
CALCIUM AS A BOON OR BANE FOR ATHLETE: A REVIEW

Dr. Ramesh Chand Chauhan*

*Associate Professor,
Department of Physical Education,
Govt. Degree College Dhama,
Shimla, Himachal Pradesh, INDIA
E mail id: rameshch75@gmail.com

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ABSTRACT

Minerals are essential for a wide variety of metabolic and physiologic processes in the human body. Calcium is one of the essential nutrients that is necessary for many functions in human health. About 99 percent of calcium in the body is stored in the skeletal system, while the remaining one percent is present in other cells, such as muscle cells. Although this muscle cell calcium is involved in a variety of physiologic processes associated with energy metabolism and muscle contraction. Exercise increases the reabsorption of calcium from bones and inadequate intake of calcium resulting in hypocalcaemia. Hypocalcaemia is one of the factors causing the decline in leg muscle strength in athletes. Although adequate calcium intake is necessary to promote bone health and prevent osteoporosis, increased physical activity alone does not necessarily demand an increased intake of dietary calcium or other micronutrients. Athletes may lose calcium via sweat, in which case replenishment is advocated either via dietary intake of calcium-rich foods or a commercial calcium supplement. The important message to athletes is to consume a diet adequate in energy, protein, fat, vitamins, minerals, and fluids to support the physical demands and replenish the physiologic losses incurred with physical training. Research has shown that adequate calcium intake can reduce the risk of fractures, osteoporosis, gastrointestinal diseases and kidney stone etc. The purpose of this article is to review the health benefits of calcium and consequences of calcium supplementation on osteoporosis/osteoporotic fractures, cardiovascular events, kidney stones, gastrointestinal diseases, and other important diseases. Furthermore, an effort is made to address the role of dietary or supplemented calcium on several indices of physical performance. In the end, we suggest that calcium supplementation should be prescribed and taken cautiously, accounting for individual's risks and benefits. Clearly, further studies are needed to examine the health effects of calcium supplementation to make any solid recommendations on physical performance of people of different genders, ages and ethnicities.

KEYWORDS: *Osteoporosis, Cardiovascular Diseases, Kidney Stones, Gastrointestinal Diseases, Hypocalcaemia, Bone Formation.*

1. INTRODUCTION

Basic role of calcium:

Calcium is the most abundant mineral in the body. Not only is calcium essential for the health of our bones and teeth, but it plays important roles in muscle contraction, nervous system function, stabilization of blood pressure, blood clotting and secretion of hormones. It also contributes to normal brain function and helps maintain a regular heartbeat. [1]

Adequate calcium is needed to enable the contraction of heart muscle which in turn pumps blood around your body. It's also required in the process by which your skeletal muscles contract. Szent, Gyorgyi in his study on calcium regulation of muscle contraction concluded that

Calcium triggers contraction by reaction with regulatory proteins that in the absence of *calcium* prevent interaction of actin and myosin. It helps nerve signals to be transmitted and it's essential for normal blood clotting when injury occurs. It is also needed to activate the enzyme lipase which breaks down fat stores to produce energy. [2]

It is well established that calcium is an extremely important and integrative component of human body, with 99% of the body's calcium being contained within the skeleton. Brini M, and others stated that Plasma calcium homeostasis plays a vital role in maintaining human life activities, such as maintenance of the skeleton, regulation of hormonal secretion, transmission of nerve impulses, and vascular activities. It is known that dietary calcium is absorbed mainly in the small intestine. Through circulation, it is mostly deposited into bones. Excessive or unabsorbed calcium is excreted in urine and feces. The homeostasis of calcium is mainly maintained by both parathyroid hormone (PTH) and calcitonin. When serum calcium level drops, PTH promotes calcium release from the bones and stimulates reabsorption of calcium by the kidney tubules. In addition, PTH indirectly increases calcium absorption in the intestine via calcitriol, which is produced by the kidney and is the hormonal form of vitamin D. On the other hand, when serum calcium level rises, calcitonin would suppress calcium release from the bones and reduce calcium reabsorption by the kidney tubules stated by Kleeman CR and others. [3]

However, as noted above, young women involved in weight-control sports, such as figure skating and distance running, may have inadequate dietary intake of calcium. Additionally, exercise may increase calcium losses. Dressendorfer and others found in their study that urinary calcium increased and serum calcium decreased below the clinical norm following the high-intensity interval phase, but these changes were reversed following the tapering phase. Thus, it appears that calcium excretion may be increased with high-intensity training.

