

Calcium As A Mean Of Reducing Risk Of Low Bone Mass

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Calcium and Skeletal Health

Calcium is one of the most abundant minerals in the body, and the body uses the mineral to keep the bones and teeth of an individual strong and healthy. In general, the adult human body requires 1200g of calcium, which is 1-2% of the body weight, and 99% of this is found in mineralized tissues such as bones and teeth (Cashman, 2002). In addition to bone and teeth health, it also supports the skeletal system of the body by maintaining its structure and functions.

Nutritional Determinants of Bone Mass

A variety of macronutrients and micronutrients are determinants of bone health. The body needs an adequate amount of calcium to perform its functions accurately, and if the requirements are not met, then there will be certain health issues because of the lack of calcium in the body. Because the human body is not able to synthesize calcium, therefore, most of the calcium needs are met through diet. Dietary components are essential for bone mineral density, and they determine the amount of calcium the body consumes (Cashman, 2002). The mineral calcium is significant not only for bone and skeletal functions but also required for nerves, muscles, and cells to work properly.

Vitamin D and Calcium Mobilization

Calcium also requires Vitamin D to perform a function, and the rapid release of minerals from the bones is essential for the functions of the body. If the body does not have enough calcium intake, then it takes calcium from the bones to perform its functions. As a result, a loss of bone mass occurs. Loss of bone mass will make the bones weaker and will have several bone-related health issues. One of the major issues which arise from the low bone mass is osteoporosis. Osteoporosis is a common medical condition related to bone health and is basically a systematic impairment of bone mass, strength, and microarchitecture, which increases the tendency of fragile bone structures and fractures (Rachner et al., 2011). The thyroid glands secrete the hormones known as parathyroid hormones (PTH) because of low calcium in the blood, which is coupled with receptors (Cashman, 2002). With this process, the structure of the bone matrix starts breaking down, converting the calcium salt stored in the bones into a soluble form. With this, the bone structure is weak and fragile and, in some cases, might lead to holes in the bone. Osteoporosis is one of the major public health issues across the globe, and people have been reported to have poor bone health. According to the

estimations, 18 million people in the United States have low bone mass and are at higher risk of developing osteoporosis, and similar statistics have been reported from other regions in the world (Cashman, 2002). Because of insufficient calcium intake in the diet, people have issues with their bones and fragility fractures.

Recommended Calcium Intake Across Life Stages

Several international and national organizations have recommended the daily intake of calcium at each stage of life. The requirement of calcium varies for each individual in their different phases of life. For example, during the period of rapid development, which is childhood and adolescence, there is a great need for calcium in the individual in that period. For example, the recommended intake for children between the ages of 6 and 10 years is from 500mg to 1200mg (Bonjour et al., 2009). For other age groups from puberty to adolescence, a daily intake of food that provides 1000 mg calcium is safe and reasonable as well as will meet the dietary requirement. The World Health Organization (WHO) has recommended that individuals who live in a country with high fracture incidents should at least consume foods that provide a minimum of 500mg of calcium daily (Lanou et al., 2005). Intake of sodium also affects the requirement for calcium as sodium and calcium excretions are related to the tubules in the kidney. For example, 30mg of calcium takes 2300mg of sodium (Cashman, 2002). There are also other factors that influence the requirement for calcium intake, such as genetic factors and environmental factors. An example of genetic factors is the architecture and geometry of bone, whereas environmental factors include lifestyle and dietary intake (Flynn, 2003). There are several foods that are rich in calcium, and one of the positive aspects of calcium-rich foods is that along with a good quantity of calcium, these foods also become a source of other important nutrients.

Dietary Sources of Calcium

Dairy is one of the main sources of calcium. According to a survey, 60% of the calcium intake is from milk and dairy among adults in the United States (Anderson et al., 2011). Milk and dairy products have a large amount of calcium and are available widely. For example, as per nutritional estimates, 8oz of any type of cow's milk has approximately 300mg of calcium (Anderson et al., 2011). The remaining percentage of calcium is present in baked products, dark green leafy vegetables, and some other foods. Calcium intake below or above the recommended intake is not healthy for any individual. Low-fat dairy products are also another excellent source of calcium. For example, low-fat yogurt has 30% to 50% more calcium as compared to 1 cup (8oz) of milk (Anderson et al., 2011). There is also a difference in calcium intake based on gender and race. Studies have been performed to explore the difference, and it was reported that there was a significant difference in the calcium intake of blacks and whites (Bryant et al., 2003). The difference indicates that calcium intake is affected by environmental and racial factors. There are some people who have made dietary choices, such as being vegetarian or opting for a vegan diet. Studies have shown that vegans have less calcium intake than vegetarians and omnivores (Anderson et al., 2011). Vegans or vegetarians usually complete the

required intake from other non-meaty or non-dairy sources, but the quantity of calcium in those components is low. Calcium absorption from plant sources from soya milk and dried beans is about 50% as compared to normal milk (Kohlenberg-Mueller and Raschka, 2003). Therefore, vegetarians or vegans will have issues with fulfilling their calcium needs as their food components do not have calcium-rich food, but they rely on foods with indirect calcium sources.

