THE INFLUENCE OF MENOPAUSAL STATUS AND DIETARY BEHAVIOUR PRACTICES ON BONE HEALTH STATUS AMONG POSTMENOPAUSAL CHINESE WOMEN IN KOTA BHARU, KELANTAN

by

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ABSTRAK

Osteoporosis merupakan suatu gangguan rangka tulang bercirikan jisim tulang yang rendah dan kemerosotan mikrostruktur jisim tulang, di mana ia akan meningkatkan kerapuhan tulang dan kecenderungan terhadap kepatahan tulang terutama dalam kalangan wanita semasa menopaus, susulan dari kehilangan jisim tulang secara berlebihan yang menyebabkan mereka mempunyai risiko tinggi terhadap osteoporosis. Oleh itu, modifikasi amalan pemakanan adalah penting untuk mengelakkan kehilangan jisim tulang yang berlebihan dalam kalangan wanita menopaus. Tujuan kajian ini adalah untuk mengkaji pengaruh status menopaus dan amalan tingkah laku pemakanan mengenai status kesihatan tulang dalam kalangan wanita Cina menopaus berusia antara 51 hingga 78 tahun di Kota Bharu, Kelantan. Seramai 73 wanita pasca menopaus Cina telah menyertai kajian ini. Beberapa soal selidik telah digunakan untuk mendapatkan maklumat mengenai ciri-ciri sosio-demografik, status kesihatan umum,amalan tingkah laku pemakanan dan amalan gaya hidup yang lain, manakala jisim tulang bagi seluruh badan, paha proksimal dan tulang belakang lumbar (L2-L4) diukur menggunakan dua peranti absorptiometry X-ray tenaga (DXA). Min umur peserta ialah 57.2 tahun, dengan majoriti peserta kajian (67.1%) berada dalam julat normal bagi indeks jisim tubuh (IJT). Selepas pelarasan penuh untuk usia, YSM dan BMI dalam analisis multivariat kovarians (ANCOVA), keputusan menunjukkan bahawa mereka yang melaporkan penggunaan supplemen kalsium dan vitamin D yang tinggi dalam seminggu mempunyai kandungan BMD tulang belakang lumbar yang lebih tinggi berbanding dengan wanita yang tidak mengambil supplementambahan ini. Penemuan ini menunjukkan bahawa amalan pengambilan vitamin D dan kalsium supplemen memberi kesan positif terhadap kesihatan tulang dalam kalangan wanita menopaus Cina, seterusnya

dapat membantu untuk mengurangkan risiko kehilangan tulang yang tinggi dan risiko keretakan osteoporosis.

ABSTRACT

Osteoporosis is a skeletal disorder characterized by low bone mass and micro architectural deterioration of bone tissue, which consequently increase in bone fragility and susceptibility to fracture especially in postmenopausal who is considered as higher risk of osteoporosis due to excessive loss of bone mass. Therefore, understanding the modifiable factors of dietary practices is important to prevent excessive bone loss among postmenopausal women. The aim of the present study was to examine the influence of menopausal status and dietary behavioral practices on bone health status among postmenopausal Chinese women aged 51 to 78 years in Kota Bharu, Kelantan. A total of 73 postmenopausal Chinese women had completed the study. A piloted questionnaires was used to assess the socio-demographical status, general health status, dietary intake and behavioral practices, and lifestyle practices, whereas bone masses of the total body, proximal femur and lumbar spine (L2-L4) were assessed using a dual energy *X*-ray absorptiometry device (DXA). Mean age of the participants were 57.2 years, with majority of them (67.1%) achieved the normal ranges of body mass index (BMI). After full adjustments for age, YSM and BMI, multivariate analysis of covariance (ANCOVA) showed that nutritional supplement use of weekly calcium and vitamin D status had significant higher lumbar spine BMD levels that that of those who did not consume The finding suggesting that weekly consumption of nutritional supplement of calcium and/or vitamin D provide beneficial and positive impacts on bone mass among postmenopausal Chinese women consequently could help to reduce the risk of excessive bone loss and the risk of osteoporotic fractures.

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LISTS OF ABBREVIATION

ANCOVA : Analysis of covariance

BMC : Bone mineral content

BMD : Bone mineral density

BMI : Bod y mass index

BA : Bone area

CI : Confidence interval

DMARD : Disease modifying antirheumatic drugs

DEXA : Dual energy *X*-ray absorptiometry

HDL : High-density lipoprotein

HRT : Hormone replacement therapy

MS : Metabolic syndrome

PA : Physical activity

PTH : Parathyroid hormone

RNI : Recommended nutrient intake

SHS : Second hand smoke

WHO : World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background

Osteoporosis is regarded as skeletal disorder characterized by low bone mass and micro architectural deterioration of bone tissue, which consequently increase in bone fragility and susceptibility to fracture (WHO, 2001). The disease often develops unnoticed over many years, with no symptoms or discomfort until fracture is occurred. The most common skeletal sites of osteoporotic-related fracture occur at hip, vertebral and wrist in which it afflicts elderly population especially the postmenopausal women (Johnell & Kannis, 2006).

