OSTEOPOROSIS PREVENTION EDUCATION FOR ADOLESCENTS.

A Systematic Review of the Literature.

By

LYNLEY ANN PAPADOPOULOS. RN, BHSc (Nursing), Pg Cert

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Faculty of Health and Environmental Studies

Primary Supervisor: Caryn Zinn
Senior Lecturer
Division of Sport and Recreation
Auckland University of Technology

ATTESTATION.

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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L.A PAPADOPOULOS

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ABSTRACT.

Osteoporosis is known as the silent disease as it is often not diagnosed until an individual presents with a low impact fracture. Many people of all ages appear to be unaware of the risk factors and preventive behaviours. Adolescence is a period of significant growth and change. It is during this time that the majority of bone mass is accumulated. Education to increase awareness of risk factors and preventive behaviours is identified as being paramount in helping to prevent the onset of this disease later in life. Studies reveal that adolescent diets are frequently lacking in calcium intake and levels of physical activity are lower than is recommended. These are two lifestyle factors that can help to improve bone density. Education on these factors can contribute significantly to reducing the risk of developing osteoporosis.

Results: The review indicates that there are poor levels of knowledge regarding osteoporosis among the adolescent population group. There are a small number of studies that include the older adolescent in the assessment of knowledge and even fewer studies that solely focus only on adolescents. Some studies include assessment of health beliefs and behaviours and in most cases an educational intervention has not lead to significant changes in these. In New Zealand, there have been no studies that examine the question of osteoporosis knowledge among adolescents. Only one study that was based in New Zealand was found that looked at the question of osteoporosis knowledge and this was in a group older than adolescents.

There are only a limited number of educational programmes available for the adolescent group. Most of these have been developed overseas. An evaluation of internet resources has demonstrated that these are not necessarily suitable in the reading level and the level of information provided. Some resources are available in New Zealand although there appears to be little in the literature that supports the use of these.

INTRODUCTION.

"Osteoporosis: A Paediatric Disease with Geriatric Consequences" (Hightower, 2000, p.59)

This study seeks to explore the significance of osteoporosis as a public health problem both internationally and nationally. A comprehensive background is provided for the reader to facilitate a better understanding of the disease and why the period of adolescence is of significance to implement health promotion strategies for future disease prevention.

The systematic review then seeks to investigate two aspects of osteoporosis education:

1) The current state of adolescent knowledge regarding osteoporosis
2) The range of osteoporosis prevention strategies for the adolescent population group.

This review will explore these aspects of osteoporosis education at the national (within New Zealand) and international level.

SEARCH STRATEGIES.

A comprehensive literature search was undertaken in order to construct this systematic review. Many academic databases were searched for material, as well as specific websites and other sources. Search strategies included the use of key words/phrases, names of instruments discussed in Part One of the review, and authors' names. Below is a summary of all sources used:

<u>Databases:</u>

- MEDLINE
- CINAHL
- Proquest
- Ebscohost
- GOOGLE Scholar
- Web of Knowledge
- Science Direct
- PubMed

<u>Key words/phrases used for searches within each database:</u>

- osteoporosis prevention education
- adolescents
- anorexia nervosa
- osteoporosis
- Health Belief Model
- Health Belief Model and osteoporosis
- Nutrition and adolescents
- Osteoporosis in New Zealand
- osteoporosis prevention
- Milk in Schools programme
- Bone density
- Orem's Self Care Theory

Instrument names:

- -Facts On Osteoporosis Quiz
- Osteoporosis Preventing Behaviours Survey
- Osteoporosis Health Belief Scale
- Osteoporosis Knowledge Test
- Osteoporosis Self-Efficacy Scale
- Healthy Bones Knowledge Questionnaire
- Multiple Osteoporosis Prevention Survey
- Calcium Quiz
- Cooper Institute Physical Activity Questionnaire
- Osteoporosis Risk Factor Questionnaire
- Physical Activity Questionnaire for Older Children
- Teenager's Nutrition Questionnaire
- The Smoking Behaviour Questionnaire

Psychometric Tools:

- Cronbach's alpha
- KR2- formula
- Pearson Product-moment correlation coefficient

Authors names:

- -Goulding, A
- Gibbons, M
- Faulkner,R
- Sedlak,C
- Bachrach,L

Websites:

- www.nof.org
- www.nichid.nih.gov
- www.jama.com
- www.who.int
- www.betterbones.com
- www.cdc.gov
- www.educationforhealth.net
- www.niams.nih.gov
- www.nhc.govt.nz
- www.orthonurse.org
- www.biomedcentral.com
- www.iofbonehealth.org
- www.acc.co.nz
- www.bones.org.nz

Other sources:

- Conference proceedings
- National Association of Orthopaedic Nurses (NAON) Osteoporosis Special Interest Group.

BACKGROUND.

Definition of osteoporosis.

Osteoporosis, like many diseases, has a general definition as well as more specific definitions by specialists in the field. In a general sense osteoporosis is defined as a disorder characterised by abnormal loss of bone density (Anderson, Anderson & Glanz, 1998). The World Health Organisation (WHO) defines it as a "systemic skeletal disease characterised by low bone density and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility"(World Health Organisation, 2003a,p.139) . The WHO breaks the definition of osteoporosis down even further to a bone density value that has been agreed upon by specialist clinicians in the field. Bone density is measured using dual energy x-ray absorptiometry (DEXA) which assigns a score known as a T-score (Gordon, Bachrach, Carpenter, Karsentry & Rauch, 2004). Normal bone density has a T-score that lies between +1 and –1 standard deviation for young adults. Osteoporosis has a statistical value that is -2.5 standard deviations below the standardised mean value for young adults (Schoen, 2001; Werner, 2005). To avoid confusion osteopenia is considered to have a T-score that is between -1 and -2.5 standard deviations below that standardised mean value for young adults (Schoen, 2001). Osteopenia is a condition of less than normal mineralised bone.

Pathophysiology of bone development.

Bone is a living, dynamic tissue that is constantly changing, growing and repairing itself. Skeletogenesis is the process through which bone is laid down, eventually forming a mature skeleton (Downey & Siegal, 2006). This is done by the laying down of the osteoid matrix by osteoclasts, followed by crystalline apatite being laid down.

Bone formation begins in the embryo during the second month of pregnancy, developing, like other connective tissue, from mesenchyme tissue (Anderson et al, 1998; Maher, Salmond & Pellino, 2002).In the 5th week of uterine life limb buds develop. This is followed by cartilaginous model of bone developing. From the 7th week to the 6th month of uterine life

there is cartilage and bone development. The development of a collagen matrix and calcium deposition leads to immature bone. The process of cartilage being replaced by bone is known as endochrondral bone formation (Downey & Siegal, 2006). By the 6th month the medullary canal of long bones is developed. Primary ossification centres are apparent in the middle of long bones between 6th and 16th weeks. (Schoen, 2001). When one is born, one has what are termed secondary ossification centres, located in the epiphyses of long bones. These centres appear just before birth and ossify in the late teenage years when skeletal maturity is reached. The purpose of these centres is to allow for continued bone growth after birth. During growth these areas, known as epiphyseal plates, maintain a constant thickness. As adolescence ends and adulthood begins, the cells in the plates divide less often and the plates become thinner and thinner until they are entirely made up of bone (Marieb, 2004). It is well documented that bone mass increases significantly during growth, and adolescence is seen as a key time when growth occurs (Gordon et al., 2004). The parathyroid hormone (PTH) is known to regulate calcium homeostasis by increasing the release of calcium from bone and resorption of this from the kidneys. It plays a significant role in formation and maintenance of bone (Downey & Siegel, 2006). Another endocrine function is that of the thyroid gland, which synthesises a polypeptide hormone known as calcitonin. Calcitionin has an inhibitory action on osteoclasts, thus lowering serum calcium levels (Downey & Siegel, 2006).Other hormones that influence bone growth and density include glucocorticoids, thyroid hormones (thyroxine and tri-iodothyronine) and oestrogens.

Maximum bone density is said to be attained by the age of 30 years (Schrader, Blue & Horner, 2005; Thomas, 2005). Ali and Siktberg (2001) state that maximum bone density is attained by the age of 20 years, but the majority concur with 30 years, or simply state “by early adulthood” without clarifying what that might mean (Portsmouth, Henderson, Graham, Price, Cole & Allen, 1994). Between 40% and 60% of peak bone mass is accumulated through the adolescent years (Golden, 2003). Peak bone mass is considered a determinant of bone mass later in life. It is believed that an increase in the peak bone mass at the period of skeletal maturity is directly

related to a decreased risk of osteoporosis related fractures (Ali & Siktberg, 2001; Gordon et al., 2004). Once peak bone mass has been achieved, there is a 1-2 % decline in bone mass each year until menopause. At this time, bone mineral density levels decrease rapidly due to low oestrogen levels (Golden, 2003). It has been estimated that women lose up to 40% of their total bone mass after menopause (Anderson, Chad & Spink, 2005). Oestrogen plays a significant role in minimising bone loss in women. This hormone works to protect the bones in three ways:

1) By suppressing osteoclastic activity and increasing the number of vitamin D receptors on osteoblasts.
2) Promoting renal reabsorption of calcium.
3) Helping to promote the intestinal absorption of calcium.

There is research to indicate that oestrogen promotes osteoblastic activity, increasing the growth of new bone and causing the thyroid gland to produce calcitonin, providing even more protection at a cellular level. The absence of oestrogen caused by the cessation of ovarian function alters skeletal homeostasis. This leads to a net loss of bone density in postmenopausal women (Maher et al., 2002).

According to Terrio and Auld (2002), there is an aspect of osteoporosis that is encouraging in that the disease is largely preventable by optimising peak bone mass in the younger years, maintaining bone mass throughout adulthood and minimising bone loss in the later adult years. These authors state that adequate calcium intake and weight- bearing physical activity have all been suggested to be effective strategies for building, maintaining and slowing loss of bone mass. Concurrent with this notion, Lau and Woo (1998) discuss studies that indicate low dietary calcium intake and lack of load bearing activity are important risk factors in the development of osteoporosis.

Significance of the problem internationally.

Osteoporosis is becoming recognised as a growing global public health problem (Sedlak, Doheny, Estok & Zellar, 2005; Winzenberg, Oldenburg, Frendin, De Wit & Jones, 2006). It has even been described as reaching epidemic proportions (Ribeiro, Blakeley & Laryea, 2000). In the US alone 24-28 million Americans have osteoporosis with 1.3 million fractures being attributed to the disease. This equates to 21% of postmenopausal women having the disease and 16% having associated fractures (Taggart & Connor, 1995; Ribeiro et al., 2000; Ali & Siktberg, 2001; Chan & Ko, 2006).

Recently osteoporosis has become a major health problem in Asia. In Hong Kong this disease is among the top five conditions that cause disability. More significantly, the mortality rate for fractures of the hip is estimated at 20%, while up to 70% of sufferers remain permanently disabled (Chan & Ko, 2006). These figures are consistent with data from the US where again the mortality is 20% and one third receive nursing home care in the first year after injury (Parsons, Faulkner & Krumweide, 2004). According to the International Osteoporosis Foundation (IOF) (IOF, 2007) the incidence of hip fractures has increased by 200 % over the last 20 years. Mainland China records a 300% increase over the last 30 years. Chan and Ko (2006) report that the risk of women suffering an osteoporosis-related fracture is higher that the combined risk of breast, endometrial and ovarian cancer, which demonstrates the significance of the problem. This is corroborated by Anderson and Chad (2005) who also state that although either gender can be affected, over 80% of osteoporosis sufferers are women.

Using the criteria determined by the WHO, it is estimated that 13-18% of women worldwide aged 50 and over have osteoporosis. If this prevalence of osteoporosis is confined to women over the age of 80 years of age, the value increases to 70 % (Werner, 2005). A WHO technical report (2003a) indicates that osteoporosis is three times more common in women, partly due to women having a lower peak bone mass than men as well as due to hormonal changes at menopause. Women also live longer than men, therefore have further reductions in bone mass.

According to WHO (2003a), the most serious osteoporotic fracture is that of the hip. A 1990 WHO report estimated that 1.3-1.7 million hip fractures occur world wide (WHO, 2003a). By 2025, this number is expected to increase significantly to almost 3 million, possibly higher. When one considers that in 1965 the estimated number of hip fractures was 500,000, the notion that osteoporosis has reached epidemic proportions is more easily understood. With the previously mentioned 20% mortality rate for fractures of the hip, this is significant. Within the European Union alone it is estimated that age related fractures will increase by up to 300% over the next 50 years, with hip fractures increasing by 135% (Compston, Papapoulos & Blanchard, 1998).