Inadequate calcium intake and increased calcium losses may predispose one to osteoporosis. This may be especially so in women who develop the female athlete triad (disordered eating, amenorrhea, osteoporosis). Gremion and others noted that long-distance runners with oligo-amenorrhea had greater decreases in bone mineral density in the spine than in the femur, even though they had similar energy, calcium and protein intakes compared to amenorrheic runners. [4]

The National Institutes of Health consensus panel on osteoporosis indicated that supplementation with calcium, along with vitamin D, may be necessary in persons not achieving the recommended dietary intake such as these female athletes. Additionally, athletes with amenorrhea should consult with their physician regarding the need for drug or hormonal therapy to help prevent osteoporosis. Pentti K, Tuppurainen MT, et al. in their Kuopio Osteoporosis Study, a doubt was for the first time raised in the beneficial effects of calcium supplementation on bone due to its adverse cardiovascular effects by this randomized control study. [5]

Role of Calcium for Athletes:

From a sports perspective, trace amounts of calcium can be lost in sweat (especially in long-distance races in warm environments) and adequate calcium is required to promote bone growth in the young skeleton and bone maintenance in the aging skeleton.

Quite simply, athletes need more nutrients than less-active people. They demand more from their bodies than even average fitness buffs and so must compensate with the right nutrients from foods or supplements to keep performance and recovery at its peak. The more intense the exercise or sport, the greater the body's nutrient needs. Athletes who participate in endurance sports, those involve more than one hour of consistent activities have specific needs because of what they demand from their bodies. For example, athletes lose more electrolytes, such as calcium, magnesium, potassium and sodium, through perspiration and must diligently replace them. The wear and tear of intense activity may necessitate increased intake of antioxidants such as vitamin

E, which can help protect muscle cells from oxidative damage. Since muscle-tissue breakdown is common during intense exercise, athletes also need more proteins to repair the tissues. [6]

An athletes have to be very active throughout the day. They exercise a lot in order to maintain a fit and healthy body. They require a lot of strength for performing well in the sport that they play. Be it running, hiking, swimming, cycling, attending cross fit or engaging in any other sports, the body requires extra nutritional supplements, to function properly. Athletes train themselves to reach their full potential and to compete at the highest level. Many competitive athletes, in a wide variety of sports, train to keep their skeletal muscles and heart healthy and strong to compete. [7]

Calcium is one of the most important minerals for athletes to consume on a regular basis. It not only serves several essential functions in the body, including building healthy, strong bones and teeth but it might also improve your sports performance.

Calcium plays a vital role in muscle contraction and relaxation. Without it, your muscles cannot function properly. Each time a muscle is about to contract, calcium is pumped into the muscle fiber, enabling it to shorten. When the muscle relaxes, calcium is pumped out of the fiber, which can then return to its resting state. [8]

This process occurs repeatedly every time your muscles contract and relax, so having sufficient calcium in your body is critically important. A calcium deficiency will cause your muscles to suffer from unexpected twitching, cramps and fatigue, all of which degrade your performance.

