food category. For instance, the average calcium content of 1 cup latte, 1 cup flat white, 1 cup flavoured, and soy milk was taken to define the calcium content of 1 serve. The frequency of consumption was converted to an equivalent of a serve per day. For example, frequency of 2 times per month is 0.07 per day, 2 times per week is 0.14 per day and 2 times per day is 2. Total calcium (mg) intake per day is obtained from number of serves multiplied by calcium content for each food item and the sum of all consumed food items. Calcium content used for food item/category is shown in appendix 9.

3.6.1 : FFQ -Food groups.

The FFQ items were grouped into food groups according to the NZANS 2008/2009 for comparison purposes.

Table 3.1- Classification of food item into NZANS food groups

NZANS Food group	FFQ Food items
Grains & pasta	Macaroni cheese
Bread	All bread
Milk	All milk drinks (cow, soy, rice, goat, flavoured milk, latte, flat white)
Cheese	Hard, soft, and fresh cheese
'Yoghurt and Ice cream'	Yoghurt and ice cream
Fish & seafood	Canned salmon & sardine, and fresh or frozen fish
Vegetables	½ cup vegetables, tofu, and hummus
Nuts & seeds	Almonds and other nuts
Sugar & sweets	Chocolate
Non-alcoholic drinks	Tea and coffee with milk

The New Zealand Eating and Activity Guidelines for adults aged 19-64years recommends five essential food groups to provide optimal nutrition (Ministry of Health, 2020). The five food groups are

1. Grains - whole grains and foods naturally high in fibre are encouraged
2. Milk and milk products - low and reduced fat products are encouraged
3. Legumes, nuts and seeds, fish and other seafoods, poultry, eggs, and red meat
4. Vegetables
5. Fruits

3.6.3 : Analysis of 3 Day Diet Diary (3DDD)

Food records were entered in FoodWorks 10 to determine calcium intake. Food items were extracted from the New Zealand food files 2016, Australian Food Composition Database, and AusFoods 2019. Double entry was done on five of the first ten food records to compare calcium estimate between nutritionists entering the data. A difference of less than 10% was obtained and considered favourable. The selection of food items was the primary cause of the discrepancies found, and choice of food items were adjusted. Assumptions made for all unclear 3DDD entries

were documented, verified, and updated before final analysis. FoodWorks generated an individual's average calcium intake from the 3DDD as mg calcium per day.

3.6.4 : Validation and Reproducibility of FFQ

The 3DDD is used to assess validity of FFQ1 based on the five statistical tests reported in Lombard, Steyn, Charlton, and Senekal (2015). Validation tests usually measure the strength of relationship and level of agreements between 3DDD and FFQ. One test (Spearman correlation coefficient -SCC) measures the strength and direction of relationship while the other four statistical tests (2-5) were used to determine the level of agreements between estimated calcium intake of 3DDD and FFQ1:

1. Spearman correlation coefficient (SCC) is used to measure the strength and direction of relationship at the individual level for non-normal distributed data.
2. Wilcoxon signed- rank test is used to compare calcium intake as estimated by 3DDD and FFQ1.
3. Cross classification – Participants' calcium intakes were first put into tertiles and then cross classification is used to identify proportion of participant's calcium intake correctly classified into same, adjacent, and opposite tertiles.
4. Weighted Kappa statistics is used to determine agreement between 3DDD and FFQ1 and excludes any chance agreements.
5. Bland -Altman Plot is used to quantify agreement between 3DDD and FFQ1. The means of individual's calcium intake from 3DDD and FFQ1 were plotted against difference (FFQ-3DDD). The mean difference and 95% limits of agreement (LoA) (mean ± 1.96 standard deviation) was measured to determine agreement and between the two methods. This method determines the presence and direction of proportional bias.

Two statistical tests are used to measure the reproducibility of the FFQ (Masson et al., 2003). So, the strength of the relationship of estimated calcium intake between FFQ1 and FFQ2 was tested using SCC. To assess difference in ranking of participant calcium intake between the two FFQs, the Wilcoxon sign- rank test is used. The cut-offs and interpretation of the statistical tests for validation and reproducibility are listed in Table 3.2.

Table 3.2: Statistical Test Cut-offs Criteria (Lombard et al., 2015)

Statistical test	Good	Acceptable	Poor outcome
Correlation coefficient	≥0.50	0.2-0.49	<0.20
Wilcoxen signed -rank test	p>0.05		p≤0.05
Cross classification	≥50% S-tertiles		≤50% S-tertiles
	≤10% O-tertiles		>10% O- tertiles
Weighted kappa statistics	≥0.61	0.2-0.60	<0.2
Bland Altman plot	p>0.05		p<0.05

1. *S-tertiles= same tertiles*
2. *O-tertiles= opposite tertiles*

3.7 : Data Management

All Survey data was downloaded from Survey Monkey, sorted, and cleaned prior to data coding. Data coding was conducted accordingly to the r-OKT and OHBS scores based on the responses. Missing values were coded as 99 and were excluded in data analysis (scores calculation). All cleaned and coded data (r-OKT, OHBS) was entered in IBM statistical package for social science (SPSS) version 27 for statistical analysis. All statistical tests for validation and reproducibility were carried out by SPSS for analysis.

3.7.1 : Statistical Analysis

1. All dependent and independent variables were tested for normal distribution using the Shapiro-Wilk test. Shapiro-Wilk test is robust and suitable for a sample less than 2000 (Razali & Wah, 2011). A p-value <0.05 is regarded as non-normally distributed (non-parametric) and > 0.05 as normally distributed (parametric).
2. Normal data is reported as mean (±standard deviation) and non-normal data as median (25th, 75th percentiles). Frequency and percentage were used for categorical data.
3. OKT and OHBS scales were tested for reliability test using the Cronbach alpha. An alpha of 0.65-0.8 was considered acceptable (Vaske, Beaman, & Sponarski, 2017).

4. Chi-square was used to test the relationship between the number of milk and milk products servings calculated from the FFQ and whether a participant's intake achieved the calcium EAR.
5. Bivariate correlation using Spearman's rho was used to investigate relationships between calcium intake and health belief model constructs (OKT score, susceptibility, severity, calcium benefits, calcium barriers, health motivation), and demographic information.
6. Bivariate correlation using Pearson and Spearman's rho for normally distributed and non-normally distributed data respectively was used for correlations between independent variables and family history.
7. Dependent variable (calcium intake) was log transformed for multiple regression.
8. Multiple linear regression was used to determine the predictor(s) of calcium intake. All independent variables (OKT score and health belief constructs: susceptibility, severity, exercise benefits, calcium benefits, exercise barriers, calcium barriers, and health motivation) were entered into the model simultaneously. Multicollinearity, and heteroscedasticity were checked for violation; however, none was found. None of the variables have strong correlations ($r > 0.9$) between each other, and collinearity statistics are within the acceptable range. Also, all residuals are within -3 and 3 (Field 2009).

CHAPTER 4: RESULTS

The purpose of the study was to examine associations between calcium intake, osteoporosis knowledge, and osteoporosis health beliefs among young female adults. One hundred thirty participants completed the OKT, OHBS questionnaires and 129 completed the BHQ.

4.1 : Demographic Characteristics

Participants (n=130) were aged between 18-25 years of age (Table 4.1). More than 2/3 of the females were between 19-22 years of age. A quarter of the females had a family history of osteoporosis, and some (16%) were unsure if they had or not. Further, 6% also had a history of a stress fracture, and one (0.8%) had osteopenia. Based on these indicators, approximately a third of the study participants had an indicator of increased osteoporosis risk (family history, stress fractures, and osteopenia).

Table 4.1: Demographics of the study participants

Demographic	n (%)
Age	
18	17 (13.2)
19-20	47 (36.4)
21-22	42 (32.5)
23-24	13 (10.1)
25	10 (7.8)
Family history with osteoporosis or hip fracture	
Yes	34 (26.3)
No	74 (57.4)
Don’t Know	21 (16.3)
Medical history of Stress fracture	
Yes	8 (6.2)
No	119 (91.5)
Don’t Know	3 (2.2)
Medical history of Osteopenia	
Yes	1(0.8)
No	129(99)
Medical history of Osteoporosis	
No	129(100)

Note: n= 129 for all except for stress factor n=130

4.2 : Osteoporosis Knowledge Test (OKT)

A moderate level of knowledge was found among study participants (Table 4.2). The mean score for OKT was 16.9 (±3.7) (58%) with 11.1 (±2.7) (58%) for the exercise subscale, and 12.9 (±3.2) (56%) for the nutrition subscale. Each score was tested for reliability using Cronbach alpha test and were as follows: OKT (0.654), exercise subscale (0.540) and nutrition subscale (0.639).

Table 4.2: Osteoporosis Knowledge Test Score Mean (SD), percentage, and interpretation

Domain	*Mean (±SD)*	*%*	*Interpretation*
OKT Score	*16.9(3.7)*	*58.3*	*moderate knowledge*
Exercise Subscale Score	*11.1(2.7)*	*58.4*	*moderate knowledge*
Nutrition Subscale Score	*12.9 (3.2)*	*56.1*	*moderate knowledge*

Note: 1. n is 122 for OKT score and nutrition subscale scale while 124 for exercise subscale

2. Total OKT score (29); Total Exercise subscale score (19); Total Nutrition subscale score (23)

Domains of the OKT (Complete results in appendix 11)

Results will be presented according to the four domains: risk, exercise, nutrition and general followed by the summary.

4.2.1 : Risk Domain

The mean score for the risk domain was 6.1 (±1.88) or 61%. Participants demonstrated a range of knowledge levels as some participants had very good scores (10), and some low scores (1). Having eating disorders and family history were correctly identified as risk factors by 93% of respondents followed by eating a low calcium diet with 82% correct, almost ¾ of the participants knew being post-menopausal is a risk factor. Other risk factors such as drinking alcohol (36.9%), being white or Asian (25.4%), and daily smoking (59%) were less well known.

4.2.2 : Exercise Domain

A mean score of 3.9 (±1.35) or 65% was recorded for the exercise domain. Jogging/ running and aerobic dancing was correctly recognized by a high number of participants (>80%) as the best physical activities to prevent osteoporosis. More than half of the participants (60%) did not know about the recommended frequency of weight-bearing exercise (WBE) per week, and that brisk walking is a WBE. Half of the participants incorrectly selected swimming as one of the best activities to prevent osteoporosis (50.8%) from choice of brisk walking, stretching and *don't know*.

4.2.3 : Nutrition Domain

A mean score of 5.7 (±1.75) or 57% was reported for nutrition domain with a range of high (10) and low score (3). Cheese (97.7%) and yoghurt (96.2%) were commonly selected as the best calcium sources. However, knowledge of non-milk products as calcium sources was limited as only 34.6% knew about canned sardines, and 60.4% identified broccoli as good calcium sources as compared to chicken and grapes. Although knowledge of milk and milk products was high, the knowledge of the recommended amount of milk an adult should consume per day was very low, only 5% correctly answered 3 glasses. The majority of the participants selected 1 glass or 2 glasses per day. Even fewer (19%) correctly identified salmon as the best source of vitamin D, with spinach and *don't know* more often selected.

4.2.4 : General Domain

The general domain has only three questions. Only 14.6% correctly answered the question on when PBM is achieved. Participants had fair knowledge on diagnosing procedure (63.1%) and limited knowledge (32%) on treatment procedure, with osteoporosis thought of as an untreatable disease. Overall, the mean score of 1.1 (±0.78) or 36.7% which was lower than other domains.

4.2.5 : OKT Summary

A consistent level of knowledge about osteoporosis was found in three domains, but not the general domain. The mean scores confirmed participants had moderate knowledge of osteoporosis in domains of risk, exercise, and nutrition. Overall, the study found 26.9% of the participants had low OKT scores, 50% moderate, and 16.9% high.

4.3 : Osteoporosis Health Belief Score (OHBS)

Table 4.3 presents mean (±SD) or median (25th, 75th) scores of the total OHBS and the seven constructs. The possible score for each construct is 30, with 210 for the total OHBS. The OHBS mean was 124.5 (±10.5). A median score of 15 (12, 19) was recorded for the susceptibility construct. The severity construct has a moderate score of 19 (16.3, 22). Both exercise and calcium benefits showed high scores at 22.4 (±3.7) and 22.2 (±3.0), respectively, with low barriers to exercise 10 (6, 13) and to calcium intake 13.4 (±3.3). The health motivation construct score was high at 22 (19.5, 23.5), indicating positive health motivation. Each construct has a Cronbach alpha reliability score that falls within the acceptable range as follows: susceptibility (0.845), severity (

0.767), exercise benefits (0.758), calcium benefits (0.763), exercise barriers (0.846), calcium barriers (0.668), and health motivation (0.680).

Table 4.3: OHBS mean (SD), median (25th, 75th centile), percentage and interpretation

Constructs	*Median (25th, 75th)*	*Mean ± SD*	*%*	*Interpretation*
OHBS score	*123(117,131)*	*124.5(10.5)*	*59*	*moderate OHBS*
Susceptibility	*15(12, 19)*		*50*	*moderate susceptibility*
Severity	*19(16, 22)*		*63*	*moderate severity*
Exercise Benefit	*23(21,24)*	*22.4(3.0)*	*73*	*high exercise benefits*
Calcium Benefit	*22(20,24)*	*22.2(3.0)*	*73*	*high calcium benefits*
Exercise Barriers	*10 (6,13)*		*33*	*low exercise barriers*
Calcium Barriers	*13 (11,15)*	*13.3(3.3)*	*43*	*low calcium barriers*
Health Motivation	*22(20,24)*		*73*	*high health motivation*

Note: n= varies in each construct; OHBS score (121); susceptibility (127); severity (128) exercise benefits (129); calcium benefits (128); exercise barriers (130); calcium barriers (130); health motivation (130).

