J. Korean Dairy Technol. Sci. 22(2) : 143~150, 2004

Dairy Dietary Calcium and Osteoporosis - An Overview

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ABSTRACT

The osteoporosis is a disease characterized by lower bone mineral content, deterioration of bone tissue and a reduction in the protein and mineral matrix of the bone. The bone becomes more porous leading to increased bone fragility and risk of fracture, particularly of the hip, spine and wrist. Osteoporosis can result in disfigurement, lowered self-esteem, reduction or loss of mobility, and decreased independence. Adequate calcium intake through milk and milk products in childhood and adolescence is a decisive marker for obtaining a maximum bone mass (peak adult bone mass) and for the prevention of osteoporosis. Calcium is one of the most critical nutrients associated with the osteoporosis. Dietary calcium is of great significance for healthy skeletal growth and development. The bone mineral content and bone mineral density of young adults is directly related to the calcium intake through milk and dairy products. Milk and milk products are the important sources of calcium as the richness and bioavailability of this nutrient is very high as compared to other food products. If enough calcium is not supplemented through diet, calcium from the bone will be depleted to maintain the blood plasma calcium level. The article focuses on the various issues related to osteoporosis manifestation and the role of dietary calcium especially calcium derived from dairy products.

(Key words: Osteoporosis, Homeostasis, Dietary calcium, Bioavailability of calcium, Recommended daily allowance, Strategies for osteoporosis)

I. Introduction

Osteoporosis and related fractures represent major public health problems that are expected to increase dramatically in importance as the population ages (Tucker, 2003). Osteoporosis affects millions of middle-aged and elderly people throughout the world, especially postmenopausal women who are susceptible to bone fractures (Rusoff, 1987). It is a disease characterized by low bone mass, deterioration of bone tissue and a reduction in the protein and mineral matrix of the bone (Oria, 2003). This leads to increased bone fragility and risk of fracture, particularly of the hip, spine and wrist. Osteoporosis is often known as "the silent thief" because bone loss occurs without symptoms prevalence. The condition is a universal accompaniment of aging in both sexes and all races, but is clinically more apparent in women than men because of the adverse effect of the menopause. One in four women over the age of 50 has osteoporosis. One in eight men over 50 also has the disease. However, the disease can strike at any age (Smith et al., 1985). It is a systemic skeletal disease characterized by a too little bone mass in the bone. The composition of the bone tissue is for all practical purposes normal; there is simply less of it. In simple terms the bone becomes more porous [hence the term

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osteoporosis] and therefore weaker and more liable to fracture. The high incidence of osteoporotic fractures leads to considerable mortality, morbidity, reduced mobility and decreased quality of life (Gennari, 2001). Given the magnitude of the problem public health measures are important for preventive intervention.

Calcium is the main essential mineral for building strong bones and sound teeth. Bone remodeling occurs throughout life; new bone is deposited and existing bone is replaced. Peak bone mass development is obtained up to 35 years of age after which bone resorption is increased. It is therefore imperative that Ca intake to meet the recommended dietary allowances not only during the growing period but throughout life is of great significance (Rusoff, 1987). Consumption of foods rich in calcium at early stages of growth and development are of paramount significance in attaining the optimum bone mineral density to over come osteoporosis (Renner, 1994; Gregory et al., 1999). Supplementation sufficient dietary calcium through milk and milk products is one of the key factors in manifestation of osteoporosis (Dennis, 1992; Kansal, 1998; Gregory et al., 1999). In this article an attempt is made to highlight some of the important aspects of osteoporosis in relation to dietary calcium especially with respect to the significance of consumption of milk and milk products.