How do these nutrients help in improving performance? Calcium is the most important of all the nutrients. It is the main element that forms bones. Bones are body's structural framework that aids to its movement and thus lets the athletes perform well. If the bones are not strong enough, athletes cannot do their activities properly. Mostly the athletes do not meet their need of daily calcium intake. Inadequate calcium intake leads to lack of calcium in the body. Lack of calcium in the body can lead to many problems such as osteoporosis, reduction in bone mass and bone density and hormonal imbalance. This way bones become weak and it becomes difficult for the athletes to run, swim or play the sports. Weak bones can cause fractures even due to minor injuries, this will restrict athletes from performing their activities until recovery. In such cases, recovery also becomes slow and the chances of getting a refracture in future increase many fold. Hence proper calcium intake is very essential for athletes. Athletes should take proper calcium supplements in order to receive the required calcium intake. [9]

Role of Calcium supplementation for Athletes:

Reid IR concluded in his study that calcium supplementation is a widespread practice in different age-groups and has been promoted widely to improve bone density The public generally believes that calcium is always good for health, owing largely to successful marketing and various clinical practice guidelines As a result, calcium supplementation has become a billion dollar market in recent years and has been taken by millions of both men and women, children, adults, and the elderly wishing to improve their skeletal health. [10]

People may get more calcium from dietary intake or calcium supplementation. Due to the limited availability of calcium-rich foods and dietary habits, it is not always possible for athlete to take more and sufficient dietary calcium. Thus, there is a role for calcium supplementation for athletes with inadequate dietary calcium intake. Initial studies suggested that dietary calcium had a greater effect on bone building due to its better absorption than supplemental calcium, but further studies are needed to fully elucidate whether one is better than the other to improve bone density.

Swaim and others in their study the relationship of calcium intake and exercise to osteoporosis Health beliefs in postmenopausal women revealing that adequate calcium intake along with proper exercise can effectively prevent osteoporosis. [11]

Recently, increasing concerns have been raised regarding whether indiscriminate calcium supplementation is safe. A meta-analysis by Bischoff-Ferrari et al demonstrated an increased hip fracture risk with calcium supplementation. A recent meta-analysis of randomized clinical trials by Zhao JG and others showed that calcium supplementation was not associated with a low risk of fractures among community-dwelling older adults. There has been a concern for a significant increase in the risk of cardiovascular diseases with high supplemental calcium intake in men. Given the emerging dilemma regarding calcium supplementation, the present article reviews discusses the potential benefits and side effects of calcium supplementation on health and diseases such as osteoporosis/osteoporotic fractures, cardiovascular events, kidney stones, gastrointestinal diseases, and others. [12]

Lanou , Berkow et.al.in concluded in their study that physical activity is the primary modifiable stimulus for increased bone growth and development in adolescents⁵. Athletes mostly experience stress fractures while training which occur when the stresses placed on the bones are more than it can endurance before fully healing. When these stress fractures occur, an athlete must wait for it to heal, which can lead to missing training, practice and/ or competition for weeks or even months.

Athletes need to increase weight-bearing physical activity to increase bone strength and decrease the risk of stress fractures or decrease the weight-bearing activity to prevent overuse. In both cases, athletes have to consider calcium supplementation to keep their bones healthy and strong to reduce the risk of stress fractures. Also calcium prevents muscle cramps and hence further strengthens the bones. This is because calcium has an essential role in muscle contractions. If there is an inadequate amount of calcium, there will be a problem in muscle contraction and hence muscle cramps can occur. Calcium is also involved in regulating nerve signaling, which send signals to contract or relax muscles. This way calcium has a role in body movements, which have to be very instant and sharp for athletes. Also athletes are more likely to lose calcium and other minerals through perspiration. Since their body is very active, they perspire a lot. Hence they lose calcium and minerals in larger quantities than non-athletes. So calcium and mineral supplementation is a must for athletes. [13]

Along with calcium other minerals like magnesium and certain vitamins play a role in maintaining bone health. Magnesium is involved in regulating blood pressure, muscle contractions and relaxations, nerve functions, immunity and cardiac activity, which are very crucial for athletes. Vitamin D is essential in absorbing calcium into the body.