The IOF also reports a significantly higher rate of hip fractures among men in some Asian countries. In India the incidence of osteoporosis in men is estimated to be 1 out of 8 males and the incidence of hip fracture is 1 woman to 1 man. The peak age at which osteoporosis manifests is 70-80 years in most Western countries, however, in India it manifests among those younger, 50-60 years of age. Shatrugna, Kulkarni, Kumar, Rani and Balakrishna (2005) undertook a study of the nutritional status of Indian women from low-income groups. The study indicated that this group of people consumed a diet that was low in calcium and also contained insufficient protein and calories. Hospital studies revealed that these women experienced osteoporotic fractures at a younger age than their Western counterparts. An earlier article by Gupta (1996) hypothesized that there is a deficiency of calcium in the diet beginning early in life and also malabsorption of the calcium due to a deficiency of Vitamin D. Arya, Bhambri, Godbol and Mithal (2003) suggest that Vitamin D deficiency in India is related to inadequate exposure to sunlight and the skin pigmentation of the Indian people. The suggestion that skin pigmentation is related to Vitamin D absorption is also discussed by Toon (2005) where she suggests that African Americans have a much lower serum Vitamin D compared to Caucasians as a result of their skin pigmentation.

It is apparent that osteoporosis is a significant international public health issue, with numerous studies providing evidence to support this and predicting the significance of this in the future.

Significance of the problem in New Zealand.

According to the IOF, in New Zealand, osteoporosis causes 15,000 fractures each year with approximately one third of these being hip fractures. Non Maori women in New Zealand (mostly Caucasian) have fracture rates similar to those of North American and European women. According to Lane (1996), hip fractures are significantly lower among Maori women, possibly because of genetic differences between Maori and non Maori populations however, this has not been fully explored. A study in Malta confirms a genetic link in osteoporosis in two Maltese families so a genetic link is not an unlikely hypothesis (Vidal, Galea, Brincat & Anastasi, 2007). The study revealed that both males and females were affected. Whether the genetic link is limited to the population of Malta or can be found in other ethnic groups does not appear to be discussed. An extensive search has not revealed any research that confirms a genetic link in other population groups, but this does not mean a link does not exist.

Osteoporosis is believed to affect over 50% of women and nearly 30% of men with 40% of white women suffering an osteoporotic fracture as they age. With our aging population it is likely that there will be an increase in the impact of these fractures (Gilchrist, 2006). European research suggests that one in five patients will not survive more than a year following hip fracture. This is usually related to the onset of other health conditions that are triggered by the trauma and resultant immobility caused by fractures. Forty percent of patients who sustain a hip fracture have been reported as no longer able to live independently within a year of injury (Lane, 1996). This is consistent with other developed nations (Parsons, Failner & Krumweide, 2004).

Lane (1996) indicates that there have been no studies in New Zealand that have investigated the prevalence and incidence of vertebral fractures. Since 1996 there has been no published literature relevant to the New Zealand setting. Lane's (1996) work has been cited in more recent publications, but appears to be only in the context of overseas studies and observations. A review of literature at an international level indicates that the incidence of osteoporosis related vertebral fractures is hard to determine

as many of these fractures are asymptomatic and are not brought to clinical attention. Osteoporosis New Zealand released a report in October 2007 on The Burden of Osteoporosis in New Zealand: 2007-2020. This report indicates that about 80,000 New Zealanders will suffer an osteoporosis related fracture this year (2007) and approximately 75% will be female. This is estimated to be 2% of the overall population, but is approximately 15% of the population over the age of 65. This equates to a fracture every six minutes and it is anticipated that by 2020, if interventions are not instituted, this will increase to 120,000 people and a fracture every 4 ½ minutes. An interesting concept discussed in this report is years of life affected. It is estimated that in New Zealand the cost is 12,000 years of life with over half of these being due to premature death. The report makes the claim that more lives are lost in New Zealand due to osteoporosis than to other diseases such as Parkinson's disease, HIV/AIDS, rheumatoid arthritis or cervical cancer.

Risk factors of osteoporosis.

There are several controllable and uncontrollable risk factors which increase the predisposition to osteoporosis. The uncontrollable factors include gender, family history, ethnicity and race, advancing age, postmenopausal status and small boned body build. Environmental risk factors (controllable) include sedentary lifestyles, cigarette smoking, alcohol abuse, and poor nutrition including eating disorders, low calcium intake, caffeine consumption and replacing milk with non dairy drinks such as fizzy drinks. Excessive consumption of carbonated and caffeinated drinks is believed to impair calcium absorption and increase its loss through the kidneys. (Ali & Siktberg, 2001; Lytle & Kubik, 2003).

Many studies have indicated that changes in diet and lifestyle can help delay or prevent the onset of osteoporosis and that regular weight bearing exercise throughout life increases bone mass (Taggart & Connor, 1995).

For the purpose of this review, the focus will be placed on the environmental factors contributing to osteoporosis, as these factors provide the basis for osteoporosis prevention programmes.

Weight- bearing activity and osteoporosis.

High correlations exist between muscle mass and skeletal mass in those that exercise. Under conditions of disuse and inactivity, skeletal and muscle tissues atrophy. The mechanism during exercise that improves bone density is the stress of using the body during a period of exercise, which stimulates osteogenesis to maintain and possibly increase bone mineral density. Activity, therefore, regulates the mineral density within the skeleton (Smith, 2005).

Based on biomechanical principles, bone responds to forces in nature, including gravity, ground reaction and muscle contraction. An internal resistance develops whenever a force or load is applied to bone, known as stress. Stress can be defined in three ways:

1) *Tensile,* when two forces act along a straight line in opposite directions.
2) *Compression,* when two forces act along a straight line in the same direction.
3) *Shear,* when two forces act parallel to each other, not in the same line.

Wolff's Law, developed in 1892, describes the relationship between mechanical stresses and bone structure. This law states that bone adapts during its growth to the functional forces acting upon it. Under these principles, bone resorption has been shown to exceed deposition as seen in prolonged immobilisation (Downey & Siegal, 2006). Despite it being known that mechanical forces exert influence on bone structure and development, the exact mechanisms by which mechanical forces this occurs not known.

Jenkins and Jones (1996) report that only 16% of daily activity amounts to weight bearing activity. A study by Lloyd, Petit, Hung-Mo & Beck (2004) indicates a correlation between load bearing exercise and young adult bone mass and strength. This same study did state that there is little evidence to indicate how much exercise is needed to achieve optimal bone strength. Terrio and Auld (2002) claim that though many women were engaged in physical activity between 4.5 and 6.5 hours per day, much of this activity was standing and walking while completing household tasks. These

authors cite articles that have found positive results with high intensity weight-bearing exercise and minimal effects of low intensity exercise on bone density.

The WHO Health and Development Through Physical Activity and Sport document (2003b) indicates that physical activity is beneficial in reducing osteoporosis and helps to build and maintain healthy bones. This document also states that physical exercise helps prevent or control risky behaviours such as smoking, alcohol or other substance abuse which can also impact on bone health. Naturally, physical activity does not just influence bone health, it has an impact on cardiovascular disease, Type 2 diabetes mellitus, hypertension and obesity. According to WHO (2003b), overall physical inactivity is estimated to cause 1.9 million deaths globally. These deaths are mostly from cancer, diabetes and heart disease rather than osteoporosis, but the presence of these diseases can impact on bone health. WHO also report the alarming global trend of physical inactivity. It is reported that 60% of adults do not involve themselves in sufficient levels of physical activity that result in health benefits. Physical inactivity is reported to be more common among women, older adults, the disabled and individuals from lower socio-economic groups. Despite this, it is concerning that elevated body mass indexes are increasing among young people and middle-aged adults. Sedentary behaviours as discussed in the WHO document include watching television, using computers, and use of "passive" modes of transport (cars, buses, trains and motorcycles). Mark and Link (1999) report that, in a review of studies, adolescent females consistently participate less frequently in vigorous strengthening exercises. A six year study by Bailey, McKay, Mirwald, Crocker & Faulkner (1999) identifies the importance of weight-bearing physical activity as a determinant in the accrual of bone mineral. For example, in this study, bone mineral content was 7% and 11% higher for active boys and girls respectively, compared with inactive groups. The work by Downey and Siegel (2006) indicates that high impact weight-bearing exercise and also weight training exercise offers encouraging results in the impact on bone mineral density, even in post menopausal women.

Calcium intake and osteoporosis.

Calcium is a key mineral within the body. It is a vital component of the teeth and bones. Calcium is also involved in a number of physiological and biochemical functions that are critical for life. Some of these functions include muscle contraction, nerve transmission, maintenance of blood vessel tone and activation of enzyme reactions and hormone secretions (Looker, 2003).

The requirement for dietary calcium is related to the maintenance of an optimal reserve. A certain amount must be consumed for bone mass to be maintained (Toon, 2005). If inadequate amounts of calcium are obtained from the diet, not only is bone mass compromised, but influences also exist on the development of other conditions such as high blood pressure and certain types of cancer.

Calcium requirements vary according to different times and phases of life. The need for calcium is highest in adolescents, in pregnant women and in the elderly (Toon, 2005). During growth, an adequate dietary supply of calcium is needed for the acquisition of strong and healthy bone. Calcium balance deteriorates at menopause. This is because there is a decline in intestinal absorption and/or an increase in urinary excretion (Ministry of Health, 2006).

The best food sources of bioavailable calcium are milk and dairy products. Other calcium rich foods include shellfish (oysters, shrimp and lobster) and dark green vegetables. Fortified food sources such as orange juice and soy products are also available. These foods are not naturally high in calcium.

The requirements of calcium vary between countries, however for the purpose of this report; discussion will focus on the joint New Zealand/Australia recommendation. A joint report from the Ministry of Health in New Zealand and the Australian Government released in 2006 tables an Estimated Average Requirement (EAR) as well as a Recommended Daily Intake for all dietary nutrients. These are tabled below. Only the adolescent and preadolescent age groups have been selected for discussion in this review. The EAR is a daily nutrient level that is estimated to meet the requirements of half the healthy individuals in a particular life stage group

and gender group. The RDI is derived from the EAR value and is an average daily dietary intake that is sufficient to meet the nutrient requirements of nearly all healthy individuals in a particular life stage and gender group. “Nearly all” equates to 97-98%. When calculating individual calcium requirements, the EAR can be used to examine the probability that their usual intake is inadequate, while the RDI can be used to indicate the intake at which, or above which, there is a low probability of inadequacy. The RDI values are more commonly known and used by both practitioners and consumers (Ministry of Health, 2006).

Table 1. EAR and RDI for adolescent and preadolescent age groups in New Zealand and Australia for calcium (Ministry of Health, 2006).

Age	**EAR mg/d**		**RDI mg/d**	
	Boys	**Girls**	**Boys**	**Girls**
9-11	800	800	1,000	1,000
12-13	1,050	1,050	1,300	1,300
14-18	1,050	1,050	1,300	1,300

Evidence to support the agreed values was arrived at by information obtained from a systematic review, evidence from at least one randomised controlled trial, and evidence obtained from comparative studies and from case studies (MOH, 2006).

There is evidence to suggest that New Zealand children and adolescents are not obtaining their recommended intakes of calcium. The 2002 Nutrition Child Nutrition survey revealed that 12.2% of males and 18.2% of females aged 5-14 years obtained insufficient amounts of calcium in their diet. Results also indicated that children obtained one third of their calcium from milk (Ministry of Health, 2003). A study in New Zealand by Black and Williams (2002) showed that children that avoid milk were significantly shorter and had higher BMIs than the control group. Other comparisons revealed that the milk avoiders had smaller bones, a significantly lower total body bone area and a lower total body bone mineral content. Another significant finding was that a high proportion of the sample

group had already experienced broken bones. This equated to an annual incidence of 3.5 % fractures rather than the expected 1.0%. These authors do not make mention of the Milk in Schools programme that was instituted in the majority of New Zealand schools beginning in 1937.The students attending the schools participating in this programme were issued milk each lunch time. The scheme provided each pupil with ½ pint of milk and ran for 30 years. Dr Muriel Bell, a nutritionist from the Otago Medical School was a strong advocate for milk in schools and also advocated milk for adults especially in reducing the incidence of osteoporosis. Despite a thorough search, the reasons as to why the programme was discontinued have been unable to be uncovered, although it could be attributed to cost. However, recently Fonterra (New Zealand's largest dairy company) has provided milk for Project Energise, a two year project that has been running in the Waikato area of New Zealand in low decile schools (Graham, 2007). Whether this is still being done has not been able to be determined. The reduced intake of calcium in New Zealand is consistent with studies in Australia where dietary calcium intake is below the recommended daily intake (Ebeling & Elsmna, 2005).

Vitamin D and osteoporosis.

Vitamin D exists in two forms. Vitamin D2, also known as calciferol or ergocalciferol, is produced by ultraviolet irradiation of ergosterol. It occurs naturally in milk and fish-liver oils. Vitamin D3, also known as cholecalciferol, is the predominant form of Vitamin D of animal origin. It is found mostly in fish-liver oils, butter, brain and egg yolk. It is formed in the skin, fur and feathers of animals exposed to sunlight.

Vitamin D has a major role in calcium absorption. It also influences calcium homeostasis, as well as bone development and maintenance (Toon, 2005). Vitamin D preserves muscle strength and thus reduces the risk of falls. It works in the intestine to optimise calcium absorption, as well as in the kidneys to reabsorb calcium that would otherwise be excreted. Vitamin D deficiency causes hypoparathyroidism and accelerated bone loss. In children this results in rickets (characterised by abnormal bone formation) and in adults, this becomes osteomalacia characterised by a loss of calcification of

the bony matrix (Toon, 2005; Smith, 2005; Anderson et al., 1998). Calcitriol is the active form of Vitamin D and works with the parathyroid hormone to mobilise stem cells in bone marrow to become mature bone cells.