Constructs of the OHBS

The OHBS has seven constructs whereby each one is likely to influence behaviours related to osteoporosis. Individual constructs are measured to determine participants' perceptions of each. For instance, susceptibility and severity constructs determine how participants perceive osteoporosis as a threat while the barriers act as obstacles to partake in physical activity and get adequate calcium intake. **(Complete results in appendix 11)**

4.3.1 : Perceived Susceptibility

Perceived susceptibility refers to the individual's view of their personal risks or chances to develop osteoporosis later in life. The participants perceived that they were susceptible to osteoporosis even at this young age, with a range of scores of 6-28 with a median score of 15 out of 30. An almost equal percentage of participants had low and moderate scores with 46.5% having a low overall score, 47.2% moderate, and 6.3% high score. The only two statements with higher percent agreement were "there is a good chance that you will get osteoporosis" (30%) and "your family history makes it more likely that you will get osteoporosis" (22%). Under 20% agreed with "your

chances of getting osteoporosis are high" while only 7.7% thought "it is extremely likely that you will get osteoporosis."

4.3.2 : Perceived Severity

The severity construct measures an individual's perception of how serious osteoporosis or the consequences of having osteoporosis is. Participants perceived moderate severity, with a median score of 19 out of 30. The score ranged from 10 to 26, with 13.2% of participants with a low score, 56.3% moderate, and 30.5% high scores. More than half of the participants agreed with these statements "the thought of having osteoporosis scares you" (72.3%); "it would be very serious if you got osteoporosis" (58.5%) and "it will be very costly if you got osteoporosis" (57.4%). However, under a quarter thought of being crippled due to osteoporosis, while only 18.5% agreed that they get depressed when thinking about osteoporosis. There is some perception of the severity of osteoporosis among these young adult females.

4.3.3 : Perceived Exercise Benefits

Perceived exercise benefits indicate an individual's perception of the benefits of exercise to prevent osteoporosis. Overall, participants have a high mean score of 22 out of 30, with 62.8% having high scores, 36.4% moderate, and 0.8% low scores. There was high agreement with statements about benefits of exercise for bone health and osteoporosis prevention, with agreement ranging from 71.5% to 80% with these three statements. "Exercising to prevent osteoporosis also improves the way your body looks" has the highest number agreeing (80%) followed by "regular exercise prevents problems that would happen from osteoporosis" (76%). The statement "you feel better when your exercise to prevent osteoporosis" has the lowest number agreeing at 56.9 percent. The findings show that participants agreed that exercise reduces osteoporosis risk.

4.3.4 : Perceived Calcium Benefits

This calcium benefits construct measures an individual's thoughts on the benefits of calcium intake to prevent osteoporosis. A high mean score of 22 out of 30 was found, with 60.2% high scores and 39.2% with moderate scores. High mean agreement was reported on benefits of calcium to bones and prevention of osteoporosis statements. Lower agreement was found on "you would not worry as much about osteoporosis if you took in enough calcium" (53.8%) and "taking in enough calcium prevents painful osteoporosis" (43.8%). Although calcium benefits to bones and osteoporosis were known, 40% of them did not agree with "you feel good about yourself when you take in enough calcium to prevent osteoporosis".

4.3.5 : Perceived Exercise Barriers

Participants' thoughts on barriers to exercise were measured in the exercise barriers construct. The median score was 10 out 30, with 83.1% having low scores, 16.9% moderate and none reported high barriers. Less than a fifth agreed with these two statements: "exercising regularly would mean starting a new habit which is hard for you to do (17.7%) and "you feel like you are not fit enough to exercise regularly" (11.5%). These two were the most often agreed barriers among these females, while being "uncomfortable when exercising" and "no place to exercise" had low agreement with less than 5% each. No one agreed with the statement "your spouse or family discourages you from exercising". Overall participants perceived low exercise barriers.

4.3.6 : Perceived Calcium Barriers

Participants thoughts of barriers to consuming adequate calcium were measured in the calcium barrier construct. A mean score of 13 out of 30 was reported for this construct, with 66.9% of participants having low scores, 33.1% moderate, and none had high scores. This shows that participants perceived low barriers to calcium intake as none of the statements were agreed to by more than 22%. The cost of calcium-rich foods was the highest agreed barrier (21.5%), followed by changing your diet to accommodate calcium-rich foods, which is hard to do (13.1%). Surprisingly, the perception of "calcium-rich foods have too much fat" and "you do not like calcium-rich foods" were the two barriers least agreed with, by only 9.2% and 7% respectively.

4.3.7 : Perceived Health Motivation

Perceived health motivation measures someone's thoughts on his/her ability to seek/take health actions. The median score was 22 out of 30, with 54.3% having a high score, 45% moderate, and 0.7% low. Participants commonly agreed with "keeping healthy is very important for you" (94.4%). Also, engaging in early detection of health problems and following recommendations to keep healthy were commonly agreed with 70% and 71.5% respectively. Although keeping healthy and following recommendations were highlighted, only 65% agreed with "you eat a well-balanced diet". In contrast to the other items in this construct, three-quarters of the participants disagreed with "you have a regular check-up even when you are not sick".

4.3.8 : OHBS Summary:

Overall, participants of this study had moderate perceptions of osteoporosis susceptibility and severity. Low perceptions of exercise and calcium intake barriers were found with high perceptions of exercise and calcium intake benefits and health motivation.

4.4: Assessment of Calcium Intake

Calcium intake was estimated three times for each participant, twice with a FFQ and once with a 3DDD. The median intakes were 692mg, 662mg and 771mg for FFQ1, FFQ2 and 3DDD respectively.

Table 4.4: Calcium intake from FFQ1, FFQ2 and 3DDD

Dietary method	FFQ1	FFQ2	3DDD
Number of participants (n)	129	91	93
Calcium Median (mg)	692	662	771
Calcium percentile (25th ,75th) mg	462, 1025	460, 896	658, 1012
Calcium Range (mg)	101- 2943	63-1787	194-2194

4.4.1 : Validation and Reproducibility of FFQ.

Validation tests for FFQ1 found acceptable and good findings from the 5 statistical tests. The Spearman's Correlation Coefficient (SCC= 0.450, p=0.00) showed acceptable associations between FFQ1 and 3DDD. The Wilcoxon Signed -rank test (248.53, p=0.214) result showed good agreement (no difference) between FFQ1 and 3DDD.

For the cross classification (Table 4.5) percentage of correctly classified calcium intake on the same tertiles (55.6%) was good but poor for grossly misclassified tertiles (11.1%). Although the percentage for gross misclassified is >10%, the weighted kappa finding (0.375, p=0.001) showed acceptable agreement between FFQ1 and 3DDD findings (Masson et al., 2003).

The Bland Altman plot (Figure 4.2) showed good agreement, with the FFQ1 underestimating calcium intake by 59.53mg/d (SD, 378.68) with 95% of values ranging from 683 to 802mg/day compared to the 3DDD. Linear regression of the Bland Altman confirmed no proportional bias with a non-significant p-value of 0.140 (Lombard et al., 2015; Masson et al., 2003).

For the reproducibility of the FFQ, two statistical tests confirmed acceptable associations and agreement: SCC (r=0.408, p=0.000) shows acceptable association and Wilcoxon signed rank (p=0.735> 0.05) shows no difference between FFQ1 and FFQ2.

Table 4.5: Cross -Classification of FFQ1 and 3DDD

		3DDDT			Total
		1	2	3	
FFQT	1	17	7	6	30
	2	9	15	6	30
	3	4	8	18	30
Total		30	30	30	90

Same tertiles	**Grossly misclassification**	**Interpretation**
55.6% (50/90)	11.1% (10/90)	GOOD/POOR (>50% & <11%)

(percentage is 88.9% (80/90) when combining same and adjacent tertiles)*

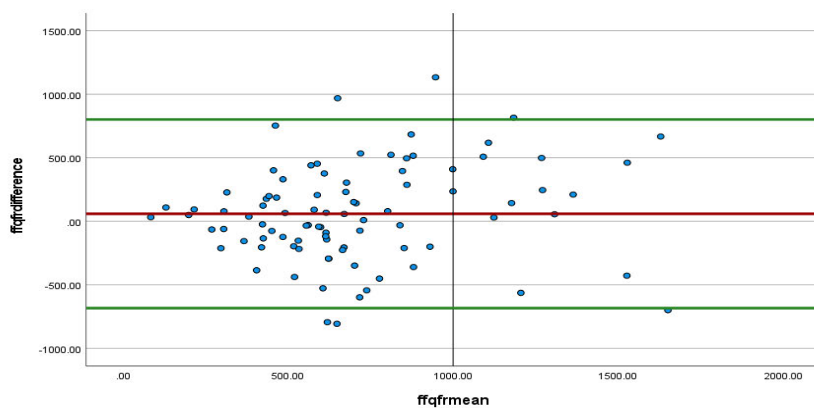

Figure 4.1: Bland Altman (limit of agreement within the 95 confidence) showing mean at 59.53mg/d (±378.68) with no proportion bias (p=0.140 from linear regression).

4.4.2 : Observation from the 10-Gross misclassification (dietary data- FFQ1 and 3DDD)

The 10-participants who were misclassified by 2 tertiles were investigated. Six participants' dietary records reported less milk and milk products in FFQ1 compared to the 3DDD and for the other four the reverse was true (Table 4.6).

Table 4.6: 10 dietary records with misclassification of estimated calcium intake by 2 tertiles.

Less in FFQ (T1) but more in 3DDD (T3)	**High in FFQ (T3) but less in 3DDD (T1)**
FFQ= 0 milk, 0 yoghurt, 3DDD= ½ cup milk /day, 1 serve yoghurt/day	FFQ=1 cheese/day, 1 serve yoghurt/day 3DDD= 0 cheese, 0 yoghurt
FFQ= 0 milk drink 3DDD= 1 cup almond milk/day	FFQ= 3 serves ice cream /day 3DDD=0 ice cream
FFQ= 1 cup milk drink/ week 3DDD= 1-2 cups milk drink/day	FFQ= 2 serves cheese/day 3DDD= 0 cheese
FFQ= 1 cup coffee with milk twice /week 3DDD= 2cups coffee with milk /day	FFQ = 1 cup milk drink/day 3DDD=0 milk drink
FFQ=1 serve cheese /day 3DDD=2 serves cheese/day	
FFQ= 0 yoghurt 3DDD= 1 serve yoghurt/day	

4.4.3 : Calcium Intake from FFQ1:

Calcium estimates from FFQ1 will be used in the subsequent analysis. FFQ1 has 129 completed records and meets the calculated sample size. Also, it has acceptable associations and agreements with 3DDD from the validation statistical tests and the reproducibility tests.

Based on FFQ1 the median daily calcium intake for 129 participants was 692 mg (462, 1025). Just above a third (34.1%) of participants met the estimated average requirement (EAR) for calcium for their age group. Hard cheese (16.9%) contributed the most calcium, followed by milk with cereal (14%), milk drinks (10.4%), yoghurt (10.3%), chocolate (8.3%), and green vegetables (8.2%) (Figure 4.2). On the other hand, other nuts, (0.8%) oily fish (0.4%), fresh cheese (0.2%) and hummus (0.2%) contributed the least.

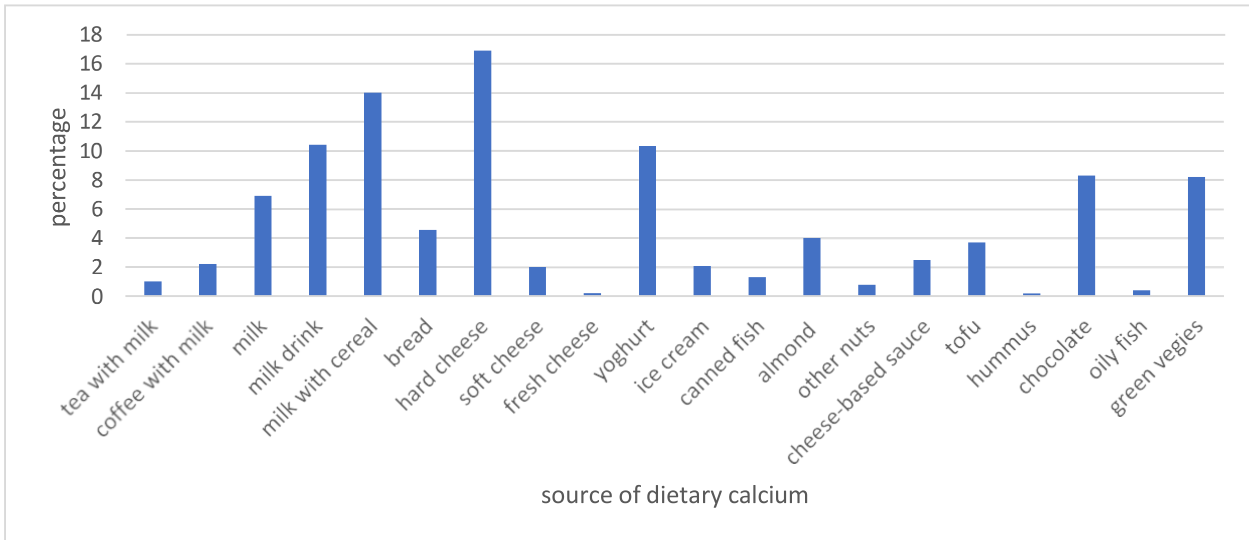

Figure 4.2: Percentage contribution of food item to dietary calcium as from FFQ1

4.4.5 : Contributors of calcium by New Zealand Adult Nutrition Survey (NZANS)Food Groups

Analysis of calcium contribution by food groups as defined in NZANS was also carried out. Food items were classified into appropriate food groups and their contribution to calcium intake was calculated by percentages. Milk food group has contributed the highest amount of calcium with (31.5%) followed by cheese (19.1%), and 'yoghurt and ice cream' (12.4%). Vegetables (green vegetables, tofu, hummus; (12.1%) and sugar and sweets (chocolate; 8.3%) were the next highest contributors to calcium intake. In all, milk and milk products food sources contributed 68.5% to calcium intake with 31.5% from the non-milk products food sources (vegetables, nuts & seed, fish & seafood, bread, and sugar & sweets).