Pros and cones of calcium supplementation:

Osteoporosis: Osteoporosis is a bone disease that occurs when the body loses too much bone, makes too little bone, or both. As a result, bones become weak and may break from a fall or, in serious cases, from sneezing or minor bumps. Osteoporosis means “porous bone.” A lifelong lack of calcium plays a role in the development of osteoporosis. Low calcium intake contributes to diminished bone density, early bone loss and an increased risk of fractures. If enough calcium in diet is not met, body will take it from bones to ensure normal cell function, which can lead to weakened bones or osteoporosis. Children need calcium to build strong bones. Adults need calcium to maintain strong bones. Over time, inadequate calcium intake can cause osteoporosis, the brittle bone disease. People with osteoporosis are at high risk for broken bones, especially at the wrist, hip and spine. The two most commonly used calcium products are calcium carbonate and calcium citrate. Calcium carbonate supplements dissolve better in an acid environment, so they should be taken with a meal. Calcium citrate supplements can be taken any time because they do not need acid to dissolve. [14]

Not only hypocalcaemia, too much calcium in your blood can weaken your bones, create kidney stones, and interfere with how your heart and brain work. Hypocalcaemia is usually a result of

overactive parathyroid glands.

Cardiovascular Disease: Cardiovascular disease (CVD) is a class of diseases that involve the heart or blood vessels. The heart is muscular pumps that push the blood to the different parts of the body. Calcium plays an important role in electrical activities and pumping action of heart. Calcium particles enter the heart muscle cells during each heart beat and contribute to the electrical signal that coordinate the heart function. Calcium particles also bind to machinery within the cell that helps the cell to squeeze together (contract) which makes the heart to pump blood effectively. In case of disease, door controlling the movements of calcium get malfunctioned, which leads to abnormal electrical signal, which may cause a disease called heart rhythm disorder. In addition abnormal condition of calcium may directly impair the pumping function and relaxation of heart. Scientist have identified that calcium handling abnormalities play a major role in many heart rhythm disorders.

Calcium deposits are part of artery-clogging plaque. They also contribute to stiffening of the arteries and interfere with the action of heart valves. Hypocalcaemia is a condition in which the calcium level in your blood is above normal. Too much calcium in the blood can interfere with the working of heart and brain. High levels of calcium in arterial blood in people who smoke are also found. Excess body fat and high cholesterol add to the problem. High blood glucose level also damages the arteries. During the healing process, calcium as well as other substances begin to deposit on the lining of the arterial wall which leads to Cardiovascular disease (CVD). Some studies show taking calcium supplements in addition to a diet high in calcium could raise your risk of heart attacks and strokes, but other experts disagree. [15]

Gastrointestinal disease: The absorption of calcium is influenced by conditions within the lumen of the small intestine. The acid secretion from the stomach converts the calcium to a salt, which is absorbed primarily in the duodenum. Unabsorbed calcium is precipitated in the ileum and is excreted in the form of feces through anus. Calcium citrate is absorbed equally well when taken with or without food and is a form recommended for individuals with low stomach acid (more common in people over 50 or taking acid blockers), inflammatory bowel disease or absorption disorders.

The normal dose of calcium supplements may cause bloating, gas, and constipation. Recent studies have also linked calcium supplements with an increased risk of colon polyps (small growths in the large intestine that can become cancerous) and kidney stones, which are hard masses usually formed in the kidneys from an accumulation of calcium and other substances. Calcium carbonate may cause acid rebound where the stomach overcompensates for the high dose of calcium carbonate, which is alkaline, by churning out more acid. People with a history of stomach ulcers may have to switch to calcium citrate.

Kidney Stone: Very high doses of calcium can cause kidney stones. Most kidney stones are calcium stones, usually in the form of calcium oxalate. Oxalate is a substance made daily by your liver or absorbed from your diet. Calcium is a nutrient that is found in dairy products, such as yogurt, milk and cheese. You need to eat calcium so that it can bind with oxalate in the stomach and intestines before it moves to the kidneys. Eating foods with calcium is a good way for oxalates to leave the body and not form stones. If your urine contains too much calcium, crystals might form in your kidneys. Over time, the crystals can combine to form kidney stones. Calcium supplements, however, may increase your risk of stones. It is likely that large doses of supplemental calcium, especially if taken separate from a meal, may lead to stone formation. If necessary, stone forming patients should be encouraged to take their calcium supplements with a meal and their stone disease should be monitored. Normally, kidney stones cause symptoms such as pressure and pain in the lower back, fever, frequent urination, discomfort urinating and bloody or discolored urine. However, sometimes kidney stones can cause

gastrointestinal symptoms such as nausea, vomiting, and stomach discomfort. The results suggest that moderate physical exercise, without increased fluid intake to compensate for excessive sweating, may cause the crystallization of uric acid and calcium oxalate in urine and may enhance the risk of the formation of renal stones composed of these salts.