One is produced by the action of sunlight on the skin and the other is found in a limited range of foods. There is, however, insufficient Vitamin D in food sources for the body to obtain enough from the diet alone (Ministry of Health, 2006). The status of Vitamin D in the body is generally maintained by exposure to sunlight, with dietary contributions usually seen as additional.

The Ministry of Health (2006), Smith (2005) and Toon (2005) all discuss the seasonal variations in Vitamin D uptake during the winter months and report on Vitamin D deficiencies which exist in some countries that are devoid of sunlight during the winter season. This is not limited to the northern hemisphere countries. In the Geelong Osteoporosis Study (Pasco, Henry, Nicholson, Sanders, Kotowicz, 2001) a seasonal variation in Vitamin D levels with a difference of 12nmol/L between summer and winter values was demonstrated. In support of this finding, a national survey in New Zealand suggests that up to 31% of New Zealand children aged 5-14 years had blood tests that indicted a Vitamin D deficiency. Vitamin D concentrations were shown to be lower in winter and lower in Pacific Island groups (Green, Skeaff, Taylor, Rockell & Whiting, 2004). Toon (2005) also discusses reports of Vitamin D deficiencies among institutionalise elderly due to lack of exposure to sunlight. The report from the Ministry of Health (2006) suggests that the darker skin tones of the indigenous people of Australia and New Zealand affects Vitamin D uptake as does the cultural behaviours of some groups which require covering. This can impair the uptake of Vitamin D.

Table 2 below displays the nutrient reference values for the adolescent and preadolescent groups for Vitamin D as recommended for Australia and New Zealand. Values are expressed as adequate intakes (AI). Adequate intake is a value used when an EAR (and consequently RDI) cannot be determined. It is based on observed or experimentally-determined

approximations of nutrient intake by a group of healthy people that are assumed to be adequate.

Table 2: AI values for the Vitamin D intakes in adolescent and preadolescent age groups in New Zealand and Australia (MOH, 2006).

Age	AI
9-13	5.0 micrograms
14-18	5.0 micrograms

Body weight and osteoporosis.

Body weight is a factor considered to be important in the development and maintenance of bone mineral density at all ages. Smith (2005) indicates that dieting and weight loss are associated with markedly lower bone mineral density (BMD). Thin, otherwise healthy women have been shown to have a lower bone density and suffer bone at a greater rate than heavier women. Weight loss in healthy women, especially after the age of fifty, has been found to be associated with decreased bone mass and bone loss (Coates, Fernstrom, Fernstrom, Shauer & Greenspan,2004). These authors also associated gastric bypass surgery for morbid obesity with increased bone resorption and a decrease in bone mass three to nine months after surgery. Rourke, Brehm, Cassel and Sethuram (2003) found that weight changes were strongly related to bone measurement changes in the adolescent population. This was a study of obese female adolescents pursing a weight loss programme. In this study there was no correlation between weight loss and BMD loss but those who did demonstrate weight loss also showed a slower progression of bone development when compared with the norm for population of female adolescents of normal weight. These authors acknowledge that further research is required in this area.

Socioeconomic impact of osteoporosis.

As with many chronic diseases, there are significant costs involved in the diagnosis and management of osteoporosis. This is especially seen when fractures develop and surgical interventions are required. Some of

these are measurable, as in costs of treatment and care, especially when an acute episode occurs. Others, such as impact on families, psychological impacts on patients and lifestyle adjustments are less clearly measurable. The overall cost of osteoporosis should be measured in terms of both direct and indirect costs. Direct costs include hospital costs. Indirect costs are associated with the patient's loss of income but can also include the impact on careers and the household. Other associated costs that are harder to determine are the intangible costs. By definition these costs are hard to quantify in monetary units and are usually those of morbidity associated with osteoporotic fractures. Osteoporosis creates obvious costs in relation to human suffering, loss of life, reduced productivity as well as health care dollars (Ribeiro et al., 2000). Up to 25% of patients with hip fractures die within the first year. In those who survive beyond a year, approximately 25% will require long-term institutional care (Berarducci, Lengachere & Keller, 2002). Age affects the direct costs of managing osteoporosis related fractures. The costs of hip fractures are twice as high in the elderly than in younger patients (WHO, 2003). The estimated cost of osteoporosis world-wide is represented in Table 3 below.

Table 3. Estimated cost of osteoporosis (per annum.) (IOF, 2007).

Country	**Cost**	**Source**
Europe	Euro 31.7 billion (£21 billion) direct costs	IOF
US	$17.5 billion	IOF
Mexico	$ 36.5 million	IOF
Hong Kong	$17 million (cost of hip fracture)	IOF
Australia	$7.4 billion (USD) of which $1.9 billion are direct)	IOF
New Zealand	**$135 million**	**IOF**
Singapore	$3.4 million (USD) inc fracture management	IOF
England & Wales	£942 million	WHO(2003)

In New Zealand the Accident Compensation Commission provides financial cover for the cost of fracture management. This also includes some support services when a patient is released from acute care.

Table 4 provides a breakdown of the costs. (Kieft, personal communication August 19, 2007). Prices are in New Zealand dollars.

Table 4. Breakdown of possible costs of care in New Zealand for elderly patients with fractures. (July 2006-June 2007- previous 12 months in brackets for comparison) These may not all be osteoporosis related, this information was not able to be obtained.

Payment type	New	Ongoing
Assessments	$603,000 (493,000)	$ 237,000 (191,000)
Death Benefits		$21,000 (21,000)
Hospital treatment	$577,000 (507,000)	$961,000 (965,000)
Independence allowance (lump sums)	$20,000 (40,000)	$217,00 (228,000)
Medical treatment (entitlement)	$16,000 (29,000)	$18,000 (31,000)
Medical treatment (fees)	$727,000 (708,000)	$495,000 (488,000)
Miscellaneous	$2,000 (15,000)	$15,000 (1,000)
Support for independence	$15,179,000 (15,073,000)	$1,711,000 (1,712,000)
Transport to treatment	$844,000 (908,000)	$79,000 ($146,000)
Vocational rehab	$35,000 ($22,000)	$9,000 ($12,000)
Weekly compensation	$356,000 (268,000)	$289,000 (335,000)
Total	**$18359000 (1806300)**	**$4052000 (4130000)**

The Osteoporosis New Zealand report (2007) indicated the cost for osteoporosis related fracture management was $300 million, with the cost of managing osteoporosis being approximately $1.5 billion. The health sector budget for 2006-7 was $10.6 billion (Hodgson, 2006), so approximately 10% of this is being used for osteoporosis prevention.

The adolescent age group.

Adolescence is defined as the period of development between the onset of puberty and adulthood, usually considered to be between the ages of

11-20 years of age (Anderson et al., 1998). This stage of life is marked by not only dramatic biological changes, but also significant cognitive and sociocultural change (Lytle, 2002). Behaviours such as smoking, alcohol consumption and recreational drug use are often initiated during this period. Lytle (2002) asserts that adolescence is a life stage where the health behaviours of individuals are most vulnerable. These behaviours carry with them a potential threat of consequences, leading to the development of adult-onset chronic disease. Another author describes adolescence as a period of life that is both full of risk and opportunity (Berger, 2003). While most take the opportunities, the risks are very real indeed. Adolescence begins with puberty, a period of rapid physical growth and sexual maturity. In physiological term this process is initiated by the hypothalamus which starts a cascade of hormonal events culminating in sexual maturity. For most, this period is a healthy time. However, while diseases may not attack teenagers, their own actions do. Two identified hazards of adolescence are eating disorders and drug use.

Adolescence, as previously indicated, is a time of considerable skeletal growth. With 40% to 60% of peak bone mass being accumulated during this time (Golden, 2000), optimum health to ensure this happens is of great importance. This is corroborated by Lytle and Kubik (2003), who state that bone growth during adolescence accounts for 45% of bone mass attainment, making adolescence a vital time for maximising physiological potential for the mineralization of bone. Peak bone mass is considered an important determinant of osteoporosis risk (Wang, Crawford, Hudes, Van Loan, Siemering & Bachrach, 2003).

The rapidly growing body requires fuel in the form of additional calories as well as additional vitamins and minerals. During the growth spurt, the need for calcium, iron and zinc (all for bone and muscle development) is about 50% greater than it was 2 years earlier (Berger,2003) The declining consumption of milk, a good source of calcium, is a trend noted over several decades. A study by Goulding et al. (2004) reveals that children who avoid drinking milk are at increased risk of fracture. Today's teenagers prefer carbonated and high-energy drinks over milk and these have

little nutritional value and can promote weight gain (Berger, 2003; Goulding et al., 2004).

The dietary habits of teenagers reveal a preference to eat foods high in salt, sugar, fat and preservatives and lacking in dietary calcium and iron (Berger, 2003). Lytle and Kubik (2003) continued to say that there has been a dramatic rise in obesity among the youth worldwide and an associated increase in Type 2 diabetes mellitus, prompting greater scrutiny of the diet of our adolescent population. Poor bone health in adolescents implies that we may not need to wait until middle age before seeing the consequences of calcium poor and phosphorous rich diets and poor levels of weight bearing activity.

Based on nutritional surveillance data in the US, Lytle (2002) indicates that many adolescents pursue a diet high in saturated fats, total fats and soft drinks which increases the risk of cardiovascular disease, cancer and osteoporosis. The US, among other Western countries, is experiencing an obesity epidemic related to excessive energy intake, low levels of physical activity and high levels of sedentary behaviours. However on the opposite side of the spectrum, some adolescents, usually female are suffering from disordered eating behaviours leading to bulimia and anorexia nervosa. Reports of disordered eating and unsafe weight loss practices among youth are on the increase (Lytle & Kubik, 2003). There is speculation that poor dietary habits impact on youths' ability to learn and negatively affects school attendance. All these issues highlight the importance of a healthy diet during the adolescent period. Adolescents who have a higher dietary consumption of calcium during the adolescent years have increased bone mass in the arms, spine and total body (Ali & Siktberg, 2001).

It is reported by Lytle and Kubik (2003) that while children are naturally active, we find that during adolescence physical activity often diminishes considerably. Activity is replaced by sedentary activities such as watching television, playing video games or using a computer. This is significant as weight bearing activity is considered an important determinant in the development of bone density and strength (Lloyd, et al., 2004).

Many psychologists feel that developing a healthy body image is an integral part of becoming an adult (Berger, 2003). Some teenagers

exercise or diet obsessively in an attempt to look alluring and trendy. A teenager's assessment of personal appearance is the most important determinant of self esteem; therefore they are often preoccupied with how they appear in the eyes of others (Berger, 2003).

Eating Disorders.

Adolescence is a time when most eating disorders have their onset. In Western countries, eating disorders, anorexia nervosa and bulimia nervosa are the most common chronic illnesses in adolescent females. It is estimated that 1 out of every 200 females worldwide between the ages of 15-19 years will have anorexia nervosa. Larger numbers of adolescent females have disordered eating but do not meet the criteria for anorexia nervosa. This group may still be at risk of developing reduced bone mass (Golden, 2003). Anorexia nervosa is characterised by self starvation. Individuals voluntarily eat so little and exercise so much that they risk decreased nutrient intake, emaciation, organ failure and potentially death. According to Berger (2003), anorexia is a disease of social context, that is, the culture supports it. It was virtually unknown prior to the 1950's.

Bulimia nervosa is more common among young females than anorexia nervosa. This condition involves binge eating followed by purging through vomiting or inducing diarrhoea by taking massive doses of laxatives. Patients with anorexia nervosa are malnourished and severely underweight, whereas patients with bulimia nervosa are not generally underweight (Vestergaard, Emborg, Stoving, Hagen, Mosekilde & Brixen,2003).

A number of theories are offered as to why either of these disorders occur including parental conflict (usually with the mother), a means of relieving emotional distress and tension in those with low self-esteem and cultural pressure to be "slim and trim" (Berger, 2003).

Osteopenia is a frequent and severe complication of anorexia nervosa. Optimising bone mass accrual during adolescence is essential and an episode of anorexia nervosa can interfere with that process (Golden, 2003). More than 90% of young women with anorexia nervosa have reduced bone mass (Golden, 2003; Smith, 2005). A young woman who develops anorexia nervosa during adolescence may never reach her potential bone

mass. Even after recovery from the eating disorder, a woman still continues to lose bone at the rate of 1-2% per year, and her bone mineral density levels will reach the fracture threshold earlier. There is, therefore, the risk of developing premature osteoporosis many years after recovery from the eating disorder (Golden, 2003). Adolescents with anorexia nervosa have a significantly lower bone mass compared with age-matched and bone age-matched controls. Two-thirds of adolescents with anorexia nervosa in one study of lumbar bone density had a density of 2 SD lower than the normal values for their age (Katzman, 2004). Changes in bone density occur very early in the course of the disease; with half of those who had their bone density measured being diagnosed with anorexia nervosa for less than one year. Weight recovery has been shown to increase whole-body bone density. However, despite this, lumbar spine bone density remains significantly reduced and any subsequent weight loss was associated with further loss in bone density.