Ⅱ. Principal Clinical Features of Osteoporosis

Osteoporosis is a metabolic bone disease characterized by low bone mass and micro architectural deterioration of bone tissue leading to enhanced bone fragility and a consequent increase in fracture risk often called a silent disease. Osteoporosis develops gradually over many years before the occurrence of clinical symptoms. Some of the important symptoms are: loss of height, curvature of the spine and fracture especially of the spine and wrist, loss of bone mass and severe deformities, bone pain (dull low backache), vertebral compression fractures, striking loss of stature, a progressive decrease in the amount of mineralized tissue, marked thinning of cortical bone and a reduction in the number and size of trabeculae in cancellous bones. The loss of estrogenic steroids in post menopausal women was felt to be important in causing decreased bone matrix formation. Bone resorption may exceed bone formation by 50 to 100 mg. of calcium /day (Deal, 1997; Anderson, 2001; Mercy, 2002).

1. Risk Factors for Osteoporosis

A number of risk factors for osteoporosis have been identified. Genetics, environmental or life style factors influence the likelihood of developing this disease. Genetic factor influences peak bone mass, skeletal structure and metabolic activity. Family History - If a family member has had osteoporotic other member may be at risk. Gender women are more susceptible than men. Ethnicity - Caucasian (white) and Asian women are most susceptible. Age - Osteoporosis is found mostly in older adults. Hormonal status - estrogen deficiency at menopause or earlier (before age of 45 years) in women and hormonal reductions in men may lead to risk. Body frame- A thin, small boned frame increase risk of osteoporosis. Diet - A diet chronically low in Calcium and Vitamin D increase risk. Exercise- Lack of regular physical activity can reduce bone mass and in older adults also reduce muscle strength. Cigarette smoking - smoking is linked to increase risk. Alcohol - Excess alcohol intake increases risk of osteoporosis. Caffeine - Caffeine can induce an initial short term increase in urinary calcium excretion and causes deterioration in calcium balance (Deal, 1997; Anderson, 2001; Lunt et al., 2001; Mercy, 2002). Low dietary intake and decreased absorption of calcium are known as important risk factors of osteoporosis. Peptic ulcer disease may be accompanied by dietary restrictions influencing negatively calcium intake (Sawicki et al., 2003).

Calcium has a variable effect on bone health in women during early post menopausal years. The period of most rapid bone loss, due to the loss of estrogen at menopause, women loose bone mineral at a rate of about 3% a year for about five years after menopause and then more slowly (1 % a year) . Therefore, during the first 5

years of menopause, Calcium is less effective in protecting the skeleton than in the pre-menopause and late menopause years. The profound and rapid loss of estrogen in the early postmenopausal years, women loss about 15% of the bone they had before menopause. Estrogen replacement therapy is effective in preventing postmenopausal bone loss from all skeletal sites. Intake of an adequate of Calcium (1200 mg per day) during the early post menopause period is important to bone health (Dennis, 1992; Anderson, 2001). Women because of their generally smaller lighter bones, rapid loss of bone at menopause and lower calcium intake are more likely to develop osteoporosis than are men. The decline in Calcium absorption associated with aging may be explained in part by low body stores of vitamin D as well as the age related decline in gut mass which generally associated with decreased food intake (Gregory et al., 1999; Lunt et al., 2001).

Skeletal bone mass is determined by a combination of endogenous (genetic, hormonal) and exogenous (nutritional, physical activity) factors. Nutrition plays an important role in bone health. The two nutrients essential for bone health are calcium and vitamin D. Reduced supplies of calcium are associated with a reduced bone mass and osteoporosis, whereas a chronic and severe vitamin D deficiency leads to osteomalacia, a metabolic bone disease characterized by a decreased mineralization of bone. Vitamin D insufficiency, the preclinical phase of vitamin D deficiency, is most commonly found in the elderly persons (Gennari, 2001). The major causes of vitamin D deficiency and insufficiency are decreased renal hydroxylation of vitamin D, poor nutrition, scarce exposition to sunlight and a decline in the synthesis of vitamin D in the skin. Calcium supplements reduce the rate of bone loss in osteoporotic patients (Gennari, 2001). Heavy physical activity in men might increase spine deformity risk even when BMD is normal. Besides age and sex other adverse risk factors include corticoid steroid, excess hyperthyroidism, immobilization, alcohol and high caffeine intake. The adverse effect of smoking on bone mineral density has been confirmed (Smith et al., 1985; Mercy, 2002).