Hip fracture is a major public health problem among postmenopausal women and elderly, in which it has been regarded as the most serious and debilitating health consequences that has been found to be significantly associated with higher risk of morbidity and mortality (Dontas & Yiannakopoulos, 2007; Johnell & Kannis, 2004; Suzuki, 2001). Hip fractures lead to an overall 12% to 20% reduction in expected survival with 5% to 20% excess mortality within the first year after the fracture (Sernbo & Johnell, 1993). Although hip fracture is accounted for less than 20% of all osteoporotic fractures (Johnell & Kanis, 2006), they are accounted for the majority of fracture-related health care costs and mortality in men and women aged 50 years and above. For instance, in the United Kingdom, the mortality risk for elderly patients with

hip fracture was 9.6% at the 30 days and 33% in subsequent year due to fracture and medical-related complications such as chest infection and heart failure (Roche *et al.*, 2005). The devastating complications associated with hip fractures create medical and financial burdens for society.

Lifetime risk of any osteoporotic fracture is reported to be high in both women and men, especially those at postmenopausal age and elderly aged above 50 years old and the risk of osteoporotic fractures is found to be approximately 40-50% and 13-22% respectively (Johnell & Kanis, 2005). Based on the world wide projection of osteoporotic-related fractures, it is estimated that the prevalence of osteoporotic fractures in Asia is increasing rapidly due to high proportion of ageing population. It is projected that about 3 million or more postmenopausal women and elderly in Asia is expected to suffer from hip fractures by the year of 2050 (Cooper *et al.*, 1992).

Osteoporotic fractures also affect the quality of life of affected individual. Elderly with vertebral fracture may suffer from increased back pain, impairment of mobility, functional limitations, social isolation and depression (Ross, 1997). Osteoporotic fractures are also associated with long term hospitalization and high expenses as a result of the rehabilitation costs. For example, it is estimated that direct annual costs attributed to osteoporotic fractures is about USD 20 billion dollar annually in the United States, and this costs is expected to rise substantially with the dramatic increase in aging populations by year 2050 (Burge *et al.*, 2007).

Although it has been clearly documented that genetic factors play an important role in the development risk of osteoporosis, but other risk factors such as dietary and physical activity are also important to prevent the risk of osteoporotic fractures. As Malaysia is heading towards becoming a developed nation, the population also begin adapt an affluent diet and sedentary lifestyle. Convergence of dietary practices results in high prevalence of obesity and diet-related non-communicable diseases worldwide including in Malaysia. Based on the food balance sheet from 1996 to 2007 respectively, there is an upward trend in the availability of calories from animal products and continual increase in the availability of sugar and sweeteners (Khor, 2012).

Asian populations have been associated with low dietary calcium intake and low physical activity which are often associated with low bone mass. Apart from a dietary behavior practices, bone health is also determined by non-modifiable factors such as genetic, gender and menopause. Modifiable lifestyle practices such as physical activity cigarette smoking and alcohol consumption are also associated with bone mass preservation in elderly and postmenopausal women. These risk factors do not affect bone mass in a parallel manner throughout life, but they exert their effects on bone mass in a complicated and interwoven manner. In order the effort to curb osteoporosis, a dietary based strategy can be implemented through a better understanding of the dietary behaviors and the nature of the menopause among postmenopausal Chinese elderly women.

1.2 Problem Statement

As the ageing population has increased dramatically worldwide, including in Malaysia, osteoporosis is emerging as an important public health problem globally. Worldwide prevalence of osteoporosis show that more than 8.9 millions fractures annually in which approximately one-fifth of the total of all osteoporotic fractures (17.4 %) is reported in elderly populations from South-East Asia (**Table 1**) (Johnell & Kanis, 2006). Moreover, the number of osteoporotic fractures is projected to increase dramatically to more than 3-fold over the next 50 years in both men and women, particularly in Asia (Cooper *et al.*, 1992)

In the recent report from the United Nation (2009), it is estimated that the total of elderly population 60 years is expected to increase double fold to 3.4 million by year 2020 (United Nation, 2009), in which majority of them are from the developing countries, including Malaysia. In Malaysia, there is a transition of age where the population structure shows significant decrease in the number of younger age and an increase in older age group. The number of elderly populations aged 60 and above has been steadily increasing for past 50 years. Based on the population spur, the number of elderly people is likely to increase up to 3.4 million by year 2020 (Mat & Taha, 2003). The rapidly increasing number of elderly populations has far-reaching implications to the public health system.