Female Athlete Triad and Osteoporosis.

While not a common problem, Female Athlete Triad is a condition that has serious implications for bone health.The female triad is a cascading event consisting of disordered eating, amenorrhoea and osteoporosis (Smith, 2005). Although it can occur with any sport, it most often appears in activities that emphasise thinness and appearance such as gymnastics, ballet, diving, distance running and cheerleading. Eating disorders may arise from pressure to achieve and maintain a particular body weight or shape. If the disorder becomes advanced enough, reduced oestrogen levels and decreased calcium intake can lead to demineralisation of bone (Smith, 2005). A study in the US of college gymnasts showed that 62% displayed some form of eating disorder. 26% of these vomited on a daily basis, 24% used diet pills, 12% fasted and 75% had been told by their coach that they weighed too much (Donaldson, 2003). It is apparent then, that eating disorders do impact on bone health.

Summary.

Osteoporosis has become recognised as a problem with a significant impact on the health of the world's population. It is a problem that is not limited to Western countries, but has become a global issue. As clearly demonstrated in the literature, the key years for bone development are during adolescence. During this period of development, significant health behaviours can be challenged and threatened resulting in detrimental health outcomes further on in life. The decisions and actions decided upon by adolescents will influence their lives in later years. The adolescent group need to be recognised as a significant target group in the management of health related issues. It is clear that many health promotion strategies are needed to address this age group if positive outcomes are expected later in life.

SYSTEMATIC REVIEW

It has become evident that adolescence plays a key role in the development of peak bone mass. It is important, therefore, for adolescents understand the importance of developing bone mass. In order to develop strategies, we first must understand what knowledge levels are currently among this age group and also what material in available to assist with this. Knowledge is required so that behaviour changes are informed. It is acknowledges that improved knowledge does not necessarily equate to improved health prevention behaviours, but a lack of knowledge decreases the possibility of this happening.

SYSTEMATIC REVIEW.

This review is in two parts:

1) The current state of adolescent knowledge regarding osteoporosis.
2) The scope of osteoporosis prevention strategies for the adolescent population group.

PART ONE.

The current state of adolescent knowledge regarding osteoporosis.

Objective: To establish the level of knowledge among adolescents regarding osteoporosis.

Inclusion criteria:

When initiating the planning of this review, the original inclusion criteria were limited to studies that involved the adolescent age group only. Unfortunately, few of these exist in the literature. It was prudent to expand the review to include studies that assessed knowledge in groups that included but were not limited to adolescents. Few studies actually assessed knowledge as an entity alone. Most studies also examined health beliefs and health behaviours related to osteoporosis prevention; therefore discussion regarding these is included in this review as the nature of the studies does not lend itself to separating out the knowledge component for examination. Extensive searching has not revealed any studies or articles that assess or refer to adolescent knowledge in New Zealand. One mulitcentre study by Spencer (2006) includes participants from New Zealand. This study has two limitations for inclusion in this review. Firstly, the study is not inclusive of

the adolescent group and secondly, it targets participants referred for DEXA scanning. However, because of the New Zealand component, this study has been included. Another study by Von Hurst and Wham (2007) is a survey of New Zealand women. Again, this does not include adolescents with the age range being 20-49. As this study appears to be the only New Zealand assessment of knowledge regarding osteoporosis, it has also been included in this review.

Frameworks used

Apart from the Facts on Osteoporosis Quiz (FOOQ), which uses Orem's Self-care theory as its framework, the other studies are based on the Health Belief Model (HBM). (See Appendix 2).

Assessment of knowledge.

There are many tools available to assess osteoporosis knowledge. Other tools also look at health preventing behaviours, self-efficacy and health belief. Pyschometric instruments are used to test reliability of the tools. Those instruments that have been validated have been assessed either using the Kuder-Richardson formula (KR20) and/or Cronbach's alpha. One study uses the Pearson Product moment correlation to assess validation.

KR 20 formula.

The KR20 formula was developed in 1937 is a measure of internal consistency reliability for measures with dichotomous choices. A dichotomous variable has only two values of categories (Polit and Hungler, 1999). Girden (2001) indicates that the KR 20 formula measures the reliability of a test whose items can be scored right or wrong. It also measures the extent to which all participants answered each question appropriately. According to Tucker (1949), the KR 20 formula is often used for quick estimates of reliability. Values can range from 0.00 to 1.00. KR 20 values for the instruments used ranged from 0.67 to 0.90. The lower scores for the Healthy Bones Knowledge Questionnaire (HBKQ) is believed to result from the low level of knowledge about the topic in the group tested

which resulted in a large number of incorrect responses. Both studies using the HBKQ report the same level of internal consistency (0.69) (Brown & Schoenly, 2004; Martin et al, 2004).

Cronbach's Alpha

Cronbach's alpha reflects the extent to which there is agreement among the responses of participants on a test where the items are scaled or weighted as in a Likert scale (Girden, 2001). Cronbach's alpha is based on the KR20 formula. It is also referred to as coefficient alpha in the literature. Cronbach's alpha scores generally increase when the correlations between items increase. The scores range from 0.00 to 0.99. According to Vehkalahti, Puntanen and Tarkkonen (2006), Cronbach's alpha underestimates reliability and has been known to give absurd, negative estimates. Striener (2003) also indicates that the use of this tool and interpretation can be subject to errors. Despite this, the tool is considered to be the most widely applied estimator of reliability. The Cronbach's alpha scores for the tools used to assess osteoporosis knowledge range from 0.52 to 0.90. The reason for one tool apparently having a low score does not appear to be given. The KR20 score was 0.72 and 0.69 for the same instrument.

Pearson Product-moment correlation coefficient

Correlation studies attempt to establish relationships between two or more variables. The Pearson Product-moment correlation coefficient (PPMCC) is a tool that measures the correlation between two variables *X* and *Y* measured on the same object (Girden, 2001). It is described by Polit and Hungler (1999) as the most widely used correlation coefficient. The coefficient describes the strength and positive or negative direction of the relationship. This can also been seen in the literature as Pearson's *r*.

Table 5 below outlines the instruments used to assess knowledge. Other instruments that assess health beliefs and behaviours have been included as these have been used in conjunction with the knowledge assessment scales.

Table 5. Instruments used in osteoporosis knowledge studies.

Instrument	Author(s)	Purpose	Description	Demographics	Psychometrics
Facts On Osteoporosis Knowledge Quiz (FOOQ). Framework- Orem's Self-Care theory.	Ailinger, Lasus & Braum(2003) 1998, revised in 2001.	1) Indication of known facts about osteoporosis. 2) Recognition of preventive health behaviours for osteoporosis. 3) Identification of major health behaviours for osteoporosis.	28 point questionnaire with True(T), False(F) and don't know(D) options.	Used across several age groups and cultures. Both sexes included in studies.	KR-20=0.76. Cronbach's alpha – internal validity = 0.84.
Osteoporosis Preventing Behaviors Survey (OPBS) used in conjunction with the Osteoporosis Knowledge Test.	Doheny & Sedlak (1995).	Three categories to examine: Activities/exercise. Dietary intake. Other risk factors (alcohol, smoking, hormonal therapy, medications that affect bone density.	45 item self report descriptive survey.	Younger and older women. Both sexes.	Reported to have content validity and reliability not recorded in articles reviewed.
Osteoporosis Health Belief Scale (OHBS). Framework- Health Belief Model (HBM). Osteoporosis Knowledge Test (OKT). Framework- HBM. Osteoporosis Self-Efficacy Scale (OSES). Framework- HBM.	Horan, Kim, Gendler, Froman & Patel (1998).	To assess the beliefs related to exercise and calcium intake in the elderly. Two subscales- exercise, calcium, OKT-calcium, OKT-exercise. To measure confidence in ability to undertake osteoporosis preventing activities	42 item questionnaire using a Likert scale. 24 item multiple choice questionnaire. Two version-21 item scale, 12 item scale. Visual analogue. Reason for two not given.	Designed for elderly, used in other groups, cultures and both sexes. Younger & older age groups, cultures. Used across a range of age groups.	KR 20=0.90 in elderly, not assessed in adolescents. KR20= OKT calcium- 0.72. OKT exercise- 0.69 in women over 35 years. Cronbach's alpha= 0.52 to 0.66. Cronbach's alpha= 0.90.
Healthy Bones Knowledge Questionnaire (HBKQ).	Modification of the OKT (Kim et al, 1991) Who did the modification does not seem apparent.	Quantify knowledge about osteoporosis and the associated risks in older children and adolescents.	Two versions- 33 questions (girls), 35 questions (boys).	Developed for use with adolescents and only used with this group.	KR20 = 0.69 Test-retest reliability for exercise r=0.87 Calcium r= 0.79.
Multiple Osteoporosis Prevention Survey (MOPS).	Unknown.	Assess the knowledge, beliefs and behaviours of women about prevention of osteoporosis.	20 section instrument.	Studies have only used women of various ages. Ethnicity given as black or white.	Not recorded.
Other questionnaires used Calcium Quiz.	www.dairycouncilofca.org	To assess daily calcium intake Not specifically an osteoporosis assessment tool.	Self reporting tool.	Unknown.	Not recorded.

Cooper Institute Physical Activity Questionnaire.	Cooper Institute.	Assess weight bearing activity not specifically an osteoporosis assessment tool.	Self reporting tool.	Unknown.	Not recorded.
Questionnaire unnamed.	Hazavehei, Taghdisi & Saidi (2007) based on Health Belief Model.	Assess risk of osteoporosis development in female adolescents.	67 questions.	Used on Iranian adolescent females.	Reliability test-retest 0.77.
Osteoporosis Risk Factor Questionnaire.	Anderson, Chad & Spink (2005).	Assess knowledge and beliefs about physical activity, nutrition and cigarette smoking on osteoporosis in the adolescent population.	Knowledge- 12 T/F questions. Beliefs- 9 statements. Likert scale. Practices- unknown.	Used for adolescent females.	Test-retest reliability- r = .70, p<.01. Pearson Product Moment correlation between 2 pilots- r=.79, p <.01.
Physical Activity Questionnaire for Older Children (PAQ-C)	Unknown	Assess general levels of physical activity in children between 9-15 years	Self report. 9 item 7-day activity recall.	Adolescents, male/female	Test-retest reliability - Males r=0.75 Females r =0.82. Alpha coefficient- 0.79.
Teenagers' Nutrition Questionnaire.	Modified from Barr (1994).	Designed specifically for the adolescent population to assess nutritional practice.	Self report.	Adolescents.	Reliability tested 2 months part- r= 0.76.
The Smoking Behaviour Questionnaire.	Unknown.	Assess cigarette smoking in adolescents.			Unknown.

As is evident, there are a number of tools available for use when assessing knowledge. The cohort created by Horan et al (1998) appears to be the most widely used. These include the OHBS, OKT and OSES. This group considers more than knowledge of osteoporosis, with questionnaires also focusing on health beliefs and self efficacy. The studies reviewed using these tools suggest that there is more to osteoporosis prevention than the improvement in knowledge levels. It has become evident that changes in belief and behaviour are also important factors. Apart from the Healthy Bones Knowledge Questionnaire, which was adapted from one of the group developed by Horan et al (1998) specifically for use with the adolescent population group, there is no indication as to why other tools were developed. Copies of all the tools have not been obtained to compare. It may be that each author seeks to examine aspects of osteoporosis that are not addressed in existing questionnaires.

In 2001 the FOOQ was revised to keep pace with the recommendations from a consensus report released in 2001 by the National Institute of Health. Each question in the quiz was reviewed to see if it corresponded with the latest consensus statement. Twenty two items were included, 11 true and 11 false. The questionnaire had a true, false and don't know format. The twenty-two items were then sent to a panel of expert reviewers, two physicians and one nurse, all working in osteoporosis clinics and having many years of experience in the field. The reviewers evaluated the items in relation to osteoporosis knowledge and given a score from 1 to 4, 1 being not relevant, and 4 being very relevant. Experts on Orem's theory also assessed each item for its relation to self-care requisites. Self-care requisites were assigned to items according to their correlation to universal, health deviation and developmental requisites contained in Orem's theory (Ailinger et al, 2003). For the purpose of their study, (Nguyen & O'Connell, 2002) rewrote some of the FOOQ questions so that the alternative answer became the correct one. Other questions were included to address Asian-specific issues.

Studies that include adolescents.

Table 6 summarises the findings of international studies assessing osteoporosis knowledge that include, but are not exclusive to adolescents.

Table 6. Studies that include, but are not limited to, adolescents.