2. Role of Dietary Calcium

Food intake high in calcium content is important in the development of skeleton and the prevention of osteoporosis. From a public health perspective, it is therefore important to know the dietary calcium intake of a population (Sloutskis et al., 1995). An adequate intake of calcium protects against increased bone resorption, as evidenced in particular by the reduced levels of serum osteocalcin, a parameter of bone turnover (Stracke, et al., 1993). Calcium intake has a positive influence on bone mass in premenopausal women and has a preventive effect on the rate of bone loss in postmenopausal women. Even small advantages in bone mass provide great reductions in fracture rates (Weaver, 1992). Foods and food components, including milk, fruit and vegetables, soy products, carbonated beverages, mineral water, dietary fiber, alcohol and caffeine have recently been examined and the evidence clearly suggests that prevention of bone loss through diet is complex and involves many nutrients and other food constituents (Tucker, 2003). The pharmacological supplement of calcium would be justified when the ingestion of milk and its derivatives is low in the juvenile and pre-menopausal ages, as well as in cloistered or institutionalized persons, for whom vitamin D supplements should be added (Oria, 2003). Some studies have reported a significant positive effect of calcium treatment not only on bone mass but also on fracture incidence. There are a number of studies on the effects of vitamin D supplementation on bone loss in the elderly, showing that supplementations with daily doses of 400~800 IU of vitamin D, given alone or in combination with calcium, are able to reverse vitamin D insufficiency, to prevent bone loss and to improve bone density in the elderly population (Gennari, 2001).

3. Recommended Allowances for Calcium

Calcium intake is one of a number of factors that affect peak bone mass. Low bone mass is related to increased incidence of osteoporotic fractures (Fleming and

Heimbach, 1994). In recent years, there has been much uncertainty about the intake of calcium for various ages and physiological states. In 1998, the expert committee of the European Community in the Report on Osteoporosis-Action on prevention has given the recommended daily dietary allowances (RDA) for calcium at all stage of life. For the elderly population, above age 65 the RDA is 700~800 mg/day. Evidence supports that routine supplementation for these people at risk of osteoporosis, by providing a daily intake of 700~800 mg of calcium and 400~800 IU of vitamin D. This is an effective, safe and cheap means of preventing osteoporotic fractures (Gennari, 2001).

Data from the USDA 1987~88 Nationwide Food Consumption Survey were used to determine populations most at risk of less than optimal calcium intake and food sources of calcium intake. About 50% of total dietary calcium was supplied by milk and milk products. Milk and cheese used as ingredients in meat, grain, and vegetable mixtures contributed another 20% of dietary calcium. The remaining 30% of calcium was provided by grains and grain products, meat, poultry, fish, vegetables, fruits, eggs, legumes, nuts, and seeds (Fleming and Heimbach, 1994). Adequate calcium intake also protects against increased bone resorption, as evidenced particular dations. The explanation for the apparently lower Calcium requirement in developing countries may be their lower protein and or Sodium intakes than in the west (Kansal, 1998). Since both these nutrients increase Calcium excretion, and also higher circulating levels of Para Thyroid Hormone and Calcitriol in people of developing countries. Recently, some research workers have suggested that calcium requirements for adults and young by the reduced serum osteocalcin, a parameter of bone turnover. The recommended dietary allowances of calcium have been fixed to 1200 mg/d in Europe for the age group between 10 and 24 years (Renner, 1994).

Table 2. New Recommendation for Calcium Intake by National Institute of Health, US

800 mg	1 to 10 years children
1,200~1,500 mg	11 to 24 years (Young adults)
1,000 mg	25 to 50 years(adult men & women)
1,500 mg	65 years (men & women)

The U.S. recommended dietary allowances (RDA) of Calcium are considerably higher than FAO/WHO or Indian Council of Medical Research (ICMR) recommenchildren may be even greater than the current RDA. The National Institute of Health (NIH) U.S.A., made a new recommendation of calcium requirements. The following table provides a comparative RDA provided by various organizations for the calcium intake.