Older adults aged 50 years and above, particularly postmenopausal women are regarded as population of high risk of developing osteoporosis. Postmenopausal women lose

Table 1. Estimated number of osteoporotic fractures by site, in men and women aged 50 years or more in 2000, by WHO region

Expected number of fracture site (thousands)					All osteoporotic fractures	
	Proximal					
WHO region	Hip	Spine	Humerus	Forearm	No.	%
Africa	8	12	6	16	75	0.8
Americas	311	214	111	248	1406	15.7
South-East Asia	221	253	121	306	1562	17.4
Europe	620	490	250	574	3119	34.8
Eastern Mediterranean	35	43	21	52	261	2.9
Western Pacific[a]	432	405	197	464	2536	28.6
TOTAL	1672	1416	706	1660	8959	100

[a]Include Australia, China, Japan, New Zealand and the Republic of Korea

(Source: Johnell & Kanis, 2006)

bone at a rate of 2–3% annually after the age of 50 years (Navaratnarajah & Jackson, 2013). For instance, in a study of hip fracture incidence among Malaysian population aged 50 and above, it was found that females from major ethnic groups namely Malay, Chinese and India were reported to have significantly higher risk of hip fracture than their male counterparts (Lee & Khir, 2007). Moreover, Chinese was reported to be the highest risk of hip fracture rates of 160 per 100,000 persons, followed by Indians (150/100000) and Malays (30/100,000) respectively (Lee & Khir, 2007). In addition, Chinese elderly population has made up the highest elderly proportion in the country and they have been associated with the characteristics of low mortality rates and high

life expectancy compared to other ethnic groups (Mat & Taha, 2003). According to Kannis *et al.*, (2012), Malaysia is categorized in moderate category for the age standardised annual incidence of hip fractures in women. For every 100,000, it is reported that approximately 200-300 women will experience hip fracture each year.

1.3 Significance of the study

Malaysia is a multicultural country with vast variety of dietary food and cultures. Different ethnic groups have different susceptibility to certain illness due to different dietary and lifestyle practices apart from the genetic susceptibility to certain disease (Lee and Khir, 2007; Suzuki, 2001). Although genetic factor is highly associated with the increased risk of osteoporosis (Pocock *et al.* 1987), other modifiable environment factors such as dietary and lifestyle practices are considered as important factor to reduce the risk of osteoporosis among postmenopausal women and elderly. Numerous studies carried out among Asian elderly and postmenopausal women such as in Hong Kong and in Japan had shown that unhealthy and inadequate nutrient intakes is significantly associated with higher risk of osteoporosis. For instance, low habitual dietary calcium intake was significantly associated with higher risk of osteoporotic hip fractures (Suzuki, 2001; Lau *et al.*, 2001). Similarly, findings was also reported among Chinese postmenopausal women aged between 50 and 65 years old in Malaysia, showed that the mean calcium intake was approximately 499 mg/day was far less than the Recommended Nutrient Intake (RNI) for calcium intake which is 800 mg for elderly population aged 51 to 65 years (Chee *et al.*, 2002).

A spur of industrialization and urbanization in recent decades has brought dramatic changes in dietary habits and lifestyle practices. Societies converged on a diet high in fats, sugar and sweeteners, energy-dense, processed and low fibre food together with increased sedentary lifestyle are found to be significantly associated with higher risks of non-communicable diseases (Noor, 2002). For example, poor dietary habits which are characterized by high consumption of energy-dense, fat and sugar foods attributed to increased frequency of eating out, food purchasing and affluent food consumption patterns along with increased trend of inactive lifestyle practices are significantly associated with higher risk of non-communicable disease (Noor, 2002).

Apart from affluent dietary practices, physiological changes associated with aging in elderly affect their nutrition status. Aging is accompanied by deterioration of bodily functions and physiological processes such as impaired absorption of certain micronutrients such calcium and vitamin D and decreased ability to synthesize vitamin D, decreased muscle mass and bone mineralization has made elderly a vulnerable to osteoporosis (Elmadfa & Meyer, 2008). Changes in appetite due to several reasons such as decreased taste, smell and visual acuity and dry mouth has contributed to decrease in food intake. Thus, elderly population is vulnerable to malnutrition and micronutrient deficiency due to long term inadequate food intake or poor diet habit (Das *et al.*, 2012; Marshall *et al.*,2001). In addition, nutritional deficiencies in particularly insufficiency of calcium and vitamin D have been reported among elderly women (Gennari, 2001; Leite *et al.*, 2003). Therefore, under nutrition is often observed in

elderly and this makes dietary factor likely to be a significant contributing factor to the pathogenesis and outcome of hip fracture in the elderly.