Study	Purpose	Instrument(s)	Design	Participants	Ethnicities	Findings
Sedlak, Doheny & Jones (1998) (HBM).	Assess whether young women who participated in an osteoporosis prevention programme demonstrate higher level of knowledge than those who do not.	OKT OHBS	Classic experimental design with one treatment group and one control group. Convenience sample. Pretest/posttest.	31 young college women. 18-26 plus 65% aged 28-29 years.	Most were white. Statistics specified.	Statistically insignificant change in control group- increase of 1.16 point in scores (OHBS). Experimental- Increase of 11 points in score OKT- Control- increase of 1.25 point in score Experimental- increase 5.33.
Sedlak, Doheny & Jones (2000).	Implementation and evaluation of 3 osteoporosis prevention programmes.	OPBS OKT OHBS	Not stated. 3 Education programmes to 3 groups, identical in content, varied length, method. Pretest/postest.	Most under age of 25, age range not given all females. Intense – 31. Intermediate- 35. Brief- 18.	Mostly Caucasian, % not given.	Assessed 3 weeks after intervention. All programmes increased knowledge. No change in health beliefs. No increase in health prevention behaviours.
Thompson (2000).	Identification of osteoporosis risk factor and prevention knowledge in 200 college women.	FOOQ	Descriptive.	200 aged 18-22 females. One campus. 141 in non health 59 in health.	Caucasian- 58%. African-American- 7%. Hispanic- 33%. Native American- 1.5%.	Overall lack of knowledge. Hypothesis that having relative with disease increased knowledge not substantiated. Health majors scored higher than others.
Snelling & Walbourn (2000).	Evaluate the effectiveness of a 4 week osteoporosis educational intervention.	FOOQ. Calcium Quiz. Cooper Institute Physical Activity Questionnaire. Bone Density Screening History.	Quasi-experimental. With two groups. Educational interventions. Test-retest.	96 college aged females.	Asked for but not given in the study	Treatment group- FOOQ score increased from 59.1% to 77.6% Control group mean score from 54.2% to 57.9%. No changes in behaviour
Geller & Derman (2001).	Conduct a needs and risk instrument to assess knowledge of	Questionnaire name and authors not specified.	Cross-sectional survey.	206 women 18-> 65 years.	African-American= 65.5%. Hispanic= 33%.	< 10% taking sufficient calcium. < 50% exercise adequately.

	osteoporosis risk factors, beliefs and attitudes.	No recorded psychometrics.			White 1.5%.	Women in study tended to be obese. 42% smoke.
Piaseu, Belza & Mitchell (2001).	Test the effectiveness of an osteoporosis educational programme for young women in Thailand.	OKT OHBS OSES	Experimental.	100 first year nursing students in 2 groups, Control =50 Treatment =50 Females.	Thai.	Significant increase in knowledge, beliefs and self efficacy among the treatment group. No change in control group.
Kasper, Peterson & Allegrante (2001).	Assess osteoporosis knowledge, beliefs & preventive behaviours.	MOPS	Cross-sectional survey.	321 women enrolled in health course.	White= 63%. Black= 29.2%.	86% had heard about osteoporosis. 3.8% reported sufficient exercise and calcium. Knowledge alone insufficient for influencing behaviours and beliefs.
Wallace (2002).	Examine personal characteristics and expanded HBM constructs associated with the osteoporosis protective behaviours.	FOOQ OHBS OSES	Cross-sectional survey.	273 college women (17-64).	Predominantly white, ethnicities not given.	Most did not meet current recommendations for exercise or calcium intake. Average 65% on FOOQ.
Nguyen & O'Connell (2002).	Quantify Asian and Asian-American college students' knowledge of osteoporosis and preventive health behaviours.	FOOQ (modified).	Survey. Convenience sample.	College students= 168 male (23%) and female (77%) Mean age 21 (+/- 3.4 yrs).	Vietnamese-39%. Hmong – 20%. Chinese-7%. Multiple- 5%. Other- 15%.	Cultural belief can have impact on preventive health behaviours. Luck, fate, predetermined destiny factors in osteoporosis. US born Asians believed osteoporosis to be public health concern. Most do not practice health preventing behaviours.
Ziccardi, Sedlak & Doheny (2004).	Describes college students' knowledge of	OPBS OKT	Descriptive with survey.	194 nursing students. Age 18-53.	92.3% white, Others not	Seniors higher level of knowledge than sophomores.

	osteoporosis, health beliefs, self efficacy and actual performance of osteoporosis preventing activities.	OHBS OSES	Convenience sample.	2 groups, sophomores and seniors. 5.7% male. 94.3% female.	specified.	No change in health beliefs. Seniors higher confidence level. No change in calcium intake or weight bearing activity.
Smith (2005).	Determine level of knowledge in college women concerning osteoporosis risk.	FOOQ	Descriptive. Convenience sample in one campus.	725 aged 19-24 years. Female. 246 studying health 236 education. 243 not specified.	Caucasian – 94%. African-American- 6%.	Health majors scored higher Caucasian scored higher than African-American. Lack of knowledge barrier in establishing preventive behaviours. Overall knowledge level inadequate even in those studying health. Education level not discussed.
Ailinger et al (2005).	Examine factors influencing osteoporosis knowledge.	FOOQ	Descriptive.	255 aged 18-66. Male- 14.5%. Female- 84%. Unknown- 1.1%. Mean -35 years.	White- 65.8%. African-American- 17.6%. Hispanic- 6.6%. Other- 3.5%.	Overall lack of knowledge similar to previous studies. Knowledge level higher in those who knew person with disease. Educational level not a factor in scores.
Chan,Ko & Day (2005).		Unknown- adapted from one used in cardiac rehabilitation.	Randomised controlled design.	41 aged 18-41+ Female.	Hong Kong Chinese.	Consumption of calcium, exercise and Vit D increased in case group after educational intervention.
Tung & Lee (2006).	Evaluation of effects of knowledge, health beliefs and preventive behaviours of osteoporosis education on men.	OKT OHBS OSES	Randomised controlled trial, pre/post test.	128 men randomized into intervention or control group, 64 in each. 19-78 years.	Hong Kong Chinese.	Pretest- low level of knowledge in both groups. Moderate level about preventive behaviours. Moderate level of self efficacy.

						Post test- intervention group results significantly higher for OKT. OHBS was also significantly higher OSES was unchanged.
Chan & Ko (2006).	Evaluation of nurse initiated education programme on four specific osteoporosis prevention behaviours.	Unknown- adapted from one used in cardiac rehabilitation.	Randomised controlled design.	76 women- 38 case, 38 control.	Hong Kong Chinese.	Increases in calcium intake, exercise and Vit D exposure.
Chan, Kwong, Znag & Wan (2007) (HBM).	Effectiveness of an osteoporosis prevention programme.	OKT OHBS OSES	Quasi-experimental study. Convenience sample.	45-18-23 year olds. Male (28.9%). Female (71.1%). Control-23. Intervention- 22.	Hong Kong Chinese.	OKT- control- decrease 0.2. Intervention- increase 5.0. OHBS- control- increase 0.9. Intervention- increase 2.6.
(Johnson, McLeod, Kennedy & McLeod, 2007).	Compare osteoporosis health beliefs among difference age and gender groups.	OHBS	Cross-sectional design.	300 with 50 in each age & gender group- 18-25 years. 30-50 years. 50 plus.	Not specified, just mostly Caucasian.	Older groups scored higher than 18-25 for susceptibility and also between genders. No significant differences in seriousness or health motivation across age and gender groups.

The following themes have emerged from these studies.

Lack of knowledge.

The studies consistently identify a lack of knowledge among participants regarding osteoporosis. Some studies only explore the level of knowledge; others include an educational intervention and then a post test. Where an educational intervention was initiated, the pre-test survey still revealed a low level of knowledge. What this is measured against is not clear. The post-test results reveal an increase in knowledge as would be expected. Of these studies, only three completed a follow up survey. Chan & Ko (2006), Chan et al (2005) and Chan et al (2007) completed these one month after the educational intervention. In these studies it was demonstrated that the changes in knowledge levels that occurred initially, continued to be apparent one month on. These results are only short term; further study would be required to assess the impact on a long term basis. Smith (2005) offers the hypothesis that if a participant had a relative who had been diagnosed with osteoporosis, their knowledge level would be higher because of the association of knowing someone with the disease. Similarly, Ailinger et al (2005) suggests that knowing someone with the disease made a difference to the knowledge level, indicating a motivation to learn about the disease and increasing understanding of the health problem. However, these hypotheses do not appear to be reflected in the study outcomes (Nguyen and O'Connell, 2002; Thompson, 2000).

The studies that involved students participating in health science majors (Smith, 2005; Thompson, 2000; Ziccardi et al, 2004) had a higher level of knowledge regarding osteoporosis than those participating in other programmes. However, this is not unexpected as students would be exposed to both clinical and classroom knowledge about the disease as part of their study. Smith (2005) felt that lack of knowledge was a barrier in establishing preventive behaviours. In this study college women did not score above 70% on the FOOQ. The average score was 63.73% which could be considered a failed grade in some university settings in the US. Ailinger et al (2005) indicated that educational level did not correlate with the knowledge score. Age, in fact, was correlated with a higher score, suggesting that older women have more awareness of osteoporosis than younger ones.

Lack of preventive behaviours.

Wallace (2002) confirms the findings of other studies where osteoporosis preventive behaviours are not undertaken to the levels recommended. These recommended levels do not appear to be discussed. In this study 30% of the women reported a completely sedentary lifestyle which not only increases osteoporosis risk but can also impact on cardiac and cardiovascular disease. Where educational interventions were initiated, the results are mixed. Ziccardi et al (2004) and Sedlak et al (2000) demonstrate that a change in knowledge level did not translate to changes in beliefs or behaviours. Sedlak et al makes the observation that knowledge level appears to be the easiest factor to change through education, with beliefs and behaviour being harder to influence and this seems to be supported by the outcomes of the research. However, in contrast to this, Tung and Lee (2006) demonstrate a change in health beliefs, with positive changes being made with no apparent difficulty. Whether these changes were sustained is not indicated. In this study the participants were only male, whereas the other studies were either only female or had the majority of their sample as female participants. The studies by Chan and Ko (2006), Chan et al (2005) and Chan et al (2007) also demonstrated changes in attitudes and beliefs among participants in their studies. Furthermore, these studies also demonstrated an improved calcium intake, level of physical exercise and improved consumption of Vitamin D/exposure to sunlight. Only female participants partook were used and all were Hong Kong Chinese. Whether cultural approaches to education and health have an influence on the changes is not indicated.

Impact of cultural beliefs.

Only one study in the group reported any particular cultural beliefs as having an impact on knowledge, beliefs and behaviours regarding osteoporosis. The study by Nguyen and O'Connell (2002) demonstrates that among some Asian cultures, luck, fate and predetermined destiny play a significant factor in the development of osteoporosis. This appears strong among the Hmong people and the Japanese. In most studies, ethnic information is requested for the demographic data, but the cultural significance on peoples' approach to health prevention is not

discussed. The majority of the studies are based in the US, with four being undertaken in Hong Kong, one of these including males only. The study by Piaseu et al (2001) was undertaken in Thailand and mentions some differences in culture, such as the fact that Thai people do not traditionally eat cheese. Two studies that are based in the US undertook to investigate ethnic groups within the country. Nyugen and O'Connell (2002) explore knowledge and beliefs among Asian and Asian-Americans, while Geller and Derman (2001) looks at African-American and Hispanic women. This study also demonstrated a lack of appropriate lifestyle and dietary practices that could decrease the risk of osteoporosis.

The study by Smith (2005) revealed a significantly higher knowledge score among Caucasians than African-American women. It is speculated that more osteoporosis information is presented to Caucasians. However, this study did only have a small representation of African-Americans which may also be a factor. There is no suggestion that cultural beliefs contributed to the higher Caucasian score.

Limitations.

Self-reported data was a limitation identified by Wallace (2002) and Snelling and Walbourn (2000). It is believed by these authors that self reported data can intentionally or unintentionally distort data although how this occurs and what it influences is not specified. Convenience sampling was seen by a number of researchers as a limitation to the study undertaken. Nguyen and O'Connell (2002) felt that the use of convenience sampling, while convenient for the researcher, produced a sample that had a majority representation of the Hmong group and therefore may not be a true representation of Asian cultures. 25% of the sample were health care students, therefore it would be expected they would have a higher level of knowledge. Ailinger et al (2005) also identified convenience sampling as a limitation but no rationale was given. Translation of assessment tools was identified by only one study as a limitation (Piaseu et al, 2001). Modifications were made to accommodate cultural differences in diet and also the process of translation means some items may have lost clarity. Also modifications made to the FOOQ by Nguyen and

O'Connell (2002) to accommodate an Asian sample were not validated so this could be seen as a limitation.

The use of a tool that may not be sufficiently valid or reliable was acknowledged by Snelling and Walbourn (2000). The Calcium Quiz and the Cooper Institute Physical Activity Questionnaire were used by these researchers and validity and reliability do not appear to have been established. Three authors (Ziccardi et al, 2004; Chan & Ko, 2006 and Wallace, 2002) felt the restrictions of their sample was a limitation. Ziccardi et al felt that 194 participants was a relatively small sample size. Wallace also included the limited geographical area as a limitation as the findings elsewhere in the country could be different.
A modest response rate was another limitation identified in the study by Wallace (2002). Despite the use of incentives, there was a response of only 27.8%.

Adolescent only studies.