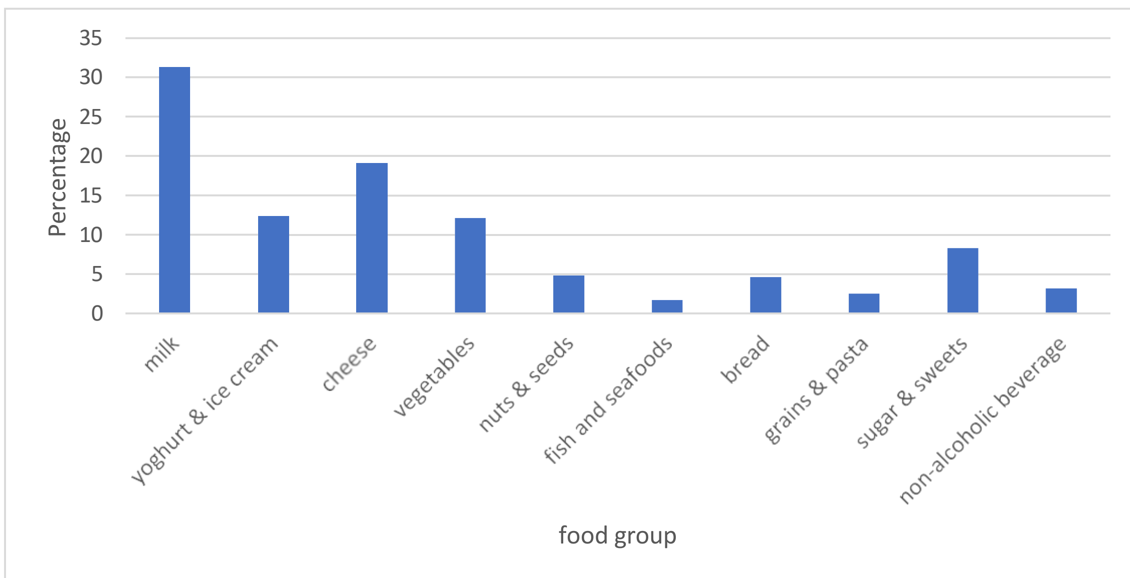

Figure 4.3: Contribution of calcium intake by food groups

4.4.6 : Consumption of food items at least per day or weekly:

Food groups were classified according to daily and weekly consumption. Food groups with lower calcium content such as green vegetables and bread were frequently consumed daily (Figure 4.4). Almost 74% of the participants consumed vegetables and 49% consumed a sliced of bread at least ≥ 1 time /day. Only a few had at least a serving of milk (39%) and cheese (22%) daily. More participants consumed food items from milk and milk products per week than per day. About 90% of the participants had milk and cheese while 78% had yoghurt and ice cream at least 1-6 times per week.

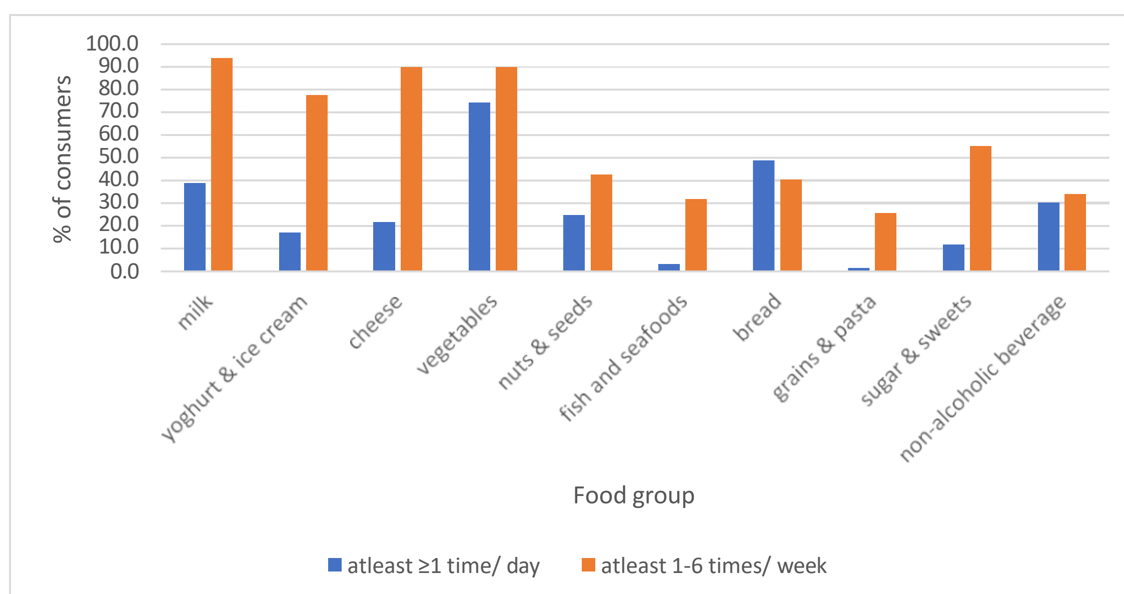

Figure 4.4: Percentage of participants consuming food group at least once or more per day or week

4.4.7 : Relationship between milk and milk products servings and calcium EAR

At the time of this survey, the New Zealand Eating and Activity Guidelines for adults recommends two servings of milk and milk products per day to meet the calcium requirement (Ministry of Health, 2015). The recommendation has now been updated to two and half servings per day (Ministry of Health, 2020). A chi-square test shows meeting the calcium EAR is strongly associated with the number of milk and milk products servings per day (chi- square=67.126, df=2, p=0.000). The Cramer's V (0.721, p=0.000) also show strong associations between milk and milk products servings and calcium EAR. The cross-tabulation (Table 4.7) shows of that 34% (44) who met the calcium EAR, 66% had 2 or more serves of milk and milk products per day, 25% had one serve and 9% had < 1 serving per day. Of the 32 participants who had ≥two servings milk and

milk products serve per day, 91% met the EAR while 94% of the 64 participants with >1 serving did not meet the EAR.

Table 4.7: Milk and milk products Servings per day and calcium EAR

	Milk products	>/= EAR	<EAR
Daily	<1 serving	4 (6.3)	59 (93.7%)
	1 serving	11(33.4%)	23 (67.6%)
	2 or more serve	29 (90.6%)	3 (9.4%)
	Total	***44 (34.1%)***	***85(65.9%)***

4.5 : Relationship of Calcium Intake with OKT and OHBS Constructs

Examination of the relationships between calcium intake and OKT and OHBS will be described in this section. For the bivariate correlation analysis, and for regression analysis in Section 4.6, the total OKT score is used. All OHBS constructs will be used as all have acceptable reliability scores.

Table 4.8 presents the correlations between calcium intake and the independent variables. OKT (r=0.220*, p=.015) showed significant correlation with calcium intake. Family history and the other constructs of OHBS did not have a statistically significant relationship with calcium intake.

Table 4.8: Spearman rho's matrix correlation for calcium intake and independent variables

Variables	**R**	**p-value**
Demographic		
Family history	.077	.387
OKT		
Total knowledge	.220*	.015
OHBS		
Susceptibility	.021	.816
Severity	.157	.079
Exercise Benefit	.042	.635
Calcium Benefit	.038	.675
Exercise Barriers	.053	.554
Calcium Barriers	-.161	.068
Health Motivation	-.006	.944

*Note: *correlation is significant at 0.05 level (2-tailed).*

4.5.1 : Correlation between Independent Variables

A correlation matrix of the independent variables (Table 4.9) showed association between family history and perceived susceptibility (r=0.213; p=0.017). OKT has weak positive associations with susceptibility (r=0 .210; p=0.029) and health motivation (r=0.293; p=0.001); and a weak negative association with calcium barriers (r=0.236; p=0.009). Also, severity has a weak positive association with calcium barriers (r=0.221*; p=0.012). No other associations were noted between the variables.

Table 4.9: Pearson and Spearman's Correlations between independent variables (family history, OKT & OHBS)

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Family history		.006	.213*	-.054	-.113	-.009	.006
2. OKT			.210*	-.086	**.162**	**-.218***	.293**
3. Susceptibility				-.066	.016	.024	.121
4. Severity					.079	.221*	-.080
5. Calcium benefits						**.067**	.039
6. Calcium barriers							-.143
7. Health Motivation							

1. *** significant at 0.01 level (2 tailed), * significant at 0.05 level (2 tailed).*
2. *Pearson correlation in bold and Spearman's correlation in normal font.*

4.6: Multiple Regression – Investigating predicators of Calcium Intake

Multiple linear regression showed that OKT (β=0.262, p=0.012) and perceived severity (β=0.313, p=0.001) were significant predictors of calcium intake. Perceived calcium barriers (β=-0.190, p=0.054) were close to being a significant predictor of calcium intake. The other five OHBS constructs: susceptibility, exercise benefits, exercise barriers, calcium benefits, and health motivation, were not predictors of calcium intake in this study population. The final model variance was 0.174; p =0.009, meaning that 17.4% of the variance of calcium intake is explained by OKT and perceived severity.

Table 4.10: Simultaneous Multiple Regression Analysis for Variables predicting Calcium Intake

Variable	B	SE B	ß	p
OKT	.041	.016	.262*	.012
Susceptibility	-.004	.013	-.028	.761
Severity	.050	.015	.313*	.001
Exercise Benefits	-.007	.020	-.036	.712
Calcium Benefits	.002	.017	.012	.895
Exercise Barriers	.010	.014	.072	.453
Calcium Barriers	-.033	.017	-.190	.054
Health Motivation	-.021	.019	-.112	.271

1. R square=0.174 *p (0.009) <0.05

CHAPTER 5: DISCUSSION

The present study aimed to examine the associations between calcium intake, osteoporosis knowledge, and osteoporosis health beliefs. This study is the first of its kind among young adult females in the lower North Island of New Zealand. The participants were mainly university/college students living in Wellington and Palmerston North. The mean age of the participant was 20.8, most of the participants were between 19-22 years of age. A quarter of the participants had a family member diagnosed with osteoporosis, and one participant has osteopenia. Their program of study, level of study, and ethnicity were not known in this study.

The findings revealed a weak positive bivariate association between calcium intake with osteoporosis knowledge (r=0.220). Calcium intake was not associated with family history, susceptibility, calcium benefits, calcium barriers and health motivation. Osteoporosis knowledge and perceived severity were the only significant predictors of calcium intake based on a multiple regression (R2=0.174) with all variables entered. The participants had a median calcium intake of 692 mg and moderate knowledge about osteoporosis as measured by the mean score of the OKT (16.9±3.7). Participants also had moderate perceptions of susceptibility to, and severity of osteoporosis with high perceptions of benefits of calcium intake and health motivation. Barriers to calcium intake were perceived as low among the participants. In this chapter, the present findings will be discussed together with previous studies.

5.1 : Osteoporosis Knowledge

This study found that participants had moderate knowledge of osteoporosis risk and preventive measures with a mean score of 16.9 ±3.7out of 29 or 58% on the OKT. Although participant's program of study was not recorded some of them were studying health. The finding is consistent with Tsai's study of South Asian women living in Auckland (Tsai, 2008). One hundred and two South Asian women between 20-49 years of age participated and had a mean score of 15±4.14 out of 26 or 58 percent. Similarly, a moderate mean score was found in another study of women between 20-49 years of age living as well in Auckland (von Hurst & Wham, 2007). This latter study involved 622 women participants, the majority had paid jobs, and 59% obtained bachelor's degree qualifications.

Comparable findings on low-moderate knowledge of osteoporosis were reported in studies among college or university students. Moderate knowledge of osteoporosis was found among 408 American college students with a mean score of 14.5 out of 24 or 60% (Ford et al., 2011). A similar finding of moderate knowledge was supported by another study among college students in America; however, the mean score was not reported (Edmonds et al., 2012). Likewise, a moderate knowledge of 50% was found among Medical students in Malaysia, which is lower than expected

for Medical students. Other studies reported generally low osteoporosis knowledge scores among college students in Canada (Gammage et al., 2012), in China (Ford et al., 2011), and nursing students in Jordan (Amre et al., 2008).

In contrast, students from health discipline programs in the USA reported having a higher mean score of osteoporosis knowledge (Nguyen & Wang, 2012). This study used the r-OKT among 206 participants who reported a mean score of 24 out of 30 or 75 percent. The study also found that specific study programs have higher scores than others. Dietetics students performed well in the OKT than nursing, pharmacy, and physical therapy students. A comparison of program scores could not be made with this present study since students' education programs were not known. It would be interesting to consider in future studies. The present findings confirm and support the previous findings that young adults have a moderate level of osteoporosis knowledge.