Calcium Supplementation

Low dietary intake of calcium can lead to health problems. However, advancements in the medical field have found a solution to the low-dietary intake of calcium by developing calcium supplements. The negative effect or imbalance of calcium intake can be corrected by increasing the intake of calcium through calcium supplements (Prince et al., 2006). The most common form of supplements is calcium carbonate and calcium citrate. The supplements are recommended for people who are likely to have reduced intake of recommended calcium from their daily food. A study has reported that a low-dose calcium supplement, which is 500 mg of elementary calcium, is effective for the bone mass of people who have a low dietary intake of calcium (Dawson-Hughes et al., 1990). The impact of calcium supplements in the replacement of low-dietary intake of calcium indicates that low-dose supplements might be beneficial for bone health. For example, low-dose calcium supplements might be effective in the prevention of pathological bone loss, issues with bone density, and other fracture issues related to bone fragility (Kim et al., 2014). Calcium supplements were encouraged by nutritionists in the early times in the United States because it was observed that calcium intake was lower than adequate levels in the diet people (Millstone et al., 2013). These supplements meet the calcium needs of people who have a low intake of calcium otherwise, but there are negative impacts of these calcium supplements as well. The supplements are only suitable for low doses and for those people who have a low intake of calcium. High doses of calcium supplements have been linked with several health issues. However, the continuous intake of calcium supplements might increase vascular calcification, cardiovascular diseases, and, in some cases, even mortality (Michaëlsson et al., 2013). Therefore, it cannot be asserted whether the supplements are entirely beneficial if used for a long time, but for a short period of time, they might be helpful in meeting the required need for calcium as well as in the prevention of low bone mass.

Calcium Homeostasis and Absorption

The regulation of calcium is essential to maintain homeostasis. The concept of calcium homeostasis is basically a balance of calcium levels between bones, blood, and muscles (Millstone et al., 2013). Calcium is absorbed through the process of active transportation and passive diffusion across the intestinal mucosa, and the absorption percentage varies across different phases of life and by gender (Del Valle et al., 2011). It is reported that with age and after menopause in women, absorption tends to decline. In women, calcium absorption is indirectly linked with age (Del Valle et al., 2011). Calcium is excreted from the body through urine or feces, as well as other body fluids, such as sweating. Bone

formation and bone resorption determine bone mass, which is measured by biochemical markers. The bone mass developed in early life determines bone health in later life. The bone mass continues to increase during early life, achieving the peak bone mass, and the age of achieving the bone mass is different for different regions and different populations. Low bone mass or density can lead to osteoporosis and osteopenia. According to the American National Health and Nutritional Examination survey, 50% of women aged 50 or above are reported to have low bone mass or bone density (AlQuaiz et al., 2014). The recommended intake of calcium is essential to achieve peak bone mass. The peak bone mass will start to decline once it hits the peak. In other words, the loss of bone mass and risk of osteoporosis might be dependent on early life nutritional intake, such as intake of calcium and events (Welten et al., 1996). There are also gender differences in the decline of bone mass. For example, in females, the bone mass starts to decline in menarche, and in males, the decline is much later after puberty (Bonjour et al., 2009).

Peak Bone Mass and Fracture Prevention

Peak bone is essential because, according to the estimations, if there is a 10% increase in peak bone mass, then there is a 50% less risk of fracture among women after menopause (Bonjour et al., 2009). Therefore, maximizing the peak bone mass during the early years will have a significant impact on bone health later in life, as well as the prevention of osteoporosis. There are certain factors that determine an individual's peak bone mass, such as genetic factors and nutritional factors. Studies have been carried out to explore the relationship between calcium intake and bone mass, and it was concluded that calcium intake is positively associated with bone mass among females (Welten et al., 1996: 1). calcium intake is crucial even in apparently healthy and well-nourished children, as well as for the accumulation of bone mass.