Table 7 below summarises the findings of the studies identifying osteoporosis knowledge conducted among adolescents. Two of these studies are based in the US, one in Iran and one in Canada. Despite discussion in the literature regarding the importance of bone development and adolescence being a significant time when the majority of bone mass is accumulated, only four studies were able to be located. Many articles in the general literature promote the idea of educational intervention in this developmental group, yet there is little evidence of research conducted.

Table 7. Summary of international studies among adolescents.

Study	Purpose	Instrument(s)	Design	Participants	Ethnicities	Findings
Brown and Schoenly (2004)	To test effectiveness of an osteoporosis prevention programme with high school students.	HBKQ	Randomised multisite study. Use of Osteoporosis Prevention Teaching in Our Nations Schools (OPTIONS) programme. Pre-test/post-test.	693 teens from 18 schools, male (48%) & female (52%). 50.5% control group. 49.5% OPTIONS.	Asian/Asian American- 5%. African American- 6%. Hispanic- 4%. Native American- 5%. White- 72%.	OPTIONS increased score by 10.7%.
(Martin, Coviak, Gendlerl, Cooper, Rodrigues-Fisher, 2004).	Explore female adolescent knowledge of osteoporosis risk factors, role of calcium and exercise in prevention. Examine the application of the HBM to change perception about risk of developing osteoporosis.	HBKQ	Descriptive with convenience sampling from one school.	107 adolescent girls in aged 11-17 (mean 14)206 females mean age 14.34.	Not specified.	Limited knowledge on osteoporosis risk factors, dietary requirements and exercise.
Anderson et al (2005).	Assess knowledge, beliefs and	Osteoporosis Risk factor Quiz.	Questionnaires.	227 females aged 12-16.	Caucasian- 61.1%.	Knowledge concerning osteoporosis limited.

	practices of 3 osteoporosis risk factors among adolescent girls.	PAQ-C. Teenagers Nutrition Smoking Behavior.			Native Canadian- 21% Metis- 15% Oriental 2.2% Black 0.9%	General knowledge for physical activity, nutrition and smoking but lacked specific details. Low-mod levels of physical activity 22% Smoking 22% 1-5/day 14% ½ pack/day 3% one or more packs .
Hazavehei et al (2007) (HBM).	Examine the application of the HBM to change perception about risk of developing osteoporosis.	Questionnaire developed by authors based on 5 domains of HBM.	Experimental study 3 groups. HBM – 76. Traditional- 60. Control- 70.	206 females mean age 14.34.	Iranian.	Overall scores- C- mean increase 14.8 T- mean increase 3.09 HBM- mean increase 45.0.

The HBKQ used by Martin et al (2004) and Brown and Schoenly (2004) is a modification of the OKT. The OKT was originally developed and tested with adult women aged 35 years and older. The language and examples in the OKT were modified to be more appropriate and better understood by adolescents. Some items were made more specific such as “exercising regularly” was altered to read “exercising 3-4 times a week for 20-30 minutes at a time”.

“Being menopausal” was changed to “stopping periods for more than 6 months”. Other items were added to reflect common adolescent issues such as anorexia, dieting and posture. The tool was then tested for reliability and validity.
Hazavehei et al (2007) developed their own questionnaire based on the HBM. This appears to be unnamed but was tested for reliability and validity.

From the four articles listed in the table, the following themes emerged:

1) Limited knowledge related to osteoporosis.
2) Limited use of osteoporosis prevention behaviours.
3) Education is a factor in osteoporosis prevention.
4) Health education using the HBM is more effective than traditional education.
5) Cultural implications.
6) Smoking.

Limited knowledge related to osteoporosis.

Martin et al (2004) reveal that overall osteoporosis knowledge was limited. This finding is corroborated by Hazavehei et al (2007) who conducted a study which assessed knowledge before and after educational intervention. The study by Brown and Schoenly (2004) revealed pre-test scores across both groups again to be low.
Only two studies included educational intervention and both these reveal a significant change in osteoporosis knowledge post-test. The low knowledge scores are consistent with other studies that include older people.

Limited use of osteoporosis prevention behaviours.

Only the studies by Hazavehei et al. (2007), Martin et al. (2004) and Anderson et al. (2005) discuss some of these behaviours. In these studies students admitted to taking less than the recommended daily intake of calcium and did not participate in the recommended level of physical exercise. Brown and Schoenly (2004) state that the

OPTIONS programme did not help participants develop a desire to, or a plan for implementing recommended preventive behaviours.

Education is a factor in osteoporosis prevention.

The OPTIONS programme used by Brown and Schoenly (2004) demonstrated that there was an improvement in the level of knowledge. The second data collection occurred 3-4 weeks after the educational session was delivered. The Iranian study completed a post test immediately after the educational interventions then a further follow up after one month. This study comprised three groups; one that used the education based on the HBM, another that used traditional education approach and a control group. Martin et al (2004) discuss a previous study that demonstrated that adolescents with a greater knowledge of osteoporosis and bone health were more likely to consume dietary calcium than those who did not have this knowledge. However, they acknowledge that knowledge does not always translate into behaviour change.

Health education using the HBM is more effective than traditional education.

The Health Belief Model (see appendix two) is identified as the underlying framework for many of the studies. The purpose of this was to discover attitudes and beliefs regarding osteoporosis by applying the HBM to the study. Hazavehei et al (2007) demonstrate that a programme based on the HBM appears to improve knowledge levels significantly when compared with a more traditional educational programme. Hazavehei et al (2007) discuss the merits of an educational programme based on the HBM. Their hypothesis was that a health education programme based on the HBM can be effective in promoting the adoption of behaviours by adolescent girls to prevent osteoporosis. This study appears to support this. The other three studies do not indicate a model that has been used as a framework for the studies.

Cultural implications.

While Hazavehei et al (2007) acknowledge that females from many cultures have a low calcium intake; this is only an implication that culture may be a factor. In none of these articles is culture discussed as being an influence on knowledge, attitudes, beliefs or behaviour. Ethnicities are obtained for demographic data in three studies but no cultural and ethnic considerations are discussed.

Smoking.

The study by Anderson et al (2005) reveals an alarming level of smoking among the adolescents in this study. Smoking was not a risk factor discussed in the other studies. In this study it was revealed that the mean age for starting smoking was 11. Ten percent had started smoking before the age of 9, 11% by age 9, 14% by age 11 and 42% by age 12 or 13. This is alarming not just in the significance for osteoporosis but also for other smoking related health problems. 38% were undecided about whether smoking affected bone health and 52% either strongly agreed or agreed.

Limitations.

The use of the same questionnaire being used at the same three testing points was identified as a limitation by Hazavehei et al (2007). It is hypothesised that this could possibly affect the test validity, but how this would influence the outcome is not discussed. These authors also state the assigning of interventions to each of the three groups could have impacted on internal and external validity and ultimately led to a biased evaluation. The lack of longitudinal follow up and only a short term follow up (one month) is viewed as a limitation as well. Martin et al (2004) do not acknowledge limitations in their study, but do mention that it is critical to measure health beliefs, self-efficacy, social support, norms and modelling. They believe that it is important to understand how these concepts could affect adolescent behaviour when developing educational interventions especially for this group.

Brown and Schoenly (2004) mention that the lack of validity and limited reliability data about the outcome measures means that researchers cannot have full confidence that the OPTIONS programme may not impart knowledge. It was noticed that many teenagers merely marked answers rather than actually reading the questions, thus there is concern regarding the reliability of the data.

Anderson et al (2005) felt that the PAQ-C may not have been sensitive enough to differentiate the intensity of activity and therefore the levels of activity may have been underestimated. Despite the reliabilities of the Osteoporosis Risk Factor Questionnaire being deemed adequate, the scores were only in the moderate range. This may be a reflection of the sample size or a reflection of the content assessed. The authors suggest that further refinement of the questionnaire may strengthen the reliability scores.

Osteoporosis Knowledge in New Zealand.

Extensive searching has only revealed two studies that assess osteoporosis knowledge among New Zealanders. Of these, only one is based in New Zealand. The other is a Scottish multicentre study that included 56 New Zealand males and females from a group of 176 that also included patients from Glasgow. Neither of these studies included nor focused on the knowledge level among New Zealand adolescents. They have been included to express the situation in New Zealand and to illustrate that there is an area that warrants further research. The two studies are described in Table 8.

Table 8. Studies that include New Zealanders in assessment of osteoporosis knowledge.

Study	Purpose	Instrument(s)	Design	Participants	Ethnicities	Findings
Spencer (2006)	Assess the level and source of osteoporosis knowledge	Questionnaire devised by researchers. Psychometrics unrecorded	Mulitcentre voluntary questionnaire	Male 26 & female 149 176 total Age range 18-85	Scottish and New Zealand, race not indicated	Poor level of knowledge Females displayed higher level of knowledge than males NZ higher level than Scotland Source of knowledge- majority stated GP
Von Hurst and Wham (2007)	Investigate the knowledge and health beliefs regarding osteoporosis risk factors of New Zealand women	OKT OHBS	Descriptive web-based survey	622 women Age 20-49	NZ European - 82% Asian- 6% NZ Maori- 4% Pacific- 1%	Average levels of knowledge about osteoporosis, lower than expected-mean score 63% Knowledge levels increase with age Low level of knowledge regarding Vit D Low levels of susceptibility to disease as low as 29% Most considered it a serious disease 77% believe that calcium rich foods are high in cholesterol High level of motivation to take care of their health

There are a number of themes in these articles that reflect those found in the international studies.

Lack of Knowledge.

Both articles demonstrate a lack of knowledge regarding osteoporosis. The study by von Hurst and Wham (2007), demonstrated that low knowledge levels were apparent despite 59% of the women holding an undergraduate degree or an equivalent qualification.

New Zealand participants in the study by Spencer (2006) demonstrated a higher level of knowledge than their Scottish counterparts. The author attributes the disparity to the fact that the New Zealand participants (living in Christchurch), lived in a higher socio-economic area than those in the Glasgow Royal Infirmary catchments area. Von Hurst and Wham (2007) made an interesting discovery in that a high proportion of women in the study considered calcium rich foods to contain high levels of cholesterol. The implication is that the benefits of low-fat dairy products are not well understood. In any health promotion strategy this factor would have to be included. Spencer (2006) reports that a large number of patients (31.8%) could not identify any risk factors; with 39.2% displaying no knowledge of osteoporosis signs and symptoms. Interestingly, but perhaps not surprising, many males do not perceive themselves to be at risk of osteoporosis. The author suggests that a lack of interest in the disease may be reflected in the poor knowledge levels.

Socio-economic status.

Of all the articles reviewed both nationally and internationally, only Spencer (2006) suggests that socio-economic status may be significant in assessing levels of osteoporosis knowledge. This may be of importance in future studies.

Perception regarding food.

Von Hurst and Wham (2007) suggest that beliefs about food may have an impact on calcium intake. A knowledge deficit regarding the cholesterol levels contained in dairy foods was identified with 77% of

participants demonstrating a belief that this was true. Older women were more likely to agree with this statement than younger ones. No reason for this is given. This has identified the need to communicate the availability of low fat/low cholesterol dairy products. No other study reviewed has mentioned any perceptions of beliefs regarding food.

Ethnicity.

Neither of these articles mention the role of culture or ethnicity in beliefs, knowledge and attitudes regarding osteoporosis and preventive behaviours. Of considerable surprise is the fact that the study by von Hurst & Wham (2007), being based in New Zealand does not consider this possibility. As New Zealand has a policy of biculturalism, all health care strategies are required to reflect the principles of the Treaty of Waitangi. There were a limited number of Maori represented in this study so this may be a factor. This limited representation may have made it difficult to fully consider the cultural impact on knowledge.

Limitations.

Spencer (2006) feels that some of the apparent lack of knowledge could be due to the questionnaire design. Some of the questions were open ended which may lead to a lower response rate than closed equivalents. The difference between the socio-economic status of the two countries could also be seen as a limitation to the study as this made drawing direct comparisons between the two groups somewhat unreliable.

Von Hurst and Wham (2007) indicate that their study was not truly representative of New Zealand women aged 20-49 years. The participants were drawn form a large metropolitan area of New Zealand and the sample did not provide a good representation of NZ Maori or Pacific women. In order to meet the requirements of the Treaty of Waitangi, a higher representation of NZ Maori and rural and urban women would be required. For the purposes of this study, an urban population was selected in an attempt to control differences among rural and urban populations, making it difficult to have a true representation of New Zealand women. In this study, self recruitment was

identified as a limitation. The number that participated in the web-based survey and those who declined was not ascertained.

Summary.

It is apparent from all the studies reviewed, that globally the level of osteoporosis knowledge is consistently low. In those studies where educational interventions have been undertaken, no long term assessment of the effect on knowledge level or implementation of health belief behaviours has been undertaken. Knowledge deficits need to be corrected before people can engage the health prevention behaviour.