5.1.1 : OKT Domains (Risk factors, exercise, nutrition, and general)

The mean knowledge of risk factors for the current study was 6.1 (±1.88) or 61%, with findings comparable with von Hurst and Wham's findings of females aged 20-49 years (von Hurst & Wham, 2007). Family history, eating a diet low in calcium, and being postmenopausal were well-known risk factors in for both study groups. The participants in our study regarded those who are White or Asian (ethnicity) was not a risk factor. Similar findings were highlighted among the South Asian women in Tsai's study and among college students in the USA from two studies, in which White or Asian was not regarded as a risk factor (Edmonds et al., 2012; Ford et al., 2011; Tsai, 2008). Not knowing that being White or Asian as a risk factor seems to be common among young adults. Interestingly, findings on lifestyle risk factors such as smoking and drinking alcohol were considered as less of a risk in terms of osteoporosis in this present study yet were and were not measured in previous New Zealand studies. Low to moderate responses were reported with 60%, and 40% of participants correctly identifying smoking and alcohol, respectively. This lack of knowledge is significant to bone health as findings from the New Zealand Health Survey (NZHS) 2018/2019 that shows 14% of adults smoked and 20% engaged in hazardous alcohol drinking (Ministry of Health, 2019). Additionally, 13% of females engaged in hazardous drinking according to the 2017/2018 NZHS and a high prevalence among those between 18-25years of age. Ensuring this information about lifestyle risk factors is known to young adults may benefit their bone health throughout the lifespan.

The females in this study had a mean score of 3.9±1.9 or 65% for the Exercise domain of the OKT. The responses to items in the exercise domain were similar to other studies that used this scale; they found that while aerobic dancing (83.1%) and jogging or running (86.9%) were known and selected as the best exercises to prevent osteoporosis, but brisk walking was not (Edmonds et al.,

2012; Tsai, 2008; von Hurst & Wham, 2007). Swimming was selected out of three other choices (walking briskly, stretching & don't know) as the best exercise to prevent osteoporosis. The finding was in line with the two studies in Auckland. Swimming may have been selected because it is perceived as healthier than brisk walking because of the cardiovascular health benefits (Lazar, Khanna, Chesler, & Salciccioli, 2013).

The mean score for the nutrition domain of the OKT was 5.7±1.8 or 57%, with participants having an inadequate knowledge of the non-milk product sources of calcium, vitamin D and of the recommended amount of milk. The current findings showed that milk and milk products were known as good calcium sources, with cheese and yoghurt correctly chosen as high calcium by 97.7% and 96.2%, respectively. Almost two-thirds of the participants knew about ice-cream as a source of calcium. Even though similar findings were found for cheese and yoghurt in the two Auckland studies, but von Hurst and Wham's study reported a higher percent correctly identifying ice-cream as a source of calcium (80.2%). Possibly the South Asian women in Auckland (Tsai, 2008) and participants who took part in this present study regard ice-cream as an unhealthy food that does not benefit bone health. Whereas the other options, grapefruit and radishes, may be viewed as ‘healthy’ so were ‘guessed’ as sources of calcium. Although participants who participated in this present study had excellent knowledge on the sources of milk and milk products, only 5% correctly selected 3 glasses of milk per day as the milk recommendation for an adult, while 40% selected 2 glasses per day. Previous findings from Tsai and von Hurst and Wham studies found 40% correctly selected 2 or more glasses which matches with the response for 2 glasses per day in the present study.

As expected, the participants of this present study had less knowledge about non-milk products as a calcium source than milk products, which is like the two previous studies in Auckland (Tsai, 2007; von Hurst & Wham, 2007). In the current study while 64% correctly chose broccoli as the best calcium source compared to other options of chicken and grapes, 34.6% chose canned sardines instead of lamb and peanut butter. Also, not knowing about salmon as the best source of vitamin D was noted among the participants of this present study it was not included in the two previous studies. The lack of knowledge could have resulted from the previous New Zealand’s recommendation which promoted only dairy products as good sources of calcium. The emphasis on non-dairy products as sources of calcium should also be emphasised in the future. For instance, the updated Eating and Activity Guidelines for New Zealand adults has included plant-based milk such as soy, almond and rice that are fortified with calcium and vitamin B12 are alternates for dairy products (Ministry of Health, 2020).

The general knowledge domain is a new addition to the r-OKT with specific questions on the

importance of achieving PBM and diagnosing and treating osteoporosis. This domain consists of three questions that were not included in the two previous Auckland studies. The present study showed, fair knowledge (63%) on the diagnostic procedure, yet poor knowledge on the stage of achieving PBM (15%) and treatment (32%). Participants had a very low knowledge on this general domain with a mean score of 1.1±0.8 or 37%. In summary, knowledge is consistent throughout the three domains with moderate scores, except for the general domain. The findings are consistent with the previous findings that young adults have low- moderate osteoporosis knowledge which suggests a possible area for improvement. More education and awareness of osteoporosis is needed to address promotion of bone health and prevention of osteoporosis among young adults.

5.2: Osteoporosis Health Belief Scale (OHBS)

The osteoporosis health belief scale (OHBS) was adapted and developed from the health belief model (HBM) (Kim, Horan, Gendler, et al., 1991). The construct "Cues to action" in the HBM was replaced with health motivation as it measures an individual's tendency to engage in health behaviours. The other four (susceptibility, severity, benefits, and barriers) subscales remain the same as the original model, along with specific exercise and calcium intake behaviours for the benefits and barriers. The seven constructs were measured individually as each one represents a specific perception of osteoporosis. A high score of susceptibility and severity indicate osteoporosis is perceived as a threat to an individual. While health motivations and belief in the benefits of exercise and calcium intake indicate positive perceptions to act, whereas barriers inhibit actions. The findings of this present study show moderate perceived susceptibility to osteoporosis (15/30), moderate severity (17/30), high benefits of exercise and calcium intake (22/30; 22/30), low barriers to exercise and calcium intake (10/30; 13/30), and high health motivation (22/30).

5.2.1 : Perceived Susceptibility

In this present study the median score for susceptibility was 15 out of 30 or 50%, which is considered moderate susceptibility. A comparable finding was found among the South Asian women between 20 and 49 years of age living in Auckland who had a mean score of 17/30 (Tsai, 2008). On the contrary, a previous larger sample of 622 New Zealand women between 20-49 years of age reported low susceptibility; however, the mean score was not reported (von Hurst & Wham, 2007). Similarly, students in two studies in the USA found university and college students perceived low susceptibility to osteoporosis. Ford et al. (2011) reported university students had a mean score of 13.4/30 (43%), while Edmonds et al., (2012) found a mean score of 13.6/30 (45%) among college students. Also, young Canadian adults between 18--25 years of age perceived low susceptibility to osteoporosis with a mean score of 10.9/25 (44%). Other studies among university students in China, Pakistan, and Malaysia also reported low susceptibility scores (Bilal et al., 2017;

Chiang, 2020; Ford et al., 2011).

The two susceptibility statements "there is a good chance that you will get osteoporosis" and "your family history makes it more likely that you will get osteoporosis" were mostly likely to be agreed with in the current study, by only 30% and 20%, respectively. Similar findings were found among the South Asian women in Tsai's study and von Hurst and Wham's study. In all, even though the present study participants perceived moderate susceptibility to osteoporosis which supports Tsai's findings, while the other studies mentioned above did not as some reported low susceptibility and one reported no score. Several possible reasons for either having low or moderate susceptibility could be interpreted that young adults see osteoporosis as a disease of the old, that osteoporosis is a silent disease (absence of symptoms), that this group has inadequate osteoporosis knowledge (Edmonds et al., 2012; Sayed-Hassan et al., 2013). The participants in the present study had good knowledge of the risk factors which could be the reason for perceiving moderate susceptibility as compared to the information that was reported in the college/ university studies mentioned above. Also, in the current study a quarter of the participants had a family member with osteoporosis.

5.2.2 : Perceived Severity

The findings from this research support the previous findings that young adults perceived the severity of osteoporosis as moderate, with a higher median score than susceptibility at 19/30 or 63% for this present study. Although young females did not feel susceptible, for almost ¾ of the participants the thought of having osteoporosis scares them (72%) while more than half believe it would be serious and costly if they were to get osteoporosis. The results were similar to the South Asian women in Auckland, who also had a mean score of 19/30 for severity (Tsai, 2008). Even though von Hurst and Wham did not report the level of perceived severity, they reported that 64% agreed that "it would be serious about getting osteoporosis." Comparable findings on moderate concerns about severity were also found among college students in the USA, young adults (18-25 years) in Canada, and nursing students in Damascus (Edmonds et al., 2012; Sayed-Hassan et al., 2013; Shanthi Johnson et al., 2008).

Nonetheless, other studies reported low severity scores among college students in America and China (Ford et al., 2011). On the other hand, a recent finding reported a high mean score (20/30) of severity among medical students in Malaysia (Chiang, 2020). The present study's findings support most previous studies that young adults perceived a moderate severity of osteoporosis. It also reflects that different cohorts of young adults may have different perceptions in various countries and areas of education or training.

5.2.3 : Perceived Benefits and Barriers to Exercise

The participants who took part in this study perceived high benefits of exercise for osteoporosis and low barriers to exercise, which matched the findings among South Asian women living in Auckland. In the current study, while 62.8% thought exercise is beneficial to prevent osteoporosis, 83.1% perceived there were either no, or few, barriers which prevented them from exercising. Fewer than 20% of the participants agreed with any of the barrier statements. Surprisingly, no one reported discouragement to exercise from family members, although a few agreed that regular exercise would be a challenge since it would be a new habit. Similar sentiments were expressed by participants in studies by Tsai (2008) in New Zealand and Edmonds et al., (2012) in the USA; yet, a few reported family discouragements.

Conversely, von Hurst and Wham (2007) found that almost a quarter of their respondents agreed with the statement "your spouse or family discourages you from exercising." The contradicting findings could be due to the difference in age groups as the participants were between 20-49years of age as compared to between 18-25 years of age in the current study. The participants in this current study were single, young adult students with low barriers to exercise.

5.2.4 : Perceived Benefits and Barriers of Calcium Intake

Like exercise, the participants of this study perceived high benefits of calcium intake for osteoporosis (22/30) and low barriers to calcium intake (13/30). Similar findings were found among the South Asian women in Auckland with a score of 23/30 for calcium benefits and 13/30 for calcium barriers (Tsai, 2008). Perceived high benefits of calcium intake were also found among college students in the USA, university students in Canada, medical students in Thailand and Malaysia (Aree-Ue & Petlamul, 2013; Chiang, 2020; Edmonds et al., 2012; Ford et al., 2011; Gammage et al., 2012). The findings confirm that young adults know and understand the benefits of calcium to bone health.

While the barriers to calcium intake were not seen as much of a problem in the present study; whereas the "cost of calcium-rich foods (22%) and "changing your diet to accommodate calcium-rich foods, which is not easy to do (13%), were the most frequently perceived barriers. Cost as a barrier was reported to be quite low in both Tsai's study (10%) and in von Hurst and Wham's study (8%). However, in a previous study among women and men between 16-94 years of age in New Zealand, the participants agreed that milk was more expensive than soft drinks and was a significant barrier to milk consumption (Wham & Worsley, 2003). Additionally, Chinese college students in China also confirmed cost was the main barrier to calcium intake (Ford et al., 2011).

Similarly, cost as a barrier to calcium intake was reported among young adult Canadians in a qualitative study (Marcinow, Simpson, Whiting, Jung, & Buchholz, 2017).

Contrary to von Hurst and Wham's study where concerns over the high cholesterol in calcium-rich foods was reported by 77%, only 9% had this concern in the present study. Tsai's study found 16% of South Asian women agreed calcium rich foods are high in cholesterol (Tsai, 2008). Interestingly other previous studies in New Zealand found that high cholesterol in milk was one of the several barriers to milk consumption (Gulliver & Horwath, 2001; Wham & Worsley, 2003). The present findings and Tsai's show a lack of agreement with von Hurst and Wham's finding on high cholesterol as a main barrier to calcium intake. This lack of agreement could be due to limited advertisement about dietary cholesterol as a risk factor for heart disease for some time in New Zealand and so the generation does not consider it as a problem. Also, increased availability and awareness of low or reduced-fat milk and milk products and plant-based milk on the market could be another plausible reason (Jani, Rush, Crook, & Simmons, 2018).

5.2.5 : Health Motivation

The study population reported having high health motivation with a mean score of 22/30 (73%). Similarly, high health motivation findings were reported among Tsai's study among South Asian women (22/30) living in Auckland and women between 40-49 years of age in von Hurst and Wham's study. Von Hurst and Wham (2007) found age as a significant factor in health motivation. Young women (20-29 years) in their study had low health motivation, which contradicts the present finding. The present study reported moderate to high agreement with five of the six statements. Regarding "Keeping healthy is very important for you", 94% agreed with it, there was also high agreement with the following statements: "keeping healthy is very important for you" (94%); "you follow recommendations to keep healthy" (72%) and "you try to discover health problems early" (70%). The South Asian women also expressed these, and 80% agree with the statement "you look for new information related to health"(Tsai, 2008), as compared to the moderate response (69%) in the present study. Other studies outside of New Zealand reported moderate to high health motivation among young adults in the USA, Canada, Thailand, Malaysia, and China (Aree-Ue & Petlamul, 2013; Chiang, 2020; Edmonds et al., 2012; Gammage et al., 2012). The high health motivation in this present study could be the result of people who volunteered for a bone health study since they are likely to have higher health motivation in general.