1.4 Objectives of the study

1.4.1 General objective:

To determine the influence of menopausal status and dietary behavioral practices on bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan.

1.4.2 Specific objectives:

i. To determine the influence of menopausal status on bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan

ii. To determine the influence of milk and dairy food consumption on bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan

iii. To determine the influence of other dietary behavioral practices of breakfast and snacking consumption on bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan

iv. To determine the influence of tea, coffee and carbonated beverages consumption on bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan

v. To determine the influence of nutritional supplements use on bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan.

1.5 Null Hypotheses

i. There was no significant difference between menopausal status and bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan

ii. There was no significant difference between milk and dairy food consumption and bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan

iii. There was no significant difference between other dietary behavioral practices of breakfast consumption and snacking and bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan.

iv. There was no significant difference between tea, coffee and carbonated beverages consumption and bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan.

v. There was no significant difference between nutritional supplements use and bone health status among postmenopausal Chinese women in Kota Bharu, Kelantan.

1.6 Conceptual Framework of the study

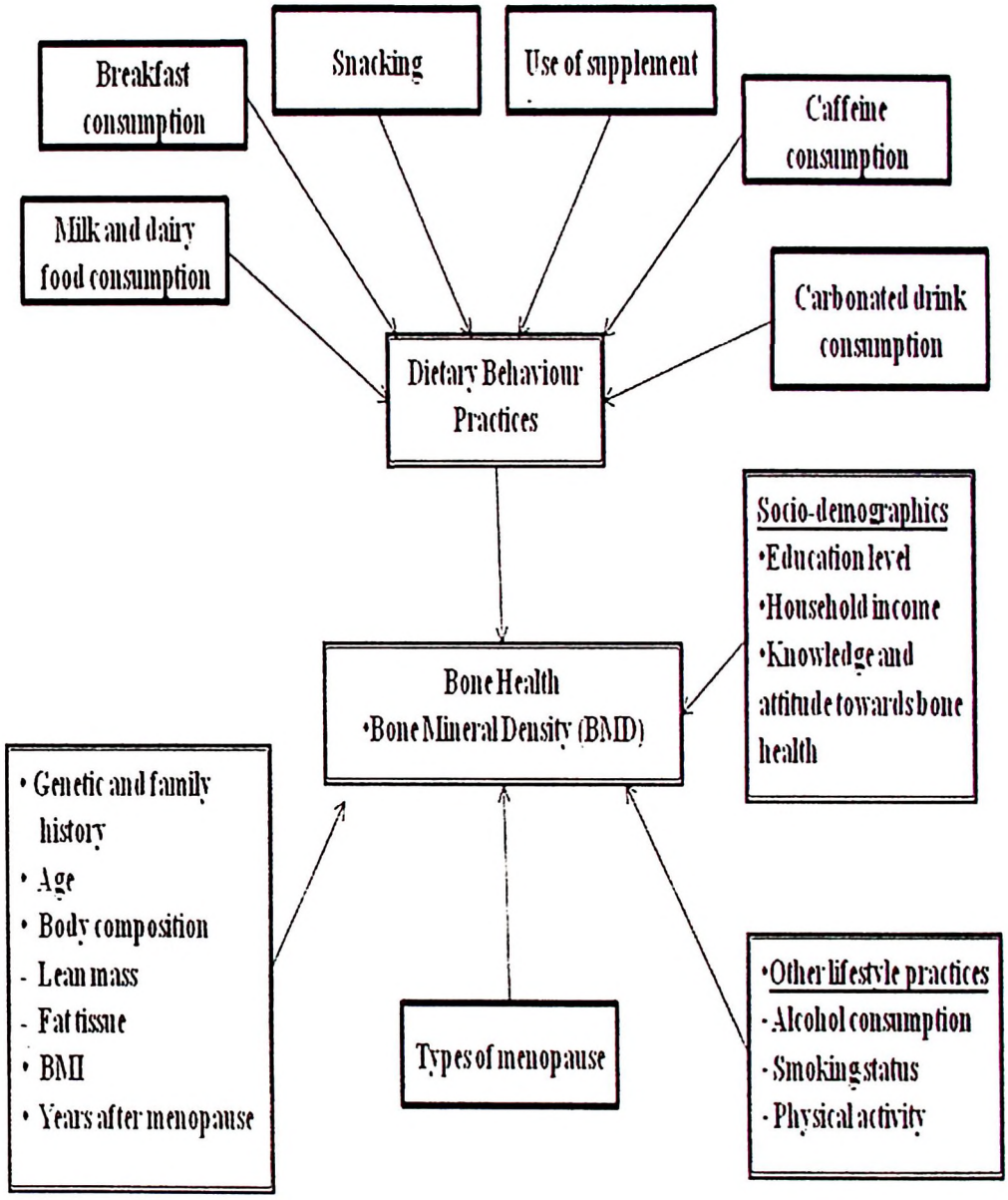

Figure 1. A conceptual framework of the study

CHAPTER 2

LITERATURE REVIEW

2.1 Magnitude and severity of osteoporosis

As the ageing population has increased dramatically worldwide, osteoporosis has becomes increasingly important public health problem worldwide. It is estimated that the total of elderly population 60 years is expected to increase double fold to 3.4 million by year 2020 (United Nation, 2009), in which majority of them are from developing countries, including Malaysia. It is reported that osteoporosis causes more than 8.9 millions fractures annually worldwide in which 17.4 % of the total of all osteoporotic fractures come from South-East Asia (Johnell & Kanis, 2006). The four most common osteoporotic fractures are hip, vertebra, humerus and forearm. The number of osteoporotic fractures is speculated to increase by more than 3-fold over the next 50 years in both men and women, in which the majority of fractures will occur particularly in Asia and Latin America.

In Malaysia, there is a transition of age where the population structure shows significant decrease in the number of younger age and an increase in older age group. The number of elderly populations aged 60 and above has been steadily increasing for past 50 years. Based on the population spur, the number of elderly people is likely to increase up to 3.4 million by year 2020 (Mat & Taha, 2003). The rapidly increasing number of elderly