2. CONCLUSION:

The issue of safety in people receiving calcium has long been a matter of debate. There is an abundance of data for beneficial effects and side effects in the literature on the role of calcium. All taken together, it is important to balance the advantages and disadvantages of calcium supplementation on human health. Based on the literature study, calcium supplementation is a double-edged sword in promoting bone formation or preventing osteoporosis, as it also may have a potential negative impact. [16]

Despite the abovementioned studies providing powerful evidence for beneficial health-related effects of taking calcium, some recent evidence has implied that calcium supplementation might increase the risk for cardiovascular diseases and malignancy. What is more notable about these adverse effects is that, under the recommended dosage, calcium would produce some unwelcome reactions; therefore, a more detailed consideration of the safety and health benefits of calcium supplementation would be warranted. A number of adverse events are possibly influenced by calcium supplementation; these include myocardial infarction, constipation, colorectal neoplasm, and kidney stone.

Many factors could account for the inconsistencies in earlier studies. First, different dosages of calcium may induce different results. Second, dietary calcium may have beneficial effects than calcium supplements. Third, different populations and sample sizes may affect the results of studies. In the reported studies, sample sizes vary from several hundreds to several thousands. Last, there are still some unknown mechanisms affecting the results. Therefore, further experimental studies are necessary to decipher the mechanisms of the calcium intake affecting those diseases. As for the types of calcium to consume, a thorough search of the literature on calcium studies suggested that dietary calcium is more beneficial for health than calcium supplements and that it is also easier to absorb. [17]

However, there is no denying that the favourable role of calcium is evident for athletes. For children and adolescents and sportspersons, sufficient calcium intake is important for building strong bone. And if taking calcium is necessary for those people, what is the proper dosage? There appears to be no clear answer to questions like these. Therefore, we recommend that calcium supplementation should be prescribed cautiously and taken into account the health status of individuals. Of course, the patients with hypocalcaemia should avoid taking calcium supplements.

Some authorities have recommended that more focus be placed on dietary calcium rather than calcium supplements. Worldwide, there are substantial differences in calcium intake, with higher intakes in Western countries and lower intakes in Asia and Africa. The research regarding the role of calcium to children, adult and athletes is inconclusive. But there is a growing body of evidence about calcium supplements that suggests no health benefit, or even worse effect." Multiple studies have found that there's little to no benefit of taking calcium supplements for the prevention of hip fractures. Some studies show taking calcium supplements in addition to a diet high in calcium could raise your risk of heart attacks and strokes, but other experts disagree.

3. SUGGESTIONS

At the end I want to suggest that the role of calcium supplementation can not be negated for the sports person because dietary product can't provide enough calcium for the sports person. If necessary what should be the real dose of calcium supplements per day for different individuals?

Questions remain unsolved as to whether taking extra calcium as calcium supplements is helpful to the sports persons or general population. Given the uncertainty about the balance of benefits and risks of calcium supplements, it's probably best to get the calcium need from dietary sources to keep your bones strong and prevent bone-thinning osteoporosis, cardiovascular disease and kidney stone etc. More studies are needed to examine these effects for making better recommendations in different genders, ages, and ethnicities.

One should not rely much on calcium supplements for bone health but to include the following:

- Weight-bearing exercise, walking, running, playing games like tennis, badminton etc. is the best thing that can be done for the bones.
- Swimming, cycling and exercising on machines such as elliptical trainers can provide a good cardiovascular workout, but they don't improve bone health.
- Getting enough vitamin D, from Sun and supplements, is also good for bones and overall health if taken cautiously.
- Vitamin K from green leafy vegetables such as spinach, Swiss chard, and kale is also important for bone health.

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