5.3: Validation and Reproducibility of the FFQ

The validity and reproducibility of the short, 20 items calcium specific FFQ was assessed. The present findings on validity confirmed good agreement with the 3-day food record based on the Wilcoxon signed-rank test, the non-bias Bland Altman, and the cross classification of the same tertiles. The Spearman's Correlation Coefficient (SCC) has moderate associations and moderate agreement with the weighted kappa statistics. The finding of the gross misclassification of calcium intake was 11.1% classified in the opposite tertiles which is slightly over the cut-off of 10 percent. Of the 5 statistical tests used, 4 had acceptable results in either agreement or association except for the cross classification. Hence, FFQ is okay for validation based on the combination of the 4 statistical tests as most validity studies used between one to three statistical tests (Lombard et al., 2015). The findings also further confirmed the reproducibility of the FFQ based on two statistical tests: the Wilcoxon signed -rank test and the SCC. There was no difference between the FFQ1 and FFQ2 and there was a moderate (acceptable) association between calcium intake estimated by the FFQ1 and FFQ2.

Although the present findings showed moderate associations between the FFQ1 and 3DDD, the results were not strong in comparison to two studies using the short FFQ. Magkos et al. (2006) carried out a validation study on calcium-specific 30 items FFQ with multiple-24hour recalls and found a moderately strong SCC r=0.639. Similarly, Ong et al. (2017), found a moderately strong SCC r=0.65 in a validation study of 51 items FFQ. According to another study using 150 food items FFQ has stated a SCC above 0.5 and a weighted kappa test above 0.4 with > 50% if same quartile/tertile and <10% of opposite quartile/tertile are recommended for epidemiology studies (Masson et al., 2003). Thus, even though this confirms that the present FFQ is acceptable but could be improved for future use.

FFQ has limitations due to overestimation and this is common due to estimation of portion size, fixed quantity range, individual's memory which can lead to biased reporting (Satija, Yu, Willett, & Hu, 2015). The FFQ used in this study has limitations as some of the food categories have a broad range of food items with disparate calcium contents. For example, the milk drink category, which includes a latte, flat white, flavoured milk, and soy milk, has a calcium content range from between 177-330mg.The average calcium content of all food/drink items in the category was used to estimate calcium intake from the FFQ. There is also, the possibility of memory bias and misreporting in the 10 3DDD with gross misclassification as compared with the FFQs. The number of servings and frequency of consumption of food items were the two forms of misreporting found in the 10 gross misclassification records in this study. Self- estimation of the number of servings per food item and misunderstanding may be the reasons for misreporting.

5.4: Dietary Calcium Intake

The participants had a median calcium intake of 692 mg (462, 1025) per day, which is below the calcium EAR per day of 1050mg (15-18 years) and 840mg (19-30 years) for women between 18-25 years of age. About two-thirds of the participants did not meet the calcium EAR. The participants' calcium intake is consistent with the findings of the New Zealand Adult Nutrition Survey (NZANS) 2008/09, where median calcium intake of similar age groups of 15-18 years and 19-30 years was 693mg and 704mg, respectively using 24-hour diet recall (University of Otago and Ministry of Health, 2011). A comparable finding was found among South Asian women between 20-49 years of age living in Auckland. The 102 participants had a median calcium intake of 685mg using a 4 -day food diary (Tsai, 2008).

The calcium intake of young women tends to be lower compared to recommendations, as reported by studies from other countries. Two studies in Australia reported calcium mean intakes of 645mg and 621mg for females aged 20-29 years old and 19-25 years old (Pasco et al., 2000; Rouf, Sui, Rangan, Grech, & Allman-Farinelli, 2018). Young women in Pakistan and Taiwan also reported low calcium intakes of 510mg and 454mg, respectively (Bilal et al., 2017). The low calcium intake was confirmed by Balk et al. (2017) and Chang (2006) in a global systematic review of young adults' calcium intake. Seventy-four countries from Northern Europe, African, South America, and Asia were part of this review. The review found young adult women's calcium intakes range between 400-700mg for Asian, African, and South American countries. Northern European countries reported calcium intakes of 800-1000mg.

This study also looked at the number of servings of milk and milk products consumed per day. At the time of the study, two servings of milk and milk products per day were recommended to meet calcium requirements (Ministry of Health, 2015). Note that in this study non-dairy milk products such as soy and almond milk were included under the milk and milk products group. Consuming two servings of milk and milk products had a significant association with meeting calcium EAR. While over a third of the participants in this present study have met the calcium EAR, 66% consumed two or more servings of milk and milk products. Interestingly, even though 34% of the women in this study did not have 2 serves of milk and milk products/day they still met the calcium EAR, which shows that other dietary patterns may provide adequate calcium. A more detailed analysis to examine diet patterns and bioavailability is worth noting in future studies.

5.4.1 : Contributors to calcium Intake

This study found that while milk and milk products provided 68.5% of the calcium intake, 31.5% was derived from non-milk products. The six main calcium contributors included milk as a drink

and with cereal (31.3%), cheese (19.1%), yoghurt and ice cream (12.4%), vegetables (12.1%), sugar and sweets (8.3%), and nuts and seeds (4.8%). The findings were different from the NZANS findings for females between 15-30 years of age with milk (20.4%), non-alcoholic beverages such as all tea, coffee, juices etc. (10.7%), bread (9.2%), yoghurt and ice cream (7.3%), cheese (6%), and vegetables (5.3%) as the main contributors. This group seems to have consumed more chocolate compared to bread which has been widely and regularly consumed by New Zealanders 12 years ago. Even though, consumption of cheese and vegetables was higher in this study population, milk remains a significant contributor to calcium intake but higher in the current study.

The NZANS was carried out over 12 years ago, and since then dietary patterns and food availability relevant to milk may have changed, e.g., lattes and soy/almond milk. Another possible reason for the differences in calcium sources is the difference in the sampling size and the target population. The present study sample is not representative of the New Zealand population, as it is a self-selected sample of university students in the lower North Island of New Zealand.

5.5 : Summary of calcium intake, osteoporosis knowledge, and osteoporosis health beliefs

The present study group had moderate osteoporosis knowledge with exceptional knowledge on milk and milk products as good sources of calcium. Likewise, the benefits of calcium were widely known, with limited barriers to calcium intake and high health motivation reported. Although this study population is young, they perceived moderate susceptibility and severity of osteoporosis.

According to the HBM theory, while positive behaviour is expected based on the positive health motivation and low calcium barriers findings whereas, this study group had inadequate calcium intake. Just above a third of the participants met the calcium EAR for their respective age groups. Nevertheless, their calcium intake was inadequate. The associations between osteoporosis knowledge and osteoporosis health beliefs will be examined below.

5.6 : Calcium intake, osteoporosis knowledge, and osteoporosis health beliefs relationship

Knowledge and health beliefs are expected to influence positive behavioural changes such as adequate calcium intake. The relationships between calcium intake, osteoporosis knowledge (OKT score), and osteoporosis health beliefs were investigated using bivariate correlation. The present study found positive associations between calcium intake and osteoporosis knowledge ($r=0.220$, $p=0.015$). Surprisingly no other significant associations were found between calcium intake and the osteoporosis health beliefs constructs. The findings contradict Tsai's findings as no associations between calcium intake and osteoporosis knowledge were noted while significant associations between calcium intake with calcium barriers and health were noted (Tsai, 2008). A negative association for calcium barriers and positive for health motivation were also found. Similarly, to

Tsai's findings, no associations between calcium intake and osteoporosis knowledge were found among college students in the USA and Canadian adolescents (Edmonds et al., 2012; Gammage & Klentrou 2011). However, both studies found positive associations with calcium intake and health motivations. Negative associations of calcium intake with calcium barriers, susceptibility and exercise barriers were found by Gammmage and Klentrou (2011) among Canadian adolescents. The findings also show a positive association of calcium intake with self- efficacy, as the expanded osteoporosis health belief scale (E-OHBS) was used to measure the osteoporosis beliefs. The E-OHBS has the seven constructs with an extra construct of self-efficacy which examines individual's confidence level regarding changing behaviours. In addition, a recent study among Malaysian university students found no associations with calcium intake, osteoporosis knowledge and osteoporosis health beliefs (Chiang, 2020).

An examination of the relationships between the independent variables showed a few associations. Family history was positively associated with susceptibility meaning those who had a family history of osteoporosis increased their perception of susceptibility. Similar associations were found among the university students in Malaysia and South Asia women living in Auckland (Chiang, 2020; Tsai, 2008). Also, osteoporosis knowledge is positively associated with susceptibility, health motivation and negatively with calcium barriers. These findings support previous findings that knowledge is associated with individuals' health beliefs such as susceptibility, health motivation and calcium benefits and calcium barriers in previous studies (Chiang, 2020; Edmonds et al., 2012; von Hurst & Wham, 2007). Having knowledge of osteoporosis such as the risk factors and food sources would enable the individual to take preventive measures (Edmonds et al., 2012).

5.7 : Predictors of calcium intake

Multiple regression was used to determine the predictors of calcium intake where all eight predictor variables (OKT, susceptibility, severity, exercise and calcium intake benefits, exercise and calcium intake barriers, health motivation) were entered into a simultaneous regression. The simultaneous multiple regression shows osteoporosis knowledge-OKT (ß=0.262, p=0.012 and perceived severity (ß=0.313, p=0.001) were significant predictors of calcium intake with the final model variance of R2=0.174; p=0.009 or 17.4% variance of calcium intake. A further regression excluding OKT was analysed to examine only the health beliefs that showed severity (B=0.267, p=0.005) and calcium barriers (B=-0.239, p=0.013) as significant predictors. However, the final model variance was lower at 10.5% and not significant (R2=0.105, p=0.079).

The findings from the current study contradict the previous findings among South Asian women in Auckland as calcium barriers, health motivation and dietary supplements were found to be

predictors of calcium intake with 27% variance (Tsai, 2008). On the same note calcium barriers and health motivation were predictors of calcium intake together with age, ethnicity, exercise barriers and exercise among college students in the USA (Edmonds et al., 2012). In this USA study, the final model variance was 12.2% and was significant with only the health beliefs and demography variables that were entered into the regression model. Similarly, calcium barriers were found to be a predictor of calcium intake among university students in Iran together with perceived severity (Mostafa et al., 2016). The same as in Edmond's study, only osteoporosis health beliefs were included in the multiple regression analysis.

Comparable findings to those from the present study were found among university students in Malaysia (Chiang, 2020), which found that knowledge (ß=-.175) and perceived severity (ß=-.122) were predictors of calcium intake (milk, cheese, yoghurt, calcium supplements) along with health motivation (ß=.017). The final model variance was low at 6% of calcium intake. The significance of various predictors in these studies could be due to the different tools used in estimating calcium intake and the variables (osteoporosis knowledge and osteoporosis health beliefs) used in multiple regression analysis. Another possibility of the difference could be the homogenous population of the present study and they shared high health motivation with low calcium barriers.

Although the present findings were different from the studies conducted by Tsai's and Edmond, similar predictors (osteoporosis knowledge and perceived severity) were found among university students in Iran and Malaysia. This present study indicates that increased osteoporosis knowledge is an important approach to increase calcium intake among the study population. Increasing awareness regarding osteoporosis and how serious it is could also help to increase calcium intake. The finding confirms that HBM theory that health-related action (calcium intake) is stimulated by vulnerability to serious health conditions with good osteoporosis knowledge. Calcium barriers and health motivation were not predictors of calcium intake among this current study population.

5.8 : Strengths and Limitations

5.8.1 : Strengths of the study:

One of the strengths of this study was that it utilised validated questionnaires: OKT and OHBS to measure knowledge and health beliefs related to osteoporosis. Second, the target study population (young adult females) is an important group to study as PBM is achieved at that age; therefore, understanding their level of osteoporosis knowledge and health beliefs will be essential and effective for future interventions. Lastly, the study is the first of its kind to provide baseline information on osteoporosis knowledge, osteoporosis health beliefs, and relationship to calcium intake among young female university students (18-25years) in New Zealand.

5.8.2 : Limitations of the study:

The present study suffers limitations starting with the small sample size and convenience sampling. A large sample size with random or systematic sampling would be representative and limit bias. Therefore, the findings of this study cannot be generalised to young adult women or university students as student's program of study and ethnicity were not measured. Second, although the FFQ was validated in this study, while the associations, and agreements between FFQ and 3DDD were acceptable they were not strong. A more refined calcium specific FFQ is needed with a specific food category instead of broad food categories. For instance, milk drink should be broken into specific categories such as plant- based milk and flavoured milk. Third, self-report was used to collect data which could lead to biased reporting and participants may have selected desirable behaviours related to bone health instead of true responses. Fourth, even though information on participant's ethnicity was not collected, it would be useful to tailor appropriate and effective interventions for different ethnicity groups. Fifth, while coding of the OKT stipulates use of 1 and 0, it may be better to have 3 codes to capture "I don't know" responses instead combing don't know and incorrect responses. Lastly, participants perceived positive health motivation except their confidence level (self-efficacy) in making behavioural changes was not measured, this could help explain the weak relationship.