Many of the studies indicate that an improvement in knowledge does not always equate to an improvement in health preventive behaviours. This is not limited to osteoporosis prevention. However, without knowledge, behaviour change is not informed. Despite the majority of studies collecting ethnic data, the role of culture and ethnicity on osteoporosis knowledge, attitudes and beliefs is rarely discussed. The absence of this in the New Zealand study was very apparent, given the cultural safety requirements in health care. Research studies do not necessarily need to target Maori or Pacific Island groups unless this is the intended focus. Greater representation of these groups in a general study may influence the outcomes. Osteoporosis is a disease that affects mainly females. This is reflected in the studies reviewed where there is a strong representation of female participants. There are few studies that focus on the problem in men.

It is recognised that adolescence is a key developmental area in terms of skeletal growth, with the majority of bone mass being laid down during those years. Despite this being acknowledged, there are few studies that explore osteoporosis and prevention among this age group. Those studies that have used the HBM as the framework for the research appear to have produced better results, suggesting that this is a realistic framework for osteoporosis prevention strategy. A better picture of osteoporosis knowledge, beliefs and attitudes has been obtained through the studies that have utilised more than one instrument. These studies have demonstrated that knowledge alone is not always enough to produce change, that and understanding of beliefs and attitudes is a key part of any health promotion programme.

PART TWO.

The scope of osteoporosis prevention strategies for the adolescent population group.

Objective: To ascertain what osteoporosis prevention programmes exist for the adolescent group.

Extensive searching has revealed very little in the way of formal education or health promotion programmes for adolescents that seek to improve knowledge and awareness regarding osteoporosis. A few programmes are available in the US and two resources kit in New Zealand that are available for use in schools. Websites exist which contain information for anyone who may be interested to access. Existing programmes are outlined below. In the information reviewed, theoretical frameworks upon which the works were based did not appear to be evident.

USA.

Jump Start Your Bones©. (Klotzbach-Shimomura & Keenan, 2001)

This programme is a school based osteoporosis prevention programme developed to target adolescents in 7th and 8th grade. The programme contains 12 interactive lessons, 3 each for the following disciplines: Family and Consumer Sciences, Health, Physical Education, and (Life) Science. The lessons are designed to be suitable for multicultural groups as well as cultures with a high incidence of lactose intolerance. Information for the teachers includes statistical evidence of the growing incidence among African American, Asian and Hispanic communities. The educational programme was determined by the use of focus groups to establish what was most suitable to the teachers' needs and students' desires. This programme was developed in the state of New Jersey and developed in accordance with the teaching standards from the New Jersey Department of Education. Teachers would be delivering the programme and therefore, they wanted lessons that fitted into the core curriculum, were relevant to the students, interactive and included internet-based activities. The students stated a preference for group activities where they could choose their own groups. They did not want lectures, but preferred discussion, role-playing, lab

activities and highly visual lessons. All the lessons appear to be highly interactive, involving preparing different foods, examining the amount of calcium contained in regular foods consumed, planning lab experiments showing bone weakness from loss of calcium, creating own exercise logs, group work to demonstrate how teens can influence their calcium intake and exploring physical activities suitable for increasing bone density.

This curriculum has been tested using a control group and experimental group. The results demonstrate that the experimental group, who received the lessons, demonstrated a statistically significant difference between the pre and post intervention assessments. How these assessments were conducted is not discussed and how significant the changes were is also not mentioned. The authors state that this will be part of another manuscript that is in preparation. There has been a book published with this title, but is currently unavailable for public access at this stage. There does not appear to be any research that looks at the assessment of this programme at this time.

Bone Builders. (www.ag.arizona.edu, 2007)

The Bone Builders programme is a community based osteoporosis prevention strategy. It is part of a partnership with the University of Arizona Cooperative Extension, the Arizona Department of Health Services, Arizona Osteoporosis Coalition and many others that include county health departments, health providers and interested citizens. The programme used volunteer educators, community surveys and a social marketing campaign to spread the osteoporosis message. Trained volunteers teach community classes, provide outreach education at health fairs and bone density screenings. Osteoporosis risk factor questionnaires, stages of change and knowledge surveys are collected from the classes. Bone Builders social marketing utilises a range of media resource including newspaper features, flyers, newspaper articles, posters, a website and a call number that offers taped osteoporosis information in English and Spanish (Stanford et al. 2005). The claim is made that knowledge has increased among participants in the programme. In association with this, there appears to have been an increase in calcium intake and weight-bearing exercise. There does not appear to be any published research to support this. Unfortunately, this programme is not

specifically designed for adolescents and the content of it has not able to be located. This being the case, it is not feasible to speculate as to whether or not this programme has been successful.

*OPTIONS (**O**steoporosis **P**revention **T**eaching **I**n **O**ur **N**ations **S**chools)* (NAON, 2003)

The OPTIONS programme is produced by the National Association of Orthopaedic Nurses (NAON) in the US. The programme is a healthy bones and osteoporosis prevention education presentation, developed and tested by members of NAON and is targeted at 14 and 15 year old children. It takes ½ hour to deliver, but may take longer if lengthy discussions occur. Although it was developed for the classroom, it is able to be used with community groups such as scouts and church groups. The programme has been developed so it is suitable for males and females.

Version 1 of the OPTIONS programme was tested with 900 students from 20 schools across the country. The outcome was a statistically significant improvement of the knowledge level of the participants. However, it was revealed that the perceptions of barriers to exercising and increasing calcium intake were no different. Consequently the programme was modified to make it more interesting, include more discussion questions, address specific food choices teenagers might make and give more examples about bone building exercises. The presentation is available on a CD or can be downloaded from the NAON website. It is a PowerPoint presentation which covers basic knowledge on osteoporosis, nutrition and physical activity. The images are representative of normal everyday activity. The OPTIONS programme has been taken to the UK by two nurses who attended a NAON Congress in 2002. A committee was formed to review the programme and to "anglicise" it. This was done in conjunction with the National Osteoporosis Society (Capper & Flanagan, 2005). The committee has undertaken to develop a national educational programme rather than a research project. This fits in with the UK "Healthy Schools" project and allows Royal College of Nurses Society of Orthopaedic and Trauma Nursing (RCNSOTON) to work with the education department directly. Capper and Flanagan (2005) state that a pilot study will need to be done to provide evidence of its success, although there is no

literature to date that suggests this has been carried out. There has been debate as to who should deliver the programme; the committee favouring the school nurse or the teacher after training by an expert. The schools feeling is that it would be better if an expert delivered the material. There has been a name change as 'OPTIONS' in UK schools has an alternative connotation: the choices year 9 pupils make when planning their subjects.

Better Bone (BB) Buddies. (Schrader, Blue & Horner, 2005).

The BB Buddies is an educational programme aimed at 9-15 year olds that applies HBM as the underpinning theoretical framework. It was developed with the purpose of being incorporated into the school health curriculum. The programme was designed to bring a positive, fun and educational message to children in this age group. BB Buddies has two factors that make it unique:

a) the intentional connection of current dietary behaviours to improving bone health and delaying or preventing the onset of osteoporosis
b) the integration of an international element into the programme design.

During the development of the programme there was an intergenerational component, pairing older women with younger so that the youth might better understand the implications of osteoporosis. The programme can be tailored according to length (30-60 minutes) and is able be used in a variety of settings. The programme emphasis depends on the age group at which it is being targeted at the time. The younger participants have a shorter session and the emphasis is placed on tasting snacks high in calcium and sharing examples of the dangers of broken bones such as breaking an arm on a merry-go-round. Older students received more advanced content, such as the physiology of bone growth and were asked to record a typical food day to calculate the percentage of calcium in their diet. The format of the programme includes a skit, a video, games, stories and a high calcium snack. A study of this programme revealed an increase in knowledge with evidence that the students had also shared the information with family and others. Changes in eating habits were also assessed with students reporting some changes including drinking more milk, eating a healthier diet and exercising more. Another consequence of this programme was a greater awareness among the students of the components that make up food and many reported reading food

labels more frequently. No other studies using this programme have been uncovered.

The Internet.

There are numerous web sites that provide information on osteoporosis and prevention. Wallace, Turner, Ballard, Keenum and Weiss (2005) undertook an evaluation of web based osteoporosis education materials. The readability and quality of web-based information on osteoporosis was assessed using the Suitability Assessment of Material (SAM) and DISCERN instruments. DISCERN is an instrument developed that enables both health care consumers and providers to judge the quality of written information about treatment choices (Charnock, Shepherd, Needham and Gann, 1999). The instrument was developed in two stages: first, an expert panel developed and tested the tool, and secondly the tool was tested using a national sample of information providers and consumers.

The SAM comprises six categories (content, literacy demand, graphics, layout and typography, learning stimulation and motivation and cultural appropriateness. The DISCERN instrument was used to assess the quality of treatment options. The search engines used included Google, Yahoo and MSN. The validity and reliability of these tools was established although how is not given. The overall results reveal that 51.9% of materials available were rated by SAM as being unsuitable with most scoring poorly for reading. The DISCERN score revealed overall inadequate quality of materials available. This study would suggest that most web based educational materials regarding osteoporosis are unsuitable. The age groups for the material assessed are not given. It is reasonable to assume that if overall the materials lack quality then this would apply to materials available for the adolescent group.

New Zealand educational resources for adolescents.

No education programmes in New Zealand that target adolescence in the issue of osteoporosis prevention have been located. Osteoporosis New Zealand developed a resource that was mailed to all schools in the country in 2002 to be used within the health section of the curriculum. There appears to be no evidence to suggest this has been used. The resource is known as

"Choice Action" (Osteoporosis New Zealand, 2002) part of which is able to be viewed on the web site. The key areas of learning link to the food and nutrition, physical activity and mental health units in the school curriculum. Activity sheets and questionnaires are included. The target age group is year 9-10 students (approximately 14-16 year olds).

In the 1990's another resource called Mission Dairy Energy was developed. 'Mission Dairy Energy' was developed for use in NZ schools to support the Science and Health curriculum areas and promote dairy products as a healthy food source. It includes 12 interactive learning activities. (Zinn, personal communication, March 26, 2007). This programme is not specifically focused on osteoporosis.

There are some Ministry of Health initiatives that are designed to improve dietary habits and exercise levels among New Zealanders in general. These are more aimed at rectifying the obesity problem than improving bone health.

Mission-On (SPARC, 2006) is a broad based package of initiatives to encourage young New Zealanders and their families to improve their general nutrition and physical activity levels. The target age range of this set of initiatives is 0-24 years of age. This is part of the Government's primary health initiative to address the problem of obesity, however, improved nutritional status and physical activity does have a positive impact on bone health. Mission-On builds on existing government programmes within school, early childhood education services and communities within New Zealand. Other government initiatives include Push Play, Active Schools, Fruit in Schools, Active Movement and Active Communities. Sports and Recreation New Zealand (SPARC) is expected to be heavily involved in this programme, setting up youth focussed web sites, developing a network of high-profile ambassadors to promote healthy choices and to model healthy positive lifestyles. This initiative is still only in the early stages of development although some evidence can be seen through the media promoting healthy eating choices and physical activity. This can only be viewed as a positive move, but it is as yet too early to assess the impact of these on the health of our communities.

Despite recent media reports of the burden of osteoporosis in New Zealand, there is little purposeful education in this area. Until recently, assessment of knowledge studies in New Zealand had not been undertaken either.

Despite much of the literature emphasising the importance of education for adolescents in the area of osteoporosis prevention, there does not appear to be many purpose designed programmes to fill this need. While many programmes have been used in school, details of these are scarce and appear to have been developed for research purposes. Other than the OPTIONS programme, there is no indication that other programmes have been used again or are currently in use. There appears to be a lack of community based health promotion programmes in New Zealand. Health education that does occur appears to be largely based on the school curriculum and therefore has only school aged children as the target audience.

CONCLUSION.

Osteoporosis is a problem that is growing in significance in New Zealand as well as worldwide. The origins of the disease can begin early and are often related to lifestyle choices made during adolescence and young adulthood. Numerous studies demonstrate a general lack of knowledge regarding osteoporosis risk factors and preventive behaviours. Few of these studies include adolescents exclusively, so a true picture of the level of knowledge among this age group is difficult to determine. Studies that focus exclusively on the adolescent age group are scant and those that do exist demonstrate a consistent lack of knowledge regarding osteoporosis risk factors and preventive behaviours. Where educational interventions have been implemented, knowledge levels have altered positively, but there was not always a corresponding change in beliefs, attitudes or undertaking of preventive behaviours. The longest follow up after educational intervention was one month. Whether the changes in behaviour and knowledge have been influenced on a long term basis has not been determined in the studies reviewed. The impact of cultural influence on behaviour has not been fully explored in the studies and as many of our behaviours and decisions are based on our cultural perspective, this is a factor that needs to be seriously

considered. Many studies focus only on females, but the literature suggests that males can be affected by osteoporosis as well, usually up to 25-30%. In New Zealand, there are no documented studies found that assess knowledge of osteoporosis risk factors and preventive behaviours among adolescents. Indeed, only this year, 2007, was a study published assessing these issues in older women. This study was consistent with the findings of overseas studies, in that knowledge levels were low regarding osteoporosis.

Recommendations.

Health promotion strategies need to reflect the principles of the Ottawa Charter for Health Promotion (WHO, 1986). In New Zealand initiatives also need to reflect the principles of the Primary Health Care Strategy (2001).