populations has far-reaching implications to the public health system. Older adults aged 50 years and above, particularly postmenopausal women are regarded as population of high risk of developing osteoporosis. After the age of 50 years postmenopausal women lose bone at a rate of 2–3% annually (Navaratnarajah & Jackson, 2013).Thus, incidence of fractures are higher in women compared to men at age 50 years and above (Van Staa *et al.*, 2001). For instance, in a study of hip fracture incidence among Malaysian population aged 50 and above, it was shown that females in all ethnic groups have significantly greater number of hip fracture than men (Lee & Khir, 2007). Besides, race-specific incidence data showed that the fracture rates are highest among the Chinese in which in 100000 people, there will be 160 elderly experience hip fracture followed by Indians and Malays which are 150 and 30 elderly respectively (Lee & Khir, 2007). In addition, Chinese elderly population has made up the highest elderly proportion in the country and they have been associated with the characteristics of low mortality rates and high life expectancy compared to other ethnic groups (Mat & Taha, 2003). Fractures at certain sites such as hip, vertebra and pelvis showed significant increase in incidence with age (Van Staa *et al.*, 2001). Radius ulna fracture which is more common in female also shows significant increase with advancing age (Van Staa *et al.*, 2001).

2.2 Bone growth and development throughout the life spans

Bone undergoes longitudinal and radial growth, modeling and remodeling during lifetime. Bone growth and development occur during childhood and adolescent. Modeling is the process whereby bone experience changes in shape to adapt to physiological influences or mechanical forces. Bone remodeling is the process of

renewing the bone to maintain bone strength and mineral homeostasis. This process involves resorption of old bone followed by formation of new bone to prevent bone microdamage. Bone remodeling is increased in perimenopausal and postmenopausal women (Clarke, 2008).

Bone grows in both length and width during the first two decades of life. Throughout infancy and young adulthood, bone formation predominates over resorption, thus causing a steady accumulation of bone mass to achieve peak bone mass. During pubescent growth spurt, almost half of the adult skeletal mass is gained. After puberty, bones continue to increase in thickness and density into young adulthood to achieve peak bone mass. During middle adulthood, bone resorption predominates over formation result in steady loss of bone mass which is particularly significant in postmenopausal women in their first 5-15 years after menopause.

In women, bone loss leading to osteoporosis can be grouped into menopausal bone loss and non-menopausal (age-related) bone loss. Age-related or non-menopausal bone loss includes that caused by decreased physical activity, changes in nutritional intake and requirements and any effects secondary to menopause. The large decline in bone mass associated with menopause is also a major factor contributing to the development of osteoporosis. Therefore, women experiencing early menopause have an increased risk of developing osteoporosis.

2.3 Risk factors associated with bone health in older adults

2.3.1 Genetic factor

Osteoporosis is a common disease with a strong genetic component. Twin and family studies have shown that genetic factors play an important role in regulating bone mineral density and other determinants of osteoporotic fracture risk, such as ultrasound properties of bone, skeletal geometry and bone turnover. Studies in twins and families indicate that genetic factors play an important role in the regulation of BMD and other determinant of osteoporotic fracture risk.