CHAPTER 6: CONCLUSION & RECOMMENDATIONS

6.1 : Conclusion

The findings from the present study include associations between osteoporosis knowledge (OKT) and perceived susceptibility, calcium barriers, health motivation and calcium intake. Further analysis using multiple regression showed osteoporosis knowledge (OKT) and perceived severity were predictors of calcium intake. This shows that knowledge about osteoporosis is an important modifiable factor that can influence health beliefs and behaviour (calcium intake). The study did not find calcium barriers and health motivation as predictors as previous studies found among South Asian women in New Zealand and the College students in USA.

This convenience sample of young University female students had a moderate knowledge of osteoporosis overall, yet they were not as knowledgeable regarding risks, nutrition, and the general domains. The students had exceptional knowledge correctly identifying eating disorders and family history as risk factors; jogging /running and aerobic dancing as best weight-bearing exercises; and cheese and yoghurt as the best food sources of calcium. However, their knowledge regarding ethnicity, smoking and drinking alcohol as risk factors and good exercise for bone health such as brisk walking (weight bearing exercise) were found not as high. Also, identifying non-dairy and vitamin D food sources and when peak bone mass is achieved were found not as high. The participants did know about the traditional dairy calcium sources except for the non-dairy products. The findings were like previous studies in New Zealand and among young adults in the USA.

The University students perceived moderate susceptibility and severity of osteoporosis, with family history being associated with susceptibility. Participant's good knowledge of the traditional dairy products has enabled the participants to perceive the high benefits of calcium intake and health motivation with low barriers to calcium intake. Although the study group perceived low barriers to calcium intake and high health motivations, the estimated calcium intake (692mg/d) was below the calcium EAR for their age group (18-25years). However, the low calcium intake was consistent with the previous findings among females of a similar age group in New Zealand, Australia, and the USA. The present finding shows low calcium intake existed before and now among young adults probably due to various factors. The two barriers of calcium intake highlighted by the present study were calcium rich foods cost too much and having to give up other foods to meet calcium intake. Interestingly, this study population did not believe calcium-rich foods are high in cholesterol which was once highlighted as calcium barriers in a previous study among women living in Auckland. The possible reasons why there is no longer a barrier could be due to the availability and awareness of low or reduced fat milk and milk products and non-

dairy products.

Overall, the findings confirm the HBM theory that some perceptions such as severity and knowledge influence individual's likelihood of engaging in health promoting behaviour (calcium intake) among this study population. Surprisingly most HBM constructs were not linked to behaviour (calcium intake.) This is interesting but may not be causal.

6.2 : Recommendations

- Develop education materials to focus on the importance of calcium intake and physical activity among young adults and the consequences of osteoporosis (socio-economic and health burdens of osteoporosis).
- Increase awareness of non-milk products foods, fortified foods, drinks, and using calcium supplements could help address these issues.
- A repeated study is recommended with a more representative sample to generalise the findings on young adult females or university females.
- Include self-efficacy questions to measure an individual's confidence level in taking preventive actions such as calcium intake.
- Develop a more refined calcium specific FFQ that can be used among the general population to estimate calcium intake and ranking of high and low intakes.
- Qualitative research to identify the availability of sources of information for young adults.

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APPENDIX 1: ETHICS APPROVAL

Date: 21 March 2017

Dear Dr Jasmine Thomson

Re: Ethics Notification - **SOA 17/06 - Love Them Bones: Promoting Osteoporosis Knowledge, Beliefs, and Behaviour Changes in Young Women**

Thank you for the above application that was considered by the Massey University Human Ethics Committee: **Human Ethics Southern A Committee** at their meeting held on **Tuesday, 21 March,**

Approval is for three years. If this project has not been completed within three years from the date of this letter, reapproval must be requested.

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

Yours sincerely

Dr Brian Finch
Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

APPENDIX 2: SCREENING FORM

1. Personal Information

Name	**Participant ID**
Address	**Email Address**
Date	

2. What is your age? (years)

3. What is your gender?

Male	Female

4. Have you ever been diagnosed with the following?

	No	Yes
Osteogenesis Imperfecta		
Juvenile Rheumatoid Arthritis		
Type I (insulin dependent) diabetes		
Thyroid Disease ***which is not under control***		
Inflammatory Bowel Disease (e.g. Crohn's, Ulcerative Colitis, Celiac Disease)		
Chronic Renal (Kidney) Disease		
Clinically Significant Liver Disease		

5. Have you previously been treated with the following?

	No	Yes

Corticosteroid tablets
(e.g. prednisone,
cortisone) daily for >3
months

Thank you for taking the time to fill in this screening questionnaire.

The researchers will be in touch with you shortly to let you know if you are eligible for inclusion in this study

APPENDIX 3: INFORMATION SHEET

MASSEY UNIVERSITY
COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

School of Food and Nutrition
Massey Institute of Food Science and Technology,
College of Health

Love them Bones Study: Osteoporosis Knowledge, Beliefs & Behaviour Change in Young Women

INFORMATION SHEET

Researcher(s) Introduction

The research group is a team of nutritionists interested in bone health. The lead researcher for this stage of the project is Dr Jasmine Thomson from the School of Food and Nutrition. Other researchers include Dr Louise Brough, Dr Janet Weber, Professor Jane Coad, and Professor Marlena Kruger, also from the School of Food and Nutrition, in the College of Health and Dr Mary Jane De Souza from the College of Health and Human Development at Penn State University.

Project Description and Invitation

Osteoporosis is one of the leading healthcare issues worldwide. Osteoporosis is characterised by reduced bone tissue and changes in bone structure resulting in increased fragility and risk of fractures in older adults. It is estimated that about 22% of women over 50 years of age will develop osteoporosis.

Peak bone mass, i.e. maximum bone mineral density and strength, occurs during young adulthood. Therefore, developing some lifestyle habits that help increase peak bone mass when you are 18-25 is an important strategy to reduce your risk of osteoporosis later in life.

However, we know you have a lot of things going on in your life right now, and it is hard to worry about a disease you *could* get when you are old. So we want to investigate a strategy to teach you some facts about osteoporosis and get you engaged in making some changes to your lifestyle that will reduce your risk of getting osteoporosis when you are older. We also want to investigate some of the other things going on in your life that may affect you making some good lifestyle changes.

If you would like to participate please contact Jasmine on 06 951 7559 or email j.a.thomson@massey.ac.nz

Participant Identification and Recruitment

We are recruiting women from the general community in Palmerston North and Wellington Regions. We are advertising the study in local media and social media, Universities, and workplaces. We are recruiting 142 women to participate in the full study.

Inclusion criteria

To become a participant you will need to:

- Be a healthy young woman
- Aged 18-25 years
- Not pregnant
- Live in the Palmerston North and Wellington Regions

Exclusion criteria

Unfortunately you cannot participate if you have been diagnosed with a condition that might affect your bones or absorption of nutrients such as:

- Osteogenesis Imperfecta
- Juvenile Rheumatoid Arthritis
- Type I (insulin dependent) diabetes
- Uncontrolled Thyroid Disease
- Inflammatory Bowel Disease (e.g. Chron's, Ulcerative Colitis, Coeliac Disease)
- Chronic Renal (Kidney) Disease
- Clinically Significant Liver Disease

If you are or have been medically treated with the following:

- Corticosteroid tablets (e.g. prednisone, cortisone) daily for >3 months previously

What is involved?

This assessment will be at the Human Nutrition Research Unit at Massey University in Palmerston North or at the Sport Science and Research Lab at Massey University in Wellington

First we are going to ask you some questions on your lifestyle, diet, and physical activity, next we will ask some questions on how much you already know about osteoporosis. This is not a test so do not study for it, we are simply interested in things you have picked up from friends, family, TV, and internet. You will not be marked on the number of correct answers!

After you have completed the paperwork, we have a new machine that measures your bone quality by ultrasound. The Quantitative Ultrasound transmits and receives sound waves; the intensity and speed of these sound waves are altered by the properties of your bones. Quantitative ultrasound measurements are pretty close to results from medically established methods for diagnosing low bone mineral density. The best part about the Quantitative Ultrasound is that it produces your results pretty much immediately, so you can keep your results after the measurement. We will also like to do a finger prick collection of a few drops of blood to test for presence of anaemia. We have a couple of diaries for you to take home and write about what you eat and drink, and the physical activity that you do each day.

Based on the results from the questionnaires you did we will be asking some of you back for further assessment.

This assessment will be at the Human Nutrition Research Unit at Massey University in Palmerston North.

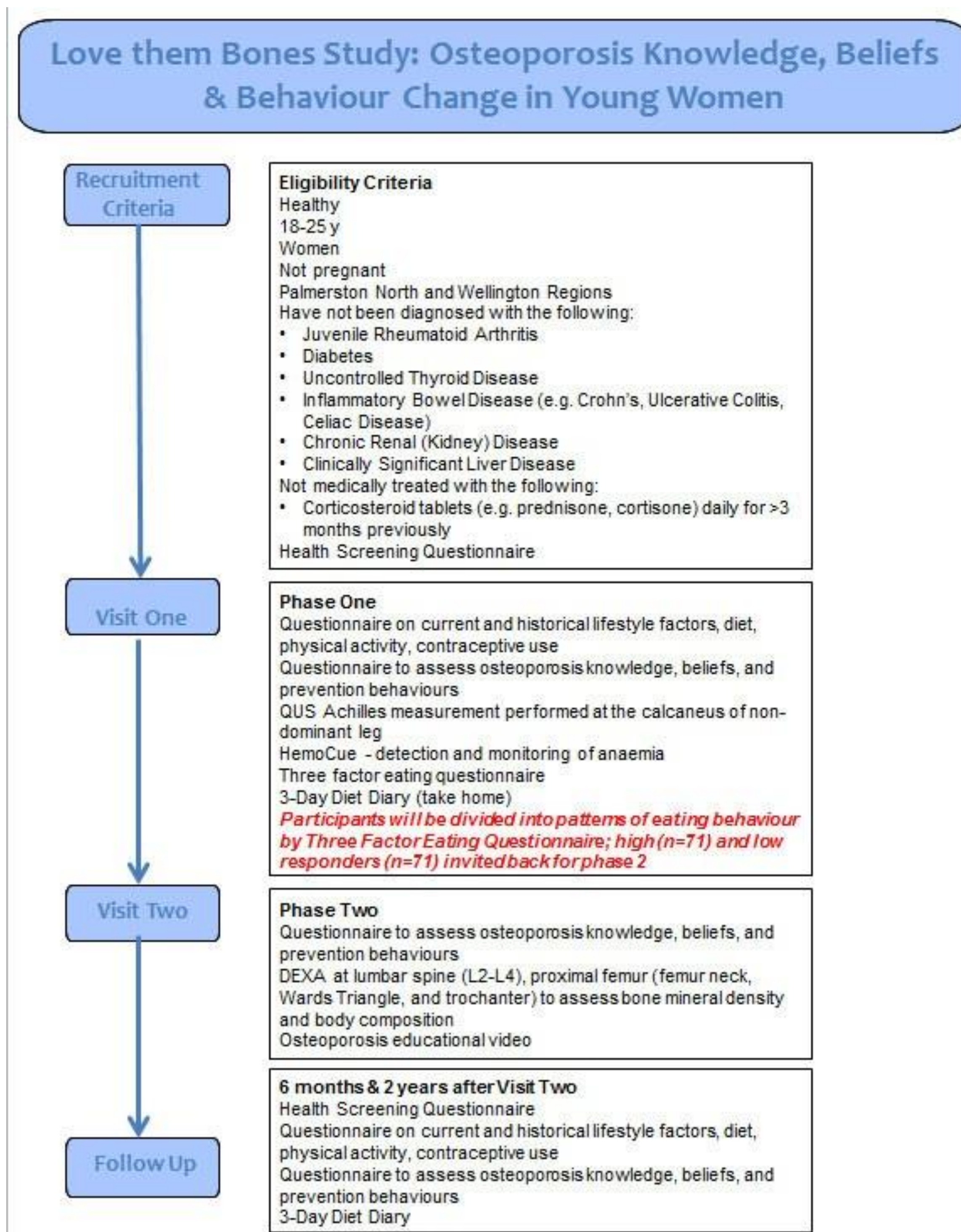
During the second visit, for those of you asked back we are going to ask you some of the questions from visit one again to see if anything has changed in the meantime. Next we will show you a short video to give you some information on osteoporosis and how to reduce your risk of getting it. Finally we will use a DEXA (Dual-emission X-ray absorptiometry) to measure your bone density, this machine uses very low dose radiation X-rays to measure the bone density of your hip and spine, and also measures your body composition (fat mass, lean mass, and bone mass of your body).

After this education session we would like to invite you to repeat the questionnaires at 6 months and 2 years to see what, if anything has changed about your daily lives in response to learning about osteoporosis and having

your bones assessed. The follow-up questionnaires will be done via email or mail. For those of you requesting mail, a postage paid self-addressed envelope will be provided.

We would like to keep in touch and contact you about your bone health in 35 years time.

Members of the bone health team would like to contact you in about 3 decades to see how your lifestyle and bone health has changed with time.



Tests involved for all participants - in more detail

Quantitative Ultrasound bone scan:

Our Achilles Quantitative Ultrasound machine will provide a quick safe and comfortable scan of your non-dominant heel bone using sound-waves. You will feel a warm water filled membrane that hugs your heel during your scan. The procedure is quick; just a few minutes from shoe off to shoe on. We will provide you with a printout of your results, for you to keep.

Finger Prick Blood Sample:

Trained staff will take capillary blood sample from your finger using lancet and HEMOCUE Hb 201+ to measure whole blood Haemoglobin value. We will ask you to sit in a comfortable lounge chair to avoid risk of fainting. The amount of blood taken is only about 2-3 drops, which should not have any harmful effects.