- Educational packages to include cultural components as cultural beliefs can impact of dietary choices
- Assessment and evaluation of the "Choice Action" package and research to establish its use. This is available, but there is no reported evidence that this is in use and whether it is effective.
- Osteoporosis to be adopted by Government as a national public health priority with funding as recommended by the Burden of Osteoporosis in New Zealand: 2007-2020 report.
- A multidisciplinary team approach to development and delivery of osteoporosis education that involves dieticians to address the nutritional issues, sports trainers to address the physical activity needs especially those involving weightbearing activities, nurses who have access to schools (such as school nurses and Public Health Nurses) and cultural representatives to ensure the values of cultural and ethnic groups are not violated.
- Compulsory physical education to be re-established for 15-18 year olds. These are the ages of maximum bone mass accrual and weightbearing is a significant factor in the laying

down of bone mass. It is also at this age that physical education becomes an option.

- Re-introduction of milk in schools with alternatives for those that are lactose intolerant, corporate sponsorship to be sought as has occurred in Project Energise currently being undertaken in the Waikato region. Preliminary information presented by Dr Dave Graham at the ANZONA conference suggests this has been positive among the children in the lower decile schools where the initiative was undertaken.
- Research to be done in New Zealand examining osteoporosis knowledge, beliefs and behaviours among adolescents.
- Active steps to increase awareness of osteoporosis through schools, community, church and cultural groups. This research needs to include longitudinal studies, looking at the long term influence of educational interventions and the impact this has on beliefs and behaviours.

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APPENDIX ONE.

GLOSSARY OF TERMS.

Glossary of terms.

Calcitonin	A hormone produced in the thyroid gland that participates in the regulation of calcium levels in the blood and stimulates bone mineralisation.
Calcium	An alkaline earth metal element. The body requires calcium for the transmission of nerve impulses, muscle contraction, blood coagulation and cardiac function. It is the fifth most common element in the body and over 90% is stored in the skeleton. Vit D, calcitonin and parathyroid hormone are essential in the metabolism of calcium.
Convenience sampling	Selection of the most readily available persons as participants in a study, also known as accidental sampling.
Glucocorticoids	Adrenalcortical steroid hormone that increases the glycogen formation, exerts an anti-inflammatory effect and influences many body functions.
Hmong	A cultural sub group of Chinese, originally from the mountains of southern China.
Mesenchyme tissue	Tissue derived from the embryonic mesoderm which is the middle of the three cell layers of the developing embryo. Gives rise to bone, connective tissue, muscle, blood, vascular and lymphatic tissue.
Metis	One of three recognised Canadian Aboriginal peoples
Oestrogen	One of a group of hormonal steroid compounds that promote the development of female secondary sex characteristics. It inhibits the development of osteoporosis.
Osteoblast	A cell, that is responsible for the formation of bone.
Osteoclast	A large multinucleate cell that resorbs calcified bone.
Osteopenia	A condition of less than normal mineralised bone.
Parathyroid hormone	A hormone secreted by parathyroid gland that acts to maintain a constant concentration of calcium in the extracellular fluid.
Polypeptide hormone	A polypeptide is a chain of amino acids joined by peptide bonds. Peptide and polypeptide hormones include thyroid hormones, parathyroid hormone.
Thyroid hormone	An iodine containing compound secreted by the thyroid gland, predominately as thyroxine (T4) and in smaller

	amounts as four times more potent triiodothyronine (T3). These hormones increase metabolic rate and help maintain skeletal maturation.
Viscoelasticity	The quality or condition of being both viscous and elastic.

APPENDIX TWO.

THEORECTICAL MODELS USED

Health Belief Model.

The HBM was constructed by Rosenstock in 1966. The HBM is based on four constructs. These are:

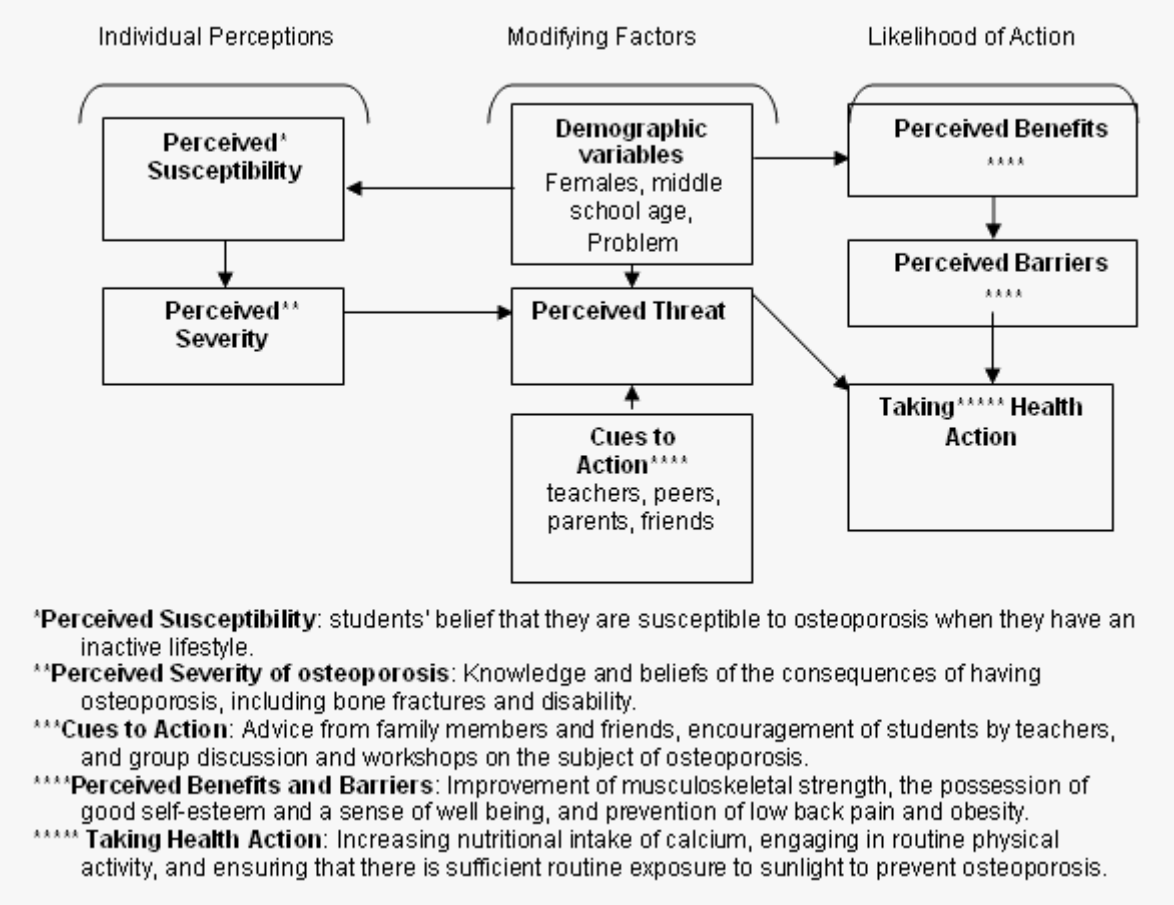
1) Perceived susceptibility (an individual's assessment of their risk of getting the condition).
2) Perceived severity (individual's assessment of the seriousness of the condition and potential consequences).
3) Perceived barriers (influences that can facilitate or discourage adoption of promoted behaviour).
4) Perceived benefits (individual's assessment of the positive consequences of adopting behaviour.

Two other constructs were added later:

1) Perceived efficacy (individual's self-assessment of ability to successfully adopt the desired behaviour).
2) Cue to action (external influences promoting the desired behaviour).

In order to develop successful educational interventions, knowledge of all the domains is believed to be vital to the planning process (Hazavehei,Taghdisi & Saidi, 2007). The framework was developed as a model for health educators and to try and explain why people would not participate in programmes to prevent or detect disease (Roden, 2004). It is claimed that use of the HBM has resulted in effective programmes in which individuals change their beliefs that lead to an increase in healthy behaviours (Hazavehei, Taghdisi & Saidi, 2007). The frame work appears to have been used successfully in osteoporosis prevention across various age groups and ethnicities. According to Roden (2004), the HBM has been regarded as a useful tool for nurses to help individuals assess and manage illness prevention or prevent health problems. It has been used in a variety of practice settings.

See below for a diagrammatic view of the Health Belief Model. This was used in a study by Hazavehei, Taghdisi and Saidi (2007). This study examined osteoporosis beliefs and behaviours among teenage girls in Iran.



Source: www.educationforhealth.net/

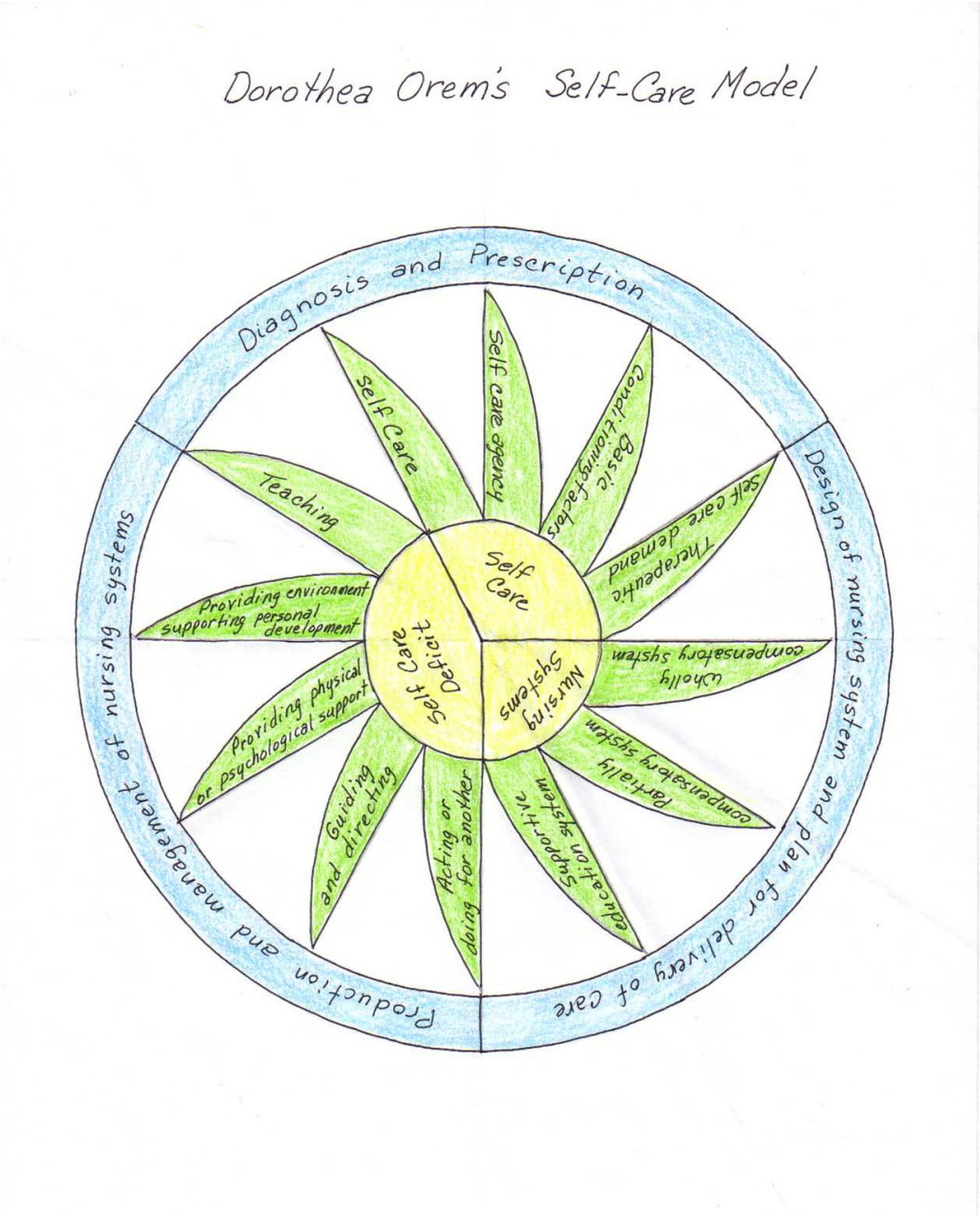
Orem's Self-Care Theory.

Orem's Self-Care theory was developed between 1959 and 2001 by Dorothea Orem. It is used particularly in rehabilitation and primary care settings where the individual is encouraged to be as independent as possible. The self care requisites are groups of needs or requirements as identified by Orem. They are classified as the following:

- Universal self care requisites- those needs that all people have
- Developmental self care requisites- those needs that relate to development of the individual
- Health deviation requisites- those needs that arise as a result of a patient's condition

Orem's theory is based on the philosophy that all patients wish to care for themselves. Patient's dependencies are rated by the following:

- Total compensation - person can do nothing or very little for themselves
- Partial compensation - patient can do some activities but assistance is still required
- Educative/supportive - patient is virtually independent, minimal assistance and education provided



Source: www. nursing.jbpub.com