4. Role of Milk and Milk Products

The bone mineral content and bone mineral density of young adults is directly related to the calcium intake through milk and dairy products. The osteoporosis results in significantly lower bone mineral content. Adequate calcium intake through milk and milk products in childhood and adolescence is a decisive marker for obtaining a maximum bone mass (peak adult bone mass) and for the prevention of osteoporosis. Furthermore, it

Table 1. Recommended Dietary Allowances (RDA) for Calcium (mg/day)

Category	United States	FAO/WHO	ICMR
Infants	400~600	500~600	500
Children and Young adults			
1~10 years	800	400~500	400
11~24 years	1,200	600~700	500~600
Adults	800	400~500	400
Pregnant and Lactating women	1,200	1,000~1,200	1,000

can be stated that increased calcium intake in the later years may not reduce the accelerated risk of osteoporosis resulting from inadequate calcium intake during childhood and adolescence (Stracke, et al., 1993, Renner, 1994). The main sources of calcium in the diet are dairy products (milk, yoghurts and cheese) fish (sardines with bones), few vegetables and fruits. The optimal way to achieve adequate calcium intake is through the diet. However, when dietary sources are scarce or not well tolerated, calcium supplementation may be used. Calcium is generally well tolerated and reports of significant side-effects are rare (Gennari, 2001). Milk and dairy products are the major food source of Ca in the US diet, supplying about 61% of intake while other food groups supply the rest. It is almost impossible to supply the recommended dietary allowances of Ca without consuming milk in some form, as most other food groups are low in Ca content (Rusoff , 1987). Milk is recommended as an excellent calcium source for bone health. Moreover, milk is considered to contain other components effective for bone health. Milk whey protein, especially its basic fraction (milk basic protein [MBP]), suppresses bone resorption. MBP suppresses bone resorption by its direct effects on osteoclasts. It directly suppresses osteoclast-mediated bone resorption, resulting in the prevention of the bone loss (Toba et al., 2000). Eighty percent of peak bone mass should be achieved from birth through adolescence. An adequate calcium intake is therefore essential, and it is advisable that 60% of the recommended calcium allowance be dairy calcium (Infante and Tormo 2000). Long term suppression of dairy products or partial withdrawal of milk products for a prolonged period may lead to potential risk of defective bone mineralization and should be monitored through bone mineral index (BMD) assessment (Infante and Tormo, 2000). An increased prevalence of osteoporosis has been observed in lactase-deficient subjects. This association has been attributed to an avoidance of calcium-containing dairy products by lactase-deficient subjects and/or an adverse affect of lactose malabsorption on calcium absorption. The lactose in yogurt can be digested and absorbed by hypolactasic subjects. Calcium in yogurt is better absorbed than calcium in milk. Yogurt remains an excellent source of calcium because this fermented product is well tolerated even by lactase-deficient subjects (Smith et al., 1985).

5. Bioavailability of Calcium

Milk and milk products are the most important sources of calcium in readily available form. The bioavailability of dietary calcium becomes important in the prevention and treatment of osteoporosis. Milk calcium is usually the referent food which is typically absorbed at 20~40% depending on the calcium status of the subject. The absorptive efficiency of most vegetable sources is as good or better than for dairy foods, unless they have high concentrations of oxalic acid (spinach, for example) or phytic acid (wheat bran cereal, for example). Few vegetable sources are concentrated sources of calcium.

Table 3. Calcium content of milk and some dairy products

Product	Calcium content(mg/100 g)
Cow milk	120
Buffalo milk	190
Goat milk	100
Sheep milk	170
Human mikk	28
Infant foods (Reconstituted)	30~70
Reconstituted milk based drinks	110~250
Cheddar cheese	580~750
Hard Cheese	700~1,500
Cottage Cheese	73
Paneer	210
Yoghurt	120~200
Ice creams	62~170
Milk base puddings and desserts	95~130

(Kansal, 1998)

Therefore, it would be difficult to obtain adequate intakes of calcium to protect against osteoporosis without liberal use of dairy products in the diet. Alternately, calcium supplements provide concentrated amounts of absorbable calcium, but they do not provide other nutrients necessary for skeletal growth and maintenance (Weaver , 1992).