Tests involved for only some participants - in more detail

DEXA Dual-emission X-ray absorptiometry bone scan:

Measurement involves you lying down on a bed fully clothed in surgical scrubs and having an X ray of your body on the Hologic DEXA machine. This machine is used to estimate bone mineral density and bone mineral content of your hip and lumbar spine (L1-L4) and total body composition. The DEXA has X-ray beams of different energies and while no dose of radiation is harmless this dose is very low and unlikely to cause harm. The total effective dose of radiation to which you will be exposed to is 10.8 microsieverts (μSv), which is much lower than the range normally used in medical diagnostics. To place this in perspective, the amount of radiation you are exposed to during a return flight to the United Kingdom is 100 μSv and from a dental X-ray 50 μSv. This procedure is quick, non-invasive and does not require anaesthetic. The room is private and the staff certified. It should take approximately 15 minutes. Your scan results will be assessed and approved by our consultant Radiologist. If your scan shows a T score of > 2.5 S.D below normal, you will be advised and a copy of the scan, the report from the radiologist and a letter provided to take to your GP to discuss if further investigation is necessary.

Although ionising radiation doses from the DEXA are relatively low, it is still ionising radiation exposure, so there is a risk to an unborn child. Therefore, we will need to ask you on two separate occasions if you are or think you might be pregnant. We will ask you at the beginning of the study and again immediately before the DEXA scan to sign a form to confirm that you are not pregnant, nor suspect that you might be pregnant. If you are pregnant you will not be able to further participate in the study to avoid the risk from ionising radiation to your unborn child.

If you elect to receive the results of your bone scan and they show abnormalities, later if you seek life or health insurance you may be asked to disclose them by the insurer. Failure to disclose them could invalidate your insurance policy.

Time Commitment

It is expected that visit one will take about an hour. Measurements done for visit two in the Human Nutrition Research Unit will also take about an hour. Questionnaires and diaries done at home will take a further 1-1.5 hours in total. Travel time from Wellington to Palmerston North for visit two for participants who are Wellington residents is approximately 2 h.

What benefits you will get from participation

- You will have contributed to scientific understanding of the influence of lifestyle factors on bone health of young women in New Zealand
- You will not be charged for any of the measurements conducted for the study.
- You will get a copy of your body composition results
- You will be provided a nutrient analysis of your diet from your 3 day diet diaries

- You go into a prize draw to win one voucher to the value of $200 from a chain store of your choice
- You will get a summary of the study results

This study is supported by a grant from the Massey Institute of Food Science and Technology Massey University Research Fund.

Data Management

We will keep your name and contact details private and they will be stored in a locked filing cabinet in my office and disposed of in 35 years' time. You will only ever be identified by a code number for any data analysis and research reports.

Please also bear in mind that it is not advisable for you to have DEXA scans performed more frequently than once per year. So, if you have already participated in a bone health study recently and had a DEXA scan we would like your permission to obtain a copy of your DEXA results from the previous measurement in order to avoid you having a second scan.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- decline to answer any particular question;
- withdraw from the study at any time;
- ask any questions about the study at any time during participation;
- provide information on the understanding that your name will not be used unless you give permission to the researcher;
- be given access to a summary of the project findings when it is concluded.

Project Contacts

There are several researchers involved in this project; however, if you have any questions about the project or any of the tests and activities planned, please contact the lead researchers in this instance.

Dr Jasmine Thomson

Phone; 06 356 9099 ext 84559

Email; J.A.Thomson@massey.ac.nz

Institute of Food, Nutrition and Human Health

Massey University

Palmerston North

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 17/06. If you have any concerns about the conduct of this research, please contact Dr Lesley Batten, Chair, Massey University Human Ethics Committee: Southern A, telephone 06 356 9099 x 85094, email humanethicsoutha@massey.ac.nz .

Compensation for Injury

If physical injury results from your participation in this study, you should visit a treatment provider to make a claim to ACC as soon as possible. ACC cover and entitlements are not automatic and your claim will be assessed by ACC in accordance with the Accident Compensation Act 2001. If your claim is accepted, ACC must inform you of your entitlements, and must help you access those entitlements. Entitlements may include, but not be limited to, treatment costs, travel costs for rehabilitation, loss of earnings, and/or lump sum for permanent impairment. Compensation for mental trauma may also be included, but only if this is incurred as a result of physical injury.

If your ACC claim is not accepted you should immediately contact the researcher. The researcher will initiate processes to ensure you receive compensation equivalent to that to which you would have been entitled had ACC accepted your claim.

APPENDIX 4: CONSENT FORM

School of Food and Nutrition
Massey Institute of Food Science and Technology,
College of Health

Love them Bones Study: Osteoporosis Knowledge, Beliefs & Behaviour Change in Young Women

PARTICIPANT CONSENT FORM - INDIVIDUAL

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... **Date:** ....

Full Name - printed ....

APPENDIX 5: OKT QUESTIONNAIRE

1. Personal Information

Name

Participant ID

Date

Below is a list of things which may or may not affect a person's chance of getting osteoporosis. After you read each statement, think about if the person is:

MORE LIKELY to get osteoporosis
LESS LIKELY to get osteoporosis
NEUTRAL, it has nothing to do with getting osteoporosis or DON'T KNOW

When you read each statement, select ONE of the 4 choices for your answer.

2. Eating a diet LOW in dairy products

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

3. Being post-menopausal; after menopause

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

4. Having a parent or grandparent who has osteoporosis

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

5. Being a White or Asian woman

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

6. Being an elderly man

More Likely	Less Likely	Neutral	Don't Know	
○	○	○	○	○

7. Having ovaries surgically removed

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

8. Taking cortisone (steroids e.g. Prednisone) for a long time

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

9. Having an eating disorder

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

10. Consuming more than 2 alcoholic drinks per day

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

11. Smoking on a daily basis

More Likely	Less Likely	Neutral	Don't Know
○	○	○	○

For the next group of questions, select one answer from the 4 choices.

Be sure to select ONLY ONE answer. If you think there is more than one correct answer, choose the BEST answer. If you are not sure, select "Don't know".

12. To strengthen bones, it is recommended that a person exercise at a moderately intense level of 30 minutes a day at least

- 3 days a week
- 4 days a week
- 5 days a week
- Don't Know

13. Exercise makes bones strong, but it must be hard enough to make breathing...

- Just a little faster
- Much faster, but talking is still possible
- So fast that talking is not possible
- Don't Know

14. Which of the following activities is the best way to reduce a person's chance of getting osteoporosis?

- Swimming
- Walking briskly
- Stretching
- Don't Know

15. Which of the following activities is the best way to reduce a person's chance of getting osteoporosis?

- Cycling
- Yoga
- Lifting weights
- Don't know

16. Which of the following activities is the best way to reduce a person's chance of getting osteoporosis?

- Jogging or running
- Golfing using a golf cart
- Gardening
- Don't know

17. Which of the following activities is the best way to reduce a person's chance of getting osteoporosis?

- Bowling
- Doing Laundry
- Aerobic Dancing
- Don't know

18. Which of these is the best source of calcium?

- Apple
- Cheese
- Cucumber
- Don't know

19. Which of these is the best source of calcium?

- Peanut butter
- Lamb
- Canned Sardines
- Don't know

20. Which of these is the best source of calcium?

- Chicken
- Broccoli
- Grapes
- Don't know

21. Which of these is the best source of calcium?

- Yoghurt
- Strawberries
- Cabbage
- Don't know

22. Which of these is the best source of calcium?

- Ice cream
- Grape fruit
- Radishes
- Don't know

23. How much milk must an adult drink to meet the recommended amount of calcium?

- 1 glass daily
- 2 glasses daily
- 3 or more glasses daily
- Don't know

24. Which of the following is the best reason for taking a calcium supplement?

- If a person skips breakfast
- If a person does not get enough calcium from their diet
- If a person is over 45 years old
- Don't know

25. Which vitamin is required for the absorption of calcium?

- Vitamin A
- Vitamin C
- Vitamin D
- Don't know

26. Which is the best source of the vitamin required for the absorption of calcium?

- Carrots
- Oranges
- Sunlight
- Don't know

27. Which is the best source of the vitamin required for the absorption of calcium?

- Spinach
- Cheese
- Salmon
- Don't know

28. When would you achieve peak bone mass?

- Childhood
- Adolescence
- Young adulthood
- Don't know

29. Osteoporosis can be diagnosed by

- Blood test
- DEXA scan
- Symptoms
- Don't know

30. Once you have osteoporosis

- There is nothing you can do about it
- You can take medication to treat it
- You must be careful lifting objects
- Don't know

Thank you for completing the survey.
Please check to be sure you answered all of the questions

Developed by Katherine Kim PhD, Mary Horan PhD, and Phyllis Gendler PhD (1991). Grand Valley State University, with support from the Grand Valley State University Research Grant-in-Aid. Revised by Phyllis Gendler PhD, Cynthia Coviak PhD, Jean Martin PhD, and Katherine Kim PhD (2011, 2012). Question 26 was developed as an addition to the Osteoporosis Knowledge Test by Pamela von Hurst (2006).

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APPENDIX 6: OHBS QUESTIONNAIRE

1. Personal Information

Name

Participant ID

Address

Email Address

Date

Osteoporosis is a condition in which the bones become very brittle and weak so that they break easily.

Below are some questions about your beliefs about osteoporosis. There are no right or wrong answers. We all have different experiences which will influences how we feel.

After reading each statement, select if you STRONGLY DISAGREE, DISAGREE, are NEUTRAL, AGREE, or STRONGLY AGREE with the statement. It is important that you answer according to your actual beliefs and not according to how you think you should answer. We need the answers that best explain how you feel.

Read each statement. Select ONE best option that explains what you believe:

2. Your chances of getting osteoporosis are high

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

3. Because of your body build, you are more likely to develop osteoporosis

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

4. It is extremely likely that you will get osteoporosis

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

5. There is a good chance that you will get osteoporosis

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

6. You are more likely than the average person to get osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

7. Your family history makes it more likely that you will get osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

8. The thought of having osteoporosis scares you

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

9. If you had osteoporosis you would be crippled

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

10. Your feelings about yourself would change if you got osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

11. It would be very costly if you got osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

12. When you think about osteoporosis you get depressed

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

13. It would be very serious if you got osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

14. Regular exercise prevents problems that would happen from osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

15. You feel better when you exercise to prevent osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

16. Regular exercise helps to build strong bones

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

17. Exercising to prevent osteoporosis also improves the way your body looks

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

18. Regular exercise cuts down the chances of broken bones

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

19. You feel good about yourself when you exercise to prevent osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

For the following 6 questions, "taking in enough calcium" means taking enough calcium by eating calcium rich foods and/or taking calcium supplements.

20. Taking in enough calcium prevents problems from osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

21. You have lots to gain from taking in enough calcium to prevent osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

22. Taking in enough calcium prevents painful osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

23. You would not worry as much about osteoporosis if you took in enough calcium

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

24. Taking in enough calcium cuts down on your chances of broken bones

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

25. You feel good about yourself when you take in enough calcium to prevent osteoporosis

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

After reading each statement, select if you STRONGLY DISAGREE, DISAGREE, are NEUTRAL, AGREE, or STRONGLY AGREE with the statement

26. You feel like you are not fit enough to exerciseregularly

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
◯	◯	◯	◯	◯

27. You have no place where you can exercise

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
◯	◯	◯	◯	◯

28. Your spouse or family discourages you from exercising

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
◯	◯	◯	◯	◯

29. Exercising regularly would mean starting a new habit which is hard for you to do

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
◯	◯	◯	◯	◯

30. Exercising regularly makes you uncomfortable

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
◯	◯	◯	◯	◯

31. Exercising regularly won't fit in your daily routine

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
◯	◯	◯	◯	◯

After reading each statement, select if you STRONGLY DISAGREE, DISAGREE, are NEUTRAL, AGREE, or STRONGLY AGREE with the statement

32. Calcium rich foods cost too much

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

33. Calcium rich foods do not agree with you

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

34. You do not like calcium rich roods

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

35. Eating calcium rich foods means changing your diet which is hard to do

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

36. In order to eat more calcium rich foods you have to give up other foods that you like

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

37. Calcium rich foods have too much fat

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

38. You eat a well-balanced diet

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

39. You look for new information related to health

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

40. Keeping healthy is very important for you

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

41. You try to discover health problems early

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

42. You have a regular health check-up even when you are not sick

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

43. You follow recommendations to keep healthy

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

Thank you for completing the survey.

Please check to be sure you answered all of the questions

K. Kim, M. Horan, P. Gendler, 1991. Reproduction with authors' express written consent

APPENDIX 7: BONE HEALTH QUESTIONNAIRE EXTRACT

Osteoporosis is a disease in which the body loses too much bone density and bones become very brittle and weak so that they break easily.

The first group of questions are about your medical history

1. Personal Information

Name	
Participant ID	
Date	

2. Do you have someone in your immediate family who had a hip fracture or was diagnosed with osteoporosis (parent, grandparent)?

Yes	No	Don't Know

3. Have you ever been diagnosed with the following?

	Yes	No	Don't Know
Stress Fractures			
Osteopenia (lower than normal bone density)			
Osteoporosis			

4. Have you had the following medical procedures?

	Yes	No	Don't Know
Hysterectomy			
Gastric Surgery (Gastrectomy, Gastric Bypass)			
Chemotherapy for breast cancer			
Radiation therapy in the previous year			

5. What is your age?

6. The next group of questions are about anthropometry, your body measurements and proportions.

	kg
What is your current weight?	
What is your highest weight at your present height? (excluding pregnancy)	
What is your lowest weight at your present height?	
What is your desired weight?	