The heritability of BMD has been estimated to lie between 50% and 85% in twin studies, with the strongest effects in the axial skeleton (Pocock *et al.* 1987, Christian *et al.* 1989, Flicker *et al.* 1995). In the twin study by Pocock *et al.*, (1987), lumbar spine and proximal femur bone mineral density and forearm bone mineral content were measured by photon absorptiometry in 38 monozygotic and 27 dizygotic twin pairs. Bone mineral density was significantly more highly correlated in monozygotic than in dizygotic twins for the spine and proximal femur and in the forearm of premenopausal twin pairs, which is consistent with significant genetic contributions to bone mass at all these sites. The smaller genetic contribution to proximal femur and distal forearm bone mass compared with the spine suggests a greater potential for lifestyle intervention in achieving a reduction in the incidence of hip and forearm fractures. Family-based studies also report strong heritability for BMD (Gueguen *et al.* 1995), with maximal effects in young adults and persist even after adjusting for lifestyle factors that are known to regulate BMD (Krall & Dawson-Hughes 1993). In another study of Finnish

twin study, it found that susceptibility to osteoporotic fractures in elderly was not strongly influenced by genetic factors, especially in elderly women (Kannus *et al.*, 1999). Therefore, strategy for prevention of osteoporotic fractures should be focus on increasing peak bone mass and preventing accelerated bone loss through modifiable factors such as dietary intake and physical activity.

2.3.2 Menopausal status

Premature menopause refers to menopause that occurs before age 40 years, and early menopause refers to menopause that occurs at or before age 45 years, both ranges being well below the median age of natural menopause (age 51 years). Premature menopause or early menopause can be spontaneous or induced. Induced menopause can be due to medical interventions surgical interventions such as bilateral oophorectomy. Regardless of cause, women who experience estrogen deficiency at an age well before the median age of natural menopause are associated with higher risk of osteoporosis. Menopause triggers a rapid phase of bone loss in women as the results of loss of ovarian function that secrete estrogen. During the menopausal transition, serum estradiol levels fall to 10% to 15% of the premenopausal level (Melton *et al.*, 1997).

Postmenopausal bone loss seems to have a biphasic pattern with a transient accelerated phase (estrogen-dependent) and a protracted slow phase (age dependent).The average bone loss during the accelerated phase is estimated to be 2%-3% per year (Hansen *et al.*, 1991). The accelerated bone loss phase occurs 8-10 years after the menopause (Riggs & Melton, 1986).

Menopause occurs naturally or through surgical. Surgical menopause happens when both ovaries are removed (bilateral oopherectomy) through surgical procedures. Ovary is a one of the reproductive sexual organs that produce estrogen. This will cause tremendous decline in estrogen level. Women with early menopause have significantly lower bone mineral density compared to women with later menopause (Knitz-Silverstein & Barrett-Connor, 1993). Early menopause remain significant independent predictor of reduced bone mineral density even after adjusted for age, obesity, cigarette smoking, past oral contraceptive use, number of pregnancies, bilateral oopherectomy, use of estrogen and thiazide medication. Similar results were also observed when a regression analysis was restricted to women with natural or surgical menopause. Gardsell *et al.* (1991) found that among women aged 50 to 69 years, those who reported that menopause occurred before age 46 had significantly lower initial bone mass and will have higher risk of experiencing fragility fracture in the following years.

2.3.3 Body composition factors

Low Body Mass Index is an important risk factor associated with low bone mass and increased bone loss among postmenopausal women. In a 2 years prospective study, it was found that there was a significant association between thinness, low bone mass, and increased postmenopausal bone loss independent of age and years since menopause. Women in the lowest tertile of percentage of body fat or body mass index has 12% lower baseline spine and hip BMD and 2-fold greater bone loss compared to those in the highest tertile ($p<0.001$) (Ravn *et al.*, 1999). Stronger relationship is observed between BMI and BMD than between percentage of body fat and BMD in which the

strength of correlation between BMI and BMD are reported to be the strongest at hip followed by spine and forearm. Besides, positive effect of body weight per se on BMD has more pronounced effect at weight bearing skeletal regions such as hip and spine. Postmenopausal women with lower BMI have low bone mass and experienced rapid bone loss, both of which are independent contributing factors to an increased risk of postmenopausal osteoporosis.