The Ca in dairy products is bioavailable and readily absorbed by the body whereas Ca in other food sources may be less so. Several government surveys have shown that a large proportion of the US population, especially females 11 yr of age and older, have very low Ca intakes that do not meet the recommended dietary allowances for Ca. Low Ca intake or bioavailability of this mineral is one of the major factors involved in this crippling bone disease (Rusoff, 1987; Patel et al., 1992; Renner, 1994,). The nutrient density of calcium in whole cow's milk is 1,846 mg/1,000 kcal. This is 3.9 to 7.6 times the recommended ratio of calcium to energy in an adult human diet. 250 gm of cow's milk contains calcium equivalent to 37% US calcium RDA or 60% of WHO calcium RDA for adults. Equal amount of buffalo's milk contains 65% of US calcium RDA or 95% of WHO calcium RDA for adults (Kansal 1998). Calcium in all forms of milk is equally well utilized. Homogenization, Pasteurization heating, drying etc., do not reduce the availability of calcium. The bioavailability of calcium in adult human ranges between 25 to 40% depending on calcium status of the subjects. Incorporation of milk in diet also improves the bio-availability of calcium from vegetable fruits (Patel et al., 1992; Renner, 1994).

6. Role of Other Nutrients

Absorption of calcium depends on the endogenous factors such as age, pregnancy and lactation and several exogenous factors namely intake level of calcium, vitamin D, Protein, dietary fiber, Phospholipids sodium and lactose besides phytate and oxalate levels (Schaafsman, 1997; Gregory et al., 1999). Dietary risk factors are particularly important, as they are modifiable. However, most of the attention to dietary risk factors for osteoporosis has focused almost exclusively on calcium and vitamin D. Recently, there has been considerable interest in the effects of a variety of other nutrients on bone status. These include minerals--magnesium, potassium, copper, zinc, silicon, sodium; vitamins-- vitamin C, vitamin K, vitamin B_{12}, vitamin A; and macronutrients--protein, fatty acids, sugars (Tucker, 2003). There are a number of studies on the effects of vitamin D supplementation on bone loss in the elderly, showing that supplementations with daily doses of 400~800 IU of vitamin D, given alone or in combination with calcium, are able to reverse vitamin D insufficiency, to prevent bone loss and to improve bone density in the elderly (Gennari, 2001).

7. Strategies for Prevention of Osteoporosis

The acquisition of bone mass in infancy and adolescence is fundamental, carrying out a reasonable amount of exercise and an optimum exposure to sunlight, together with a high consumption of calcium from the sources of dairy products are of importance (Oria, 2003). Physical activity in both genders and milk consumption in young women might protect against vertebral deformities in later life through their effects on bone density. Adequate sunlight exposure may prevent and cure vitamin D insufficiency. However, the sunlight exposure or the ultraviolet irradiation is limited by concern about skin cancer and skin disease (Gennari, 2001).

It is increasingly clear that our exposure to a complex of nutrients and food constituents interacts to affect bone status. In addition to identifying the role of individual components, there is a great need to understand the interactions of these factors within diets and, increasingly, in the presence of nutrient supplements. Furthermore, genetic factors are likely to interact with these dietary exposures, increasing the complexity of these effects. With advances in both genetics and nutrition, improved understanding of all these interactions will contribute to effective recommendations for prevention of bone loss and osteoporosis in the aging population (Tucker, 2003). Health professionals can play an important role in raising perceptions of the benefits of adequate calcium intakes,

promoting the milk products dietary guideline, and emphasizing that lower fat diets can include adequate calcium through use of reduced fat milk products (Horwath et al., 2001). Avoiding the risks such as smoking, the abusive consumption of alcohol, intense weight loss and diets that are extremely hyper caloric, a sedentary lifestyle and excessive exercise would all be other preventive measures for osteoporosis (Oria, 2003). Adequate Calcium intake continues to be important to offset calcium losses and maintain bone health in the years after peak bone mass has been reached (Anderson, 2001).