Bone Mineral Accretion During Growth

Bone mineral accretion is one of the major determinants of peak bone mass and is associated with osteoporosis at a later age. The two main critical periods for bone mineral accretion are the pre-pubertal and pubertal periods, and it is estimated that 39% of body bone mineral is gained in these years (Zhu and Prince, 2012). Calcium intake during the growth period and puberty is essential, as inadequate intake can compromise the attainment of peak bone mass and pose a higher risk of bone fragility in later life. The normal age for the attainment of peak bone mass is 20 years, and once it is achieved, there is not much difference observed in it for the next 10 to 20 years of life (Zhu and Prince, 2012). Bone mass also increases with age, increasing sevenfold during puberty and threefold during adolescence. Studies have been carried out to understand calcium retention efficiency, and this measure varies across different ethnic groups. A study conducted to explore the difference in calcium retention by race concluded that calcium retention was higher in blacks as compared to calcium retention in whites (Braun et al., 2007). Similarly, there was also a difference in the peak bone mass, and it was found that African Americans have higher peak bone mass as compared to

white Americans (Braun et al., 2007). This shows that the peak bone mass also depends on the hereditary and genetic differences among people. Low intake of calcium leads to low bone mass, and therefore, adequate intake is essential for the proper functioning of the body.

Hypercalcemia and Excess Calcium

Along with issues of deficiency of calcium, there are also situations in which the calcium level in the body is above the normal or recommended levels. When there is an electrolyte imbalance and a high level of calcium in the blood of the human body, that condition is referred to as hypercalcemia (Schenck et al., 2006). Excess of anything can negatively impact the body and its system. For example, an excess of calcium in the body and in the blood can weaken the bones, increase the risk of kidney stones, and hamper the process of the overall body. The main reason for hypercalcemia is overactive parathyroid glands, but there are several other causes, such as excessive intake of calcium, calcium supplements, or vitamin D supplements, as well as being on medication and other medical disorders (Schenck et al., 2006). Usually, when there is not enough calcium then, the body takes calcium from bones to meet their needs, and parathyroid glands secrete a hormone that triggers the bones to release the calcium (Stewart, 2005). But if the parathyroid glands are overactive, then the secretion of calcium will be more than desired, leading to excess calcium in the blood.

Skeletal Consequences of Hypercalcemia

As a lack of calcium leads to low bone mass, an excess of calcium in the blood also negatively impacts the bones. For example, if bones keep on releasing calcium in the blood, it will weaken the bones, leading to easy fractures and other bone-related issues. Hypercalcemia, whether it is acute or chronic, can be life-threatening as it affects the heart and vascular system, as well as hypertension and accelerated atherosclerosis (Karthikeyan et al., 2006). One of the main sources of an excess of calcium is the overuse of calcium supplements or intake of calcium supplements along with a high intake of dietary calcium. The excess level of calcium in the blood affects the electrical impulses and irregulates the heartbeat, leading to heart dysfunction and hypertension. Other than the heart, the level of calcium in the blood also results in kidney functions (Karthikeyan et al., 2006). In short, calcium is one of the crucial elements for the processing of daily body functions, but if it is in excess, it can be detrimental and can have severe health effects on the human body.

Dietary Recommendations for Bone Health

The recommendation for calcium intake is that calcium-rich sources of food should be part of the daily diet. From early childhood, calcium intake should be a special focus as the intake at that point in life will have a positive impact on later life. Loss of bone mass is caused by insufficient calcium intake, so

consuming the recommended intake of 1000mg calcium per day will reduce the risk of osteoporosis later in life. Bones are the major reservoir for calcium, so a lack of calcium will directly influence the bones and skeletal system. Most people are unaware of the importance of calcium for the body's functioning, so awareness campaigns or multimedia should be used to communicate the message. Women and children should be the focus of the calcium-related awareness campaigns. The recommendation of the daily reference intake (DRIs) for calcium refers to the safety limits, and staying within those bars is highly recommended for a healthy life. Body needs and requirements change throughout life, and the DRIs can be used as a standard reference for the daily intake of calcium. Achieving adequate calcium intake as a part of a daily diet without the need for supplements might be difficult, but it is achievable and endorsed.

Conclusion on Calcium and Bone Mass

In conclusion, calcium is an essential component of the body, and for the normal functions of the body, it is required that daily intake is fulfilled. Bones and skeletal systems are primarily composed of calcium. The human body does not have the ability to make calcium; therefore, the intake of calcium is essential in a diet. There are several sources that provide the essential nutrients for the daily calcium needs of the human body. The primary sources of calcium were dairy products and other non-dairy food products, as well as calcium supplements. Lack of calcium is a condition in which the daily requirement of the body, which is 1000mg for an adult, is not met. Because of this lack of calcium, the bone structure is weak, and bone mass is reduced. The weakening of bones and fragile bone structure is commonly known as osteoporosis. The low bone mass differs based on gender, race, and age groups. Men and women both experience age-related issues with bone mass, but women are more likely to have different calcium absorption levels, which usually decline because of menopause and aging. This means that women are at higher risk of having low bone mass and osteoporosis as compared to men. Early life defines the status and absorption of calcium as well as bone mass. Therefore, it is essential that calcium intake is fulfilled to reduce the risk of osteoporosis and other bone-related diseases in later life. If any diet does not have sufficient components of calcium, then calcium supplements in low doses can be used to meet the need. As the lack of calcium is dangerous, excess calcium in the body can be detrimental. Because of overactive thyroid glands, calcium is secreted in the blood, and the situation is known as hypercalcemia. Hypercalcemia is detrimental as it results in the disturbance in the regulation of electrolytes in the blood and can cause several diseases, such as cardiovascular diseases as well as hypertension.