30. Please write down the number of times that you usually eat or drink the items listed below.
e.g. if you drink 1 glass of milk 3 times a week, write 3 in the weekly column

	Daily	**OR** Weekly	**OR** Monthly	**OR** Never/Infrequently
1 cup of tea with milk				
1 cup instant coffee with milk				
1 cup of milk				
1 cup milk drink (latte/flat white, flavoured milk, milk milo, soy drink)				
1 cup milk with cereal/porridge				
1 slice of bread				
1 matchbox portion of hard cheese (e.g. cheddar)				
1 matchbox portion of soft cheese (e.g. camembert, brie)				
1 tablespoon of fresh cheese (e.g. cottage cheese, ricotta, sour cream)				
1 pottle of yoghurt				
1/2 cup dairy-based pudding (e.g. ice cream, custard, rice pudding)				
Canned fish with bones (e.g. sardines, salmon)				
1/2 cup green vegetables				
1 tablespoon of hummus				
3/4 cup bean curd/tofu				
1 handful peanuts or almonds				
1 handful of other nuts (hazelnuts, brazil, walnuts)				
1 cup of cheese sauce based dish (e.g. macaroni cheese)				
1 bar chocolate (50g) or two squares from a family sized block of chocolate (50g) (not bitter/dark)				
1 fillet of oily fish (kahawai, pilchard, salmon, warehou, alfonsino, freshwater eel, fresh tuna)				

APPENDIX 8: 3 DAY DIET DIARY (3DDD)

MASSEY UNIVERSITY
COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

School of Food and Nutrition
Massey Institute of Food Science and Technology,
College of Health

Love them Bones Study: Osteoporosis Knowledge, Beliefs & Behaviour Change in Young Women

3 DAY DIET RECORD

INSTRUCTIONS:
Please record foods soon after they are eaten so you don't forget and list only one food item per line.

Record your diet intake for 3 d; including two weekdays and one weekend day. For example come into the lab for visit one on a Wednesday, complete diet and activity records and urine collection on Thursday, Friday, and Saturday.

Be as specific as possible when describing each food/meal, the way it was prepared or cooked (if it was cooked), and the amount that you ate. Include methods used to prepare the food, *for example: fresh, frozen, stewed, fried, baked, canned, broiled, raw or braised.* For canned foods indicate the liquid in which it was canned and the amount of this that you ate or if you drained off the liquid, *for example: heavy syrup, light syrup, fruit juice, spring water, vegetable oil, brine.* Record the amounts of visible fats you add and use in cooking *for example: butter and spreads, vegetable oils, salad dressing, etc*

Remember to report only the amount that you actually ate, not the total amount prepared. Record all amounts in household measures, *for example: g, ml, tablespoon (tbsp) (= 15ml), teaspoon (tsp) (=5ml), cups (=250ml), slices or units (described on the packet).* Include brand names whenever possible, or bring in the Nutrition Label from pre-packaged meals. Do not alter your normal diet during the time you keep this diary

________________ Day of the Week: ______________________ Date: ____________

TIME	FOOD ITEM and METHOD of PREPARATION	AMOUNT EATEN

APPENDIX 9: CALCIUM CONTENT/PER SERVING

Items selected from FoodWorks with average calcium content (mg)

Food Group	Food item (taken from food Works 10 software)	Calcium
1 cup of tea with milk	Tea black regular with milk=33.50mg	34mg
1 cup of instant coffee with milk	with water & milk standard 3.3% fat=43.10mg with water & milk trim 0.5% fat=49.08mg	46mg
1 cup of milk	Milk standard 3.3% fat fluid =306.14mg Milk lite 1.5% fat fluid=338mg Milk trim 0.5% fat fluid=338mg Milk trim 0.3% fat fluid=364mg Milk whole 4% fat fluid=300.30	329mg
1cup of milk drink e.g. latte, flavoured milk, soy milk	Flat white full cream milk=214.84mg Flat white reduced milk=254.48 Latte full cream =214.84mg Latte reduced milk=254.48mg Soy milk regular=290.70 Soy milk essential =330.20 Chocolate milk=262.49 Almond milk=177.40	250mg
1 Cup of milk with cereal /porridge	Porridge with standard milk 3.3% fat= 300 Porridge with trim milk 0.5% fat=330	315mg
½ cup of dairy-based pudding e.g. ice cream	vanilla, premium=71.96 vanilla, standard=86.21mg assorted berry flavour standard=69.60mg chocolate standard=66.34	74mg
50g chocolate	Milk chocolate, dairy milk=135mg	135mg
1 matchbox hard cheese (33g)	Cheddar, mainland= 267.30mg Cheddar tasty anchor=293.70mg Edam anchor=326.70 mg Edam mainland= 283.20 mg Colby =267.30mg	288mg

1 matchbox soft cheese (33g)	Camembert=180.51mg Brie = 151.80mg	166mg
1 tablespoon fresh cheese	Cheese cottage=10.01mg Cottage light, 1% fat=13.99 Sour cream=12.61mg Cheese cream=14.20mg	13mg
1 cup cheese sauce-based dish	Macaroni cheese=200.55mg	201mg
1 pottle yoghurt (125g)	Fresh n fruity regular fat fortified=236.25 Plain low fat unsweetened=200mg Greek style low fat, cyclops=231.25mg Greek style Dewinkle=250mg	229mg
1 tablespoon hummus	Original, 6.5% fat= 4.48mg Roasted capsicum, 7.5% fat=4.40mg Sundried tomato, 7.5% fat= 4.84mg	5mg
Canned fish with bones (57g)	Sockeye, canned drained=136.23mg Pink or red flesh, canned in spring water, drained=153.90 mg Salmon chum, canned drained=136.23mg	144mg
1 fillet oily fish	King, fillet, skin & bones removed, baked= 14.34mg King, fillet, skin & bones removed, pan-fried=12.57mg Tuna, blue fin, flesh, raw=14.96mg	14mg
¾ cup bean curd/tofu (6oz)	Regular, firm raw=357.20mg Regular, firm stir fired=438.65mg Regular, firm simmered or pouched=324.63	373mg
½ cup green vegetables	Broccoli boiled, drained= 26.40mg Broccoli, microwaved=31.35mg Spinach English boiled=66mg Bok choy poached=62.65mg	47mg
1 handful almonds	Dried & blanched=74.10mg Dry roasted, salted added= 79.80mg Dried raw, unsalted=81mg	78mg

1 handful of other nuts	Walnut= 23.40 Brazil nut=54mg Hazel nut=41.10mg	40mg
Slice of bread		32mg

APPENDIX 10: OKT COMPLETE RESULT

Percentage of correct and incorrect response in the Osteoporosis Knowledge Test (n=130)

Domain	Correct	Incorrect
Risk	***Percentage (%)***	
Eating a diet low in dairy products	82.3	17.7
Being post-menopausal; after menopause	74.6	25.4
Having a parent or grandparent who has osteoporosis	93.1	6.9
Being a White or Asian woman	25.4	74.6
Being an elderly man	56.9	40
Having ovaries surgically removed	24.6	75.4
Taking cortisone (e.g. Prednisone) for a long time	52.3	46.9
Having an eating disorder	93.1	6.2
Consuming more than 2 alcoholic drinks per day	36.9	63.1
Smoking on a daily basis	59.2	40.8
Exercise		
To strengthen bones, it is recommended that a person exercise at a moderately intense level of 30minutes a day at least *(5days/week); 3 days a week; 4 days/week; don't know*	40	60
Exercise makes bones strong, but it must be hard enough to make breathing *(much faster, but talking is still possible); just a little faster; so fast that talking is not possible; don't know*	67.7	32.3
Best activities to reduce a person's chances of getting osteoporosis *(brisk walking); swimming; stretching; don't know*	*49.2*	*50.8*
Best activities to reduce a person's chances of getting osteoporosis *(lifting weights); cycling; yoga; don't know*	*67.7*	*32.3*
Best activities to reduce a person's chances of getting osteoporosis *(jogging or running); golfing; gardening; don't know*	86.9	13.1
Best activities to reduce a person's chances of getting osteoporosis *(aerobic dancing); bowling; doing laundry; don't know*	83.1	16.9
Nutrition		
Which is the best source of calcium? (cheese); apple; cucumber; don't know	97.7	2.3
Which is the best source of calcium? (canned sardines); lamb; peanut butter; don't know	34.6	65.4
Which is the best source of calcium? (broccoli); chicken, grapes; don't know	60	39.2

Which is the best source of calcium? (yoghurt); strawberries; cabbage; don't know	96.2	3.8
Which is the best source of calcium *(ice cream); grapefruit; radishes; don't know*	63.8	36.2
How much milk must an adult drink to meet the recommended amount of calcium*?; (3 or more glasses daily); 2 glasses daily; 1 glass daily; don't know*	5.4	94.6
Best reason for taking a calcium supplement (*person doesn't get enough calcium from their diet); person skips breakfast; person is over 45years old; don't know*	*89.2*	*10*
Which vitamin is required for the absorption of calcium? *(Vitamin D); Vitamin A; Vitamin C; don't know*	*52.3*	*47.7*
Which is the best source of the vitamin required for the absorption of calcium? *(sunlight); carrots; oranges; don't know*	*52.3*	*47.7*
Which is the best source of the vitamin required for the absorption of calcium? *(salmon); spinach; cheese; don't know*	19.2	80.8
General Knowledge		
When would you achieve peak bone mass? *;(adolescence); young adulthood; childhood; don't know*	14.6	85.4
Osteoporosis can be diagnosed by *(DEXA scan); blood test; symptoms; don't know*	63.1	36.9
Once you have osteoporosis *(you can take medication to treat it*); *nothing you can do about it; must be careful lifting objects; don't know*	32.3	67.7

correct responses are parenthesized

APPENDIX 11: OHBS COMPLETE RESULT

Percentage of the level of agreement (agree, disagree, neutral) responses of the OHBS- 7 constructs

Construct (%)	Level of Agreement		
	A	D	N
Susceptibility			
Your chances of getting osteoporosis are high	19.2	44.6	36.1
Because of your body build, you are more likely to develop osteoporosis	15.6	56.3	28.1
It is extremely likely that you will get osteoporosis	7.7	70.0	22.3
There is a good chance that you will get osteoporosis	30.2	41.1	28.7
You are more likely than the average person to get osteoporosis	17.7	55.4	26.9
Your family history makes it more likely that you will get osteoporosis	22.3	62.3	15.4
Severity			
The thought of having osteoporosis scares you	72.3	11.5	16.2
If you had osteoporosis you would be crippled	24.0	48.8	27.1
Your feelings about yourself would change if you got osteoporosis	45.4	31.5	23.1
It would be very costly if you got osteoporosis	57.4	11.6	31.0
When you think about osteoporosis you get depressed	18.5	53.1	28.5
It would be very serious if you got osteoporosis	58.5	19.2	22.3
Exercise Benefits			
Regular exercise prevents problems that would happen from osteoporosis	76.0	3.9	20.1
You feel better when you exercise to prevent osteoporosis	56.9	6.2	36.9
Regular exercise helps to build strong bones	71.5	8.5	20.0
Exercising to prevent osteoporosis also improves the way your body looks	80.8	3.8	15.4
Regular exercise cuts down the chances of broken bones	51.5	16.9	31.6
You feel good about yourself when you exercise to prevent osteoporosis	68.5	1.5	30.0
Calcium Benefits			
Taking in enough calcium prevents problems from osteoporosis	83.1	4.6	12.3
You have lots to gain from taking in enough calcium to prevent osteoporosis	78.5	1.5	20.0
Taking in enough calcium prevents painful osteoporosis	43.8	14.6	41.6
You would not worry as much about osteoporosis if you took in enough calcium	53.8	15.4	30.8
Taking in enough calcium cuts down on your chances of broken bones	74.4	6.2	19.4
You feel good about yourself when you take in enough calcium to prevent osteoporosis	58.9	1.6	39.5

Exercise Barriers			
You feel like you are not fit enough to exercise regularly	11.5	82.3	6.2
You have no place where you can exercise	3.8	90.0	6.2
Your spouse or family discourages you from exercising	0.0	95.4	4.6
Exercising regularly would mean starting a new habit which is hard for you to do	17.7	70.8	11.5
Exercising regularly won't fit in your daily routine	10.0	73.4	16.2
Exercising regularly makes you uncomfortable	4.6	87.7	7.7
Calcium Barriers			
Calcium rich foods cost too much	21.5	55.4	23.1
Calcium rich foods do not agree with you	11.5	70.0	18.5
You do not like calcium rich rood	7.0	81.5	11.5
Eating calcium rich foods means changing your diet which is hard to do	13.1	70.0	16.9
In order to eat more calcium rich foods, you have to give up other foods that you like	4.7	83.8	11.5
Calcium rich foods have too much fat	9.2	64.6	26.2
Health Motivation			
You eat a well-balanced diet	64.6	12.3	23.1
You look for new information related to health	69.0	8.5	22.5
Keeping healthy is very important for you	94.4	0.0	5.6
You try to discover health problems early	70.0	6.9	23.1
You have a regular health check-up even when you are not sick	15.4	67.7	16.9
You follow recommendations to keep healthy	71.5	7.7	20.8