The standard value for bone mineral density in the distal radius (R-BMD) and the osteo sono assessment index (OSI) in the OS calcaneus for each sex and age in teenagers are the important ones. To prevent osteoporosis, increasing peak bone mass is very important. Adequate calcium intake from dairy products, exercise in adolescence, are expected to result in increased bone formation and increased bone mineral density (Sasaki et al., 2000). The most rational approach to reducing vitamin D insufficiency is supplementation. In Europe, the RDA is 400~800 IU (10~20 micro g) daily for people aged 65 years or over. This dose is safe and free of side effects (Gennari, 2001).

There is general agreement that optimizing peak bone mass at early age reduces the age related loss later in life, especially after menopause protects the skeleton and reduces fracture risk. Variations in calcium status early in life may account for a 5 to 10% difference in peak bone mass which in turn contributes to more than a 50% difference in rates of hip fractures later in life. Adequate intake of calcium during childhood or puberty benefits bone health. Low calcium intake jeopardizes attainment of genetically determined peak bone mass. Increasing calcium intake of prepubertal children may reduce the risk of osteoporotic fractures later in life. During adolescence about 45% or more of the body total skeletal mass in farmed (Anderson, 2001).

Regular physical activity by children and adolescent has historically been considered essential for the healthy growth and development of all organ system of children. Muscular and skeletal benefits are great if these activities occur early in life, especially in girls before puberty. Dietary calcium intake of approximately 1,450 mg/day and moderate exercise (i.e. one year programme of walking briskly 15 to 40 minutes/day for 3 days/week) slow down the bone loss at various skeletal sites in post menopausal women. The combination of a good amount of calcium each day and regular physical activity is much more likely to lead optimal skeletal development and bone mass by the end of the second decade of life (Gennari, 2001, Mercy, 2002).

Ⅲ. Conclusion

With the changing food habits and sedentary life style there is increasing risk of Osteoporosis all over the globe. Osteoporosis develops gradually over many years before the occurrence of clinical symptoms. This disease results in low bone mass and micro architectural deterioration of bone tissue leading to enhanced bone fragility and a consequent increase in fracture risk often called a silent disease. A variety of factors including diet containing an adequate quantity of calcium and vitamin D influence the peak bone mass formation. Optimizing the peak bone mass early in life by increasing dietary intake of calcium and vitamin D through milk and milk products has an important role in preventing osteoporosis. Regular physical activities along with sufficient intake of dietary calcium are beneficial to bone health. Recommended quantity of calcium could me met through dairy foods without necessarily increasing calorie. Children and adolescents have to be encouraged to consume more and more of dairy products to combat the occurrence of osteoporosis as the bone mass and bone mineral content could be increased only at the early stages life. Lack of supplementation of adequate dietary calcium through milk and milk products is certain to lead to osteoporotic problems at later stages of life. It is advisable to meet at least 60% of the recommended calcium allowance from dairy sources. Long term suppression of dairy products or partial withdrawal of milk products for a prolonged period may lead to potential risk of defective bone

mineralization leading to osteoporosis.