2.4 Dietary behavior practices

2.4.1 Milk and dairy food intakes

There were limited information on the influence of habitual milk and dairy foods on bone mass among older Asian populations, who have low habitual calcium intakes. Asian diet is low in calcium content due to low milk and dairy food consumption. This is evidenced by the mean daily calcium intake among postmenopausal Chinese women was approximately 450 mg daily (Chee *et al.*, 2002). In the same study, it was also shown that only 26% of calcium intake was derived from milk and dairy food sources. Studies had shown that a low calcium intake may be associated with the risk of both hip (Lau *et al.*, 2001) and vertebral fracture. Habitual higher milk and dairy food intake is significantly associated with higher bone mass and lower risk of osteoporotic fractures in Caucasian postmenopausal women and elderly (Włodarek *et al.*, 2012). Based on a meta-analysis of cohort studies in middle-aged or older men and women, it was shown that in women (6 studies, 195,102 women, 3574 hip fractures), there was no overall association between total milk intake and hip fracture risk (pooled relative risk per glass

of milk per day=0.99; 95% confidence interval [CI] 0.96–1.02; Q-test p=0.37) (Bischoff-Ferrari *et al.*, 2011).

A lack of overall association between total milk intake and hip fracture risk in women can be explained by several possible explanations such as an imperfectly measured milk intake in the cohort studies in which there was lack of uniformity of intake measurement and an update of intake. Another possible explanation is that patients with diagnosed osteoporosis generally are advised to increase their calcium intake. In a recent study by Sahni *et al.*, (2013), it was suggested that not all dairy products are equally beneficial to bone health. In the study, it was found that fluid dairy intake, specifically milk, and yogurt intakes were associated with hip but not spine bone mineral density (BMD), while cream may adversely influence BMD.

In Malaysia, milk supplementation study reported that supplementation of high calcium milk significantly reduced the percentage of bone loss at the total body, lumbar spine, femoral neck and total hip compared to the control group ($p<0.001$) (Chee *et al.*,2003). Study conducted by Lau *et al.*, (2001) among postmenopausal Chinese women had shown that supplementation with high calcium milk powder retards bone loss. Serum parathyroid hormone (PTH) concentration was reported lower and serum 25-hyroxyvitamin D [25(OH) D] level was higher in the milk supplementation group than the control group at 12 months ($p < 0.05$ by paired *t*-test). Out of all the studies in this meta-analysis, only a study from Sweden showed positive association between high

milk intake and reduced risk of hip fracture. It was shown that higher milk intake associated with a 5% reduced risk of hip fracture per daily glass of milk.

Therefore, to sum it all, milk supplementation has no effect in reducing and preventing hip fracture risk but it has beneficial effects in slowing or retarding bone loss at various bone sites.

2.4.2 Breakfast Consumption

Breakfast is defined as the first meal of the day, eaten before or at the start of daily activities (e.g., errands, travel, work) characterized by its consumption within 2 hours after waking and no later than 10:00 am, and a calorie intake between 20% and 35% of total daily energy needs. Several studies in children and adolescents have found that breakfast skipping has been frequently associated with co-occurring health-compromising behaviors and the risk of obesity (Nurul-Fadhilah *et al.*, 2013) whereas regular breakfast consumption is associated with health conscious lifestyle (Cavadini *et al.*, 2000).

Analyses of behavioral data suggested that eating breakfast helped reduce dietary fat and minimize impulsive snacking (Schlundt *et al.*, 1992). In addition, breakfast skipping has also been linked to poorer overall dietary quality may possibly caused the development of chronic disease including osteoporosis. The role of breakfast consumption on chronic disease morbidity and mortality was well documented in a few studies. It was shown that there was positive association between regular breakfast intake (i.e., cereals and whole-grain foods) and reductions in morbidity and mortality

from a variety of causes (Jacobs *et al.*, 1998; Kaplan *et al.*, 1987). There is emerging evidence suggesting that regular breakfast consumption has inversely associated with reduced risk of obesity and chronic disease. Clinical studies in humans have consistently found that increased meal frequency will promote changes in metabolism that may improve risk factors for chronic disease (Farshchi *et al.*, 2004) and reduce appetite and energy intake (Jenkins *et al.*, 1994; Farshchi *et al.*, 2005). Previous studies also show that overeating is frequently linked with skipping breakfast (Keski-Rahkonen *et al.*, 2003, Niemeier *et al.*, 2006).

2.4.3 Snack consumption

Snacks are food that is consumed in between main meals. Recently, the consumption of high calorie junk food has increased and this has contributed to weight gain among adults (Drummond *et al.*, 1996). Increased snacking may be associated with a greater risk of energy imbalance and increased overweight and obesity. Energy intake has been found to increase with snacking frequency in both males and females, irrespective of physical activity. Obesity is one of the cluster risk factor of metabolic syndrome (MS) which include abdominal obesity, high glucose, triglycerides, hypertension and low HDL levels, associated with cardiovascular disease morbidity. The association between components of the MS and BMD has been researched, but results are contradictory. Incidence of osteoporotic non-vertebral fractures was reported to be higher in participants with metabolic syndrome (Von Muhlen *et al.*, 2007).