References

- AlQuaiz AM, Kazi A, Tayel S, et al. (2014) Prevalence and factors associated with low bone mineral density in Saudi women: a community based survey. *BMC musculoskeletal disorders* 15(1): 5.
- Anderson JJB, Garner SC and Klemmer PJ (2011) *Diet, Nutrients, and Bone Health*. Taylor & Francis.

Available at: <https://books.google.com.pk/books?id=cX36j-wcrIMC>.

Bonjour J-P, Chevalley T, Ferrari S, et al. (2009) The importance and relevance of peak bone mass in the prevalence of osteoporosis. *Salud publica de Mexico* 51: s5-s17.

Braun M, Palacios C, Wigertz K, et al. (2007) Racial differences in skeletal calcium retention in adolescent girls with varied controlled calcium intakes-. *The American journal of clinical nutrition* 85(6): 1657-1663.

Bryant RJ, Wastney ME, Martin BR, et al. (2003) Racial differences in bone turnover and calcium metabolism in adolescent females. *The Journal of Clinical Endocrinology & Metabolism* 88(3): 1043-1047.

Cashman KD (2002) Calcium intake, calcium bioavailability, and bone health. *British journal of Nutrition* 87(S2): S169-S177.

Dawson-Hughes B, Dallal GE, Krall EA, et al. (1990) A controlled trial of the effect of calcium supplementation on bone density in postmenopausal women. *New England Journal of Medicine* 323(13): 878-883.

Del Valle HB, Yaktine AL, Taylor CL, et al. (2011) *Dietary reference intakes for calcium and vitamin D*. National Academies Press.

Flynn A (2003) The role of dietary calcium in bone health. *Proceedings of the Nutrition Society* 62(4): 851-858.

Karthikeyan VJ, Khan JM and Lip GYH (2006) Hypercalcemia and the cardiovascular system. *Metabolic syndrome and its management*: 25.

Kim KM, Choi SH, Lim S, et al. (2014) Interactions between dietary calcium intake and bone mineral density or bone geometry in a low calcium intake population (KNHANES IV 2008-2010). *The Journal of Clinical Endocrinology & Metabolism* 99(7): 2409-2417.

Kohlenberg-Mueller K and Raschka L (2003) Calcium balance in young adults on a vegan and lactovegetarian diet. *Journal of bone and mineral metabolism* 21(1): 28-33.

Lanou AJ, Berkow SE and Barnard ND (2005) Calcium, dairy products, and bone health in children and young adults: a reevaluation of the evidence. *Pediatrics* 115(3): 736-743.

Michaëlsson K, Melhus H, Lemming EW, et al. (2013) Long term calcium intake and rates of all cause and cardiovascular mortality: community based prospective longitudinal cohort study. *Bmj* 346: f228.

Millstine D, Bergstrom L and Mayer AP (2013) Calcium: too much of a good thing? *Journal of Women's Health* 22(11): 997-999.

Prince RL, Devine A, Dhaliwal SS, et al. (2006) Effects of calcium supplementation on clinical fracture and bone structure: results of a 5-year, double-blind, placebo-controlled trial in elderly women. *Archives of Internal Medicine* 166(8): 869-875.

Rachner TD, Khosla S and Hofbauer LC (2011) Osteoporosis: now and the future. *The Lancet* 377(9773): 1276-1287.

Schenck PA, Chew DJ, Nagode LA, et al. (2006) Disorders of calcium: hypercalcemia and hypocalcemia. *Fluid, electrolyte, and acid-base disorders in small animal practice* 4: 120-194.

Stewart AF (2005) Hypercalcemia associated with cancer. *New England Journal of Medicine* 352(4): 373-379.

Welten DC, Kemper HCG, Post GB, et al. (1996) A meta-analysis of the effect of calcium intake on bone mass in young and middle-aged females and males. *Osteoporosis International* 6: 111-111.

Zhu K and Prince RL (2012) Calcium and bone. *Clinical biochemistry* 45(12): 936-942.