Ⅳ. References

1. Anderson. 2001. Calcium needs in early life for skeletal development. IDF Bulletin. 363:4-9.
2. Ann prentice. 1998. Calcium requirements of breast feeding mothers: Nutrition Reviews. 56(4):124-127.
3. Deal, C. L. 1997. Osteoporosis: Prevention, diagonisis, and management. Am. J. Med. 102:35S-39S.
4. Dennis, D. M. 1992. Calcium in the diet : Food sources recommended intakes and nutritional bio-availability. Advances in Food and Nutrition Research. 33:103-35.
5. Fleming, K. H. and Heimbach, J. T. 1994. Consumption of calcium in the U.S.: Food sources and intake levels. J. Nutr. 124 (8 Suppl):1426S-1430S.
6. Gennari, C. 2001. Calcium and vitamin D nutrition and bone disease of the elderly. Public Health Nutr. 4(2B):547-59.
7. Gregory, D. M., Judith, K., Jarvis, L. D. and Bean, M. C. 1999. Dairy foods and osteoporosis. Hand book of dairy foods and nutrition, second Edition. 193-239.
8. Kansal, V. K. 1998. Milk offers dietary calcium in best available form. Indian Dairyman. 50(8):23-26.
9. Lunt, M., Masaryk, P., Scheidt-Nave, C., Nijs, J., Poor, G., Pols, H., Falch, J. A., Hammermeister, G., Reid, D. M., Benevolenskaya, L., Weber, K., Cannata, J., O' Neill, T. W., Felsenberg, D., Silman, A. J. and Reeve, J. 2001. The effects of lifestyle, dietary dairy intake and diabetes on bone density and vertebral deformity prevalence: the EVOS study. Osteoporos Int. 12(8): 688-98.
10. Horwath, C., Parnell, W. R., Wilson, N. C. and Russell, D. G. 2001. Attaining optimal bone status: lessons from the 1997 National Nutrition Survey. N. Z. Med. J114(1128):138-41.
11. Infante, D. and Tormo, R. 2000. Risk of inadequate bone mineralization in diseases involving long-term suppression of dairy products. J. Pediatr. Gastroenterol. Nutr. 30(3):310-3.
12. Mercy, P. 2002. Osteoporosis: Risk factors and prevention. The Ind. J. Nutr. Dietet. 39:427-432.
13. Oria, E. 2003. Preventive and nutritional factors of osteoporosis. An Sist. Sanit. Navar. 26 Suppl 3:81-90.
14. Patel, R. S., Renner, E., Jayaprakasha, H. M., Singh, S. and Yoon, Y. C. 1992. Dietary calcium from milk and milk products and its importance in human nutrition. Indian Dairyman. 44: 830-835.
15. Renner, E. 1994. Dairy calcium, bone metabolism, and prevention of osteoporosis. J. Dairy Sci. 77(12): 3498-505.
16. Rusoff, L. L. 1987. Calcium--osteoporosis and blood pressure. J. Dairy Sci. 70(2):407-13.
17. Sasaki, M., Harata, S., Kumazawa, Y., Mita, R., Kida, K. and Tsuge, M. 2000. Bone mineral density and osteo sono assessment index in adolescents. J. Orthop. Sci. 5(3):185-91.
18. Sawicki, A., Regula, A., Godwod, K. and Debinsk, I. A. 2003. Peptic ulcer disease and calcium intake as risk factors of osteoporosis in women. Osteoporos. Int. 14(12):983-6.
19. Schaafsma, G. 1997. Bio-availibility of calcium. IDF Bulletin. 322:20-23.
20. Sloutskis, D., Bernstein, M., Burnand, B. and Morabia, A. 1995. Consumption of calcium-rich food in the adult population of French-speaking through milk and milk products. Eur. J. Clin Nutr. 47(9):617-22.
21. Smith, T. M., Kolars, J. C., Savaiano, D. A. and Levitt, M. D. 1985. Absorption of calcium from milk and yogurt. Am. J. Clin. Nutr. 42(6):1197-200.
22. Stracke, H., Renner, E., Knie, G., Leidig, G., Minne, H. and Federlin, K. 1993. Osteoporosis and bone metabolic parameters in dependence upon calcium intake Switzerland and of Tessin. Soz. Praventiv. Med. 40(4):201-8.
23. Toba, Y., Takada, Y., Yamamura, J., Tanaka, M., Matsuoka, Y., Kawakami, H., Itabashi, A., Aoe, S. and Kumegawa, M. 2000. Milk basic protein:A novel protective function of milk against osteoporosis. Bone. 27(3):403-8.
24. Tucker, K. L. 2003. Dietary intake and bone status with aging. Curr. Pharm. Des. 9(32):2687-704.
25. Weaver, C. M. 1992. Calcium bioavailability and its relation to osteoporosis. Proc Soc. Exp. Biol. Med. 200(2):157-60.