2.4.4 Caffeinated beverages (tea and coffee) consumption

Dietary caffeine intake is one of the proposed risk factor for bone loss among postmenopausal women. However, most of the observational studies do not support the notion that caffeine-containing beverage consumption was associated with reduced bone mass and increased fracture risk. Human physiological studies have shown the effect of caffeine on intestinal calcium absorption is relatively small, and no effect on total 24-h urinary calcium excretion. In other studies, negative calcium balance found without detecting any increase in urinary calcium excretion after a high intake of caffeine might be caused by the decrease intestinal calcium absorption with age (Heaney, 2002). Furthermore, the negative effect of dietary caffeine on bone health status found in some of the epidemiologic studies can be clarified through the inverse relationship between consumption of milk and caffeine-containing beverages. It is likely that a high caffeine intake displaces milk and dairy food from the diet and thus results in a low calcium intake. Low calcium intake is clearly linked to skeletal fragility. The negative effect of caffeine on calcium absorption is small enough to be fully offset by daily milk intake.

In a 1 year randomized clinical trial, effects of caffeine consumption at two different calcium intakes bone loss from the lumbar spine and total body among healthy nonsmoking women were examined. It is shown that daily consumption of caffeine in amounts equal to or greater than that obtained from about two to three servings of brewed coffee per day or five to seven servings of instant coffee, depending on serving size, appears to accelerate bone loss from the spine and total body in women with low

calcium intakes (Harris & Dawson-Hughes, 1994). Meanwhile, in a cross sectional study conducted by Lloyd *et al.* (1997), the study concluded that the habitual dietary caffeine intake of postmenopausal women ranged from 0-1400 mg/d and was not associated with total body or hip bone mineral density measurements. All of the observations implicating caffeine-containing beverages as a risk factor for osteoporosis have been made in populations consuming substantially less than optimal calcium intakes. There is no evidence that caffeine has any harmful effect on bone status or on the calcium economy in individuals who ingest the currently recommended daily allowances of calcium.

2.4.5 Carbonated beverages consumption

The effect of carbonated beverages on bone health lies not in what carbonated beverages contain, but in what they do not have, which is the nutrients needed for bone health. The exact mechanisms in how carbonated beverages affect the bone health are still not established. According to Heaney and Rafferty (2001), the excess calciuria associated with consumption of carbonated beverages is confined to caffeinated beverages whereas acidulant type has no acute effect. They concluded that the net effect of carbonated beverage constituents on calcium homeostasis is negligible and that the skeletal effects of carbonated beverage consumption might be caused by milk displacement from the dietary intake. In the study conducted by Tucker et al. (2006), it is shown that intake of cola, but not of other carbonated soft drinks, is associated with low BMD in women. Cola intake was associated with significantly lower ($P< 0.001–0.05$) BMD at each hip site in women. In comparison to those who consume less than 1

serving of cola per month, the mean BMD of those with daily cola intake was 3.7% lower at the femoral neck and 5.4% lower at Ward's area.

2.4.6 Dietary calcium and vitamin D supplements

Calcium is one of the most studied nutrients in bone health aspect. Adequate calcium intakes throughout life are needed to attain maximal peak bone mass and prevent bone loss at older ages. The beneficial effect of calcium intake on bone mass in postmenopausal women may be influenced by age, number of years since menopause, baseline calcium intake before supplementation, and possibly physical activity level. In addition, the effect of calcium may be stronger at the sites with more cortical bone in elderly and late postmenopausal women, and in women with low baseline calcium intakes. Calcium intake is particularly important in postmenopausal and elderly women because lack of calcium is associated with reduced bone density. Low calcium intake has been reported to be one of the risk factors for osteoporosis amongst Asian women (Lau *et al.*, 2001). Many studies have shown a beneficial effect of calcium intake in reducing the rate of bone loss in postmenopausal Caucasian women (Włodarek *et al.*, 2012). However, studies in Asian populations were limited. Calcium supplementation has been shown to be effective in retarding bone loss in postmenopausal women. In a study by Dawson-Hughes *et al.* (1997), three years of dietary supplementation with calcium and vitamin D moderately reduced bones loss at femoral neck, spine and total body and also reduce incidence of non-vertebral fracture among men and women aged 65 years and older. This is supported by the Women's Health Initiative (WHI), a double blind, placebo-controlled clinical trial, it is concluded that long-term use of calcium