A Review of Calcium Supplement Recommendations for Prevention of Bone Density Loss

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Abstract

Bone mineral density (BMD) decreases with age, especially in postmenopausal women, which can lead to osteoporosis. Osteoporosis occurs when bones weaken severely enough to cause a significantly increased risk of fractures from everyday activity. Calcium is essential for many bodily processes, as well as in mineral storage strengthening the bones. To prevent osteoporosis in elderly patients, it has been a standard clinical recommendation to take calcium supplements with the goal of intaking at least 1000-1200mg of calcium per day. However, recent research has questioned the extent to which calcium supplementation can benefit skeletal strength, as well as the risks calcium supplementation can increase of adverse cardiovascular, gastrointestinal, and renal events. In this mini review, I will argue that the risk:benefit ratio of calcium supplementation does not support its clinical recommendation in the general population. I will then explore gaps in the current research on the relationship between dietary calcium and BMD loss, which include needing more information on other drug therapies for osteoporosis and clarity on the effects of calcium in diverse populations. Finally, future developments, such as patient education to encourage preventative health behaviors, will be discussed.

Keywords: calcium, bone mineral density (BMD), osteoporosis, cardiovascular events, fractures

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Introduction

Bone mineral density (BMD) decreases as a part of overall loss of bone density with age; bone density loss (BDL) occurs as bone-building osteoblast activity slows but bone-destroying osteoclasts persist (1). If BDL becomes severe enough, osteoporosis can develop, a condition where bone tissue has thinned enough to significantly increase the risk of fractures, even from low-impact mechanical stress (1). Osteoporosis affects about 8 times as many women as men (2), but is still significant in much of the elderly population, prevalent in half of women older than 65 and 20% of men older than 70 (1). Calcium presence in bone plays an important role in protection from fractures, as well as many other essential body functions; calcium deficiencies in diet can lead to increased risk for osteoporosis and accompanying risk for fractures in falls (3). As a result of this relationship between calcium and osteoporosis, older men and women have been clinically recommended to intake at least 1000-1200mg of calcium per day, and usually need calcium supplements to reach this goal (4). However, recent research has questioned two key problems surrounding the recommendation of calcium supplements: whether calcium supplements truly increase BMD or mitigate the risk of fracture, and whether calcium supplements contribute to side effects that outweigh their purported benefits (4, 5, 6, 7). After discussing the risks of calcium supplements and their questioned benefits, gaps in the research will be explored; finally, other areas of research to better address osteoporosis will be considered.

Controversies about the risk:benefit ratio of calcium supplements

A preeminent question to answer regarding the clinical recommendation of calcium supplements is simply whether these supplements have been found to have their desired benefits: mitigating BMD loss and lowering the risk of fractures. Data from the Women's Health Initiative (WHI) found that calcium and vitamin D supplements resulted in a significant improvement in hip bone density and had no significant effect on hip fractures (8), whereas in a Northern European study such supplements were found to have a 16% reduction in fracture incidences (9). However, the WHI data have been criticized for poor adherence to study drugs and inconsistent statistical effects (5). In a more recent systematic review including the WHI data, both dietary and supplemental calcium were identified as having weak and inconsistent benefits on fractures, and evidence of publication bias was found (4). An observational study from the National Health and Nutrition Examination Survey found that although older subjects who are truly calcium deficient have fewer hip fractures with supplementation, higher levels of calcium consumption from supplements in a general, representative sample did not provide a benefit for hip or lumbar BMD (6). The focus for these studies is primarily on hip, femoral, and lumbar BMD because these locations are especially at risk for fracture due to osteoporosis (1). If calcium supplements have a questionable benefit to BMD or risk of fracture, it is important to consider if these interventions contribute to any adverse outcomes.

The primary goal of taking calcium supplements is to decrease the likelihood of fracture by protecting or increasing BMD, but a suggested secondary benefit is that calcium has been thought to protect against adverse cardiovascular events (5). It is thought that the benefit of calcium on the cardiovascular system could be that calcium increases the ratio of high-density to low-density lipoprotein cholesterol, which has been associated with a reduction of the risk of

adverse cardiovascular events (5). However, the study investigating this matter in a randomized control trial actually found calcium supplementation to be associated with an increased risk of stroke and myocardial infarction (MI), or heart attack (5). Anderson, Roggenkamp, and Suchindran assert that little excess dietary and supplemental calcium is retained in the bones, suggesting that the likeliest site this calcium goes to, if not the skeleton, is in the arteries, as well as urinary and fecal waste (6). Bolland et al. (2008) similarly discuss that calcium supplements may accelerate vascular calcification, which is associated with such adverse cardiovascular events (5). Together, these two studies suggest supplementation of calcium may contribute to adverse cardiovascular events. However, the WHI data did not find an increase or decrease in cardiovascular events due to calcium supplementation (7), and a study analyzing this data found that reported MI may have been falsely reported by subjects because adverse gastro-intestinal (GI) events were mistaken for cardiac events, especially if patients were originally admitted to a cardiac ward (10). Lewis et al. therefore suggest that calcium supplementation's associated risk of adverse cardiovascular events may partly be disguising a risk of GI problems. Finally, the finding that excess calcium may partially end up in the urinary system is consistent with the suggestion that calcium supplementation could contribute to an increased risk of kidney stones (6, 8). Not only is it disputed that calcium supplementation actually significantly improves or protects BMD, but adverse cardiovascular, GI, and renal events have been linked with supplemental calcium intake, suggesting that more research is needed to clarify the risk:benefit ratio of calcium supplements before it can continue to be safely recommended to patients at risk of osteoporosis.

Needed research clarifying effects of calcium supplementation on specific populations

Menopause, and specifically the dropping off of estrogen levels, is implicated as a cause of osteoporosis being especially common in older women (1). Although much research on calcium supplementation and bone thinning has given attention to its effects on gender (3, 5, 6, 7, 8, 11), more research is needed at the intersection of gynecological and orthopedic care; for example, it is common to prescribe estrogen to treat problems associated with menopause, but estrogen is also a vasoactive drug (5, 12). The WHI data has been criticized for the confounding presence of high uses of estrogen and other vasoactive drugs with calcium supplementation (5). This is particularly significant when considering the finding that estrogen by itself can mitigate bone loss (12). The effect of calcium supplementation on non-white populations also needs to be greatly clarified (5, 11). Furthermore, supplementation is evidently helpful for people who are actually calcium deficient (6) and was found to significantly reduce the risk of fractures among a population that is likely to lack appropriate calcium and vitamin D due to their environment (9), but these findings are not necessarily generalizable to other populations. Finally, the risk of fracture due to BMD loss can be influenced by factors other than a single supplement, considering that an inflammatory diet has been found to contribute to an increase risk of fractures (11) and other treatments, as with estrogen, can mitigate bone weakening (12). Therefore, the risks of calcium supplementation suggest that other treatments for osteoporosis should be further investigated as alternatives in future research because they represent gaps in current medical knowledge.

Future developments in the prevention of osteoporosis and BMD loss

Although drug treatments for osteoporosis besides calcium supplementation are important to investigate, bone weakening with age can also be prevented with behavior, so public

health interventions reveal a promising direction in future research. Elderly people may avoid strenuous activity because they are afraid of fractures, but because bone weals with inactivity, fractures are unfortunately made more likely as a result (1). Group-based exercise designed to maintain strength has been found to reduce the fear of falling and fracture (13). Specifically, heavy resistance training has been found to be safe for postmenopausal women with low bone mass, and improved femoral and lumbar BMD (14). Exercise in combination with patient education can be a powerful tool to prevent osteoporosis, as in several studies that have employed the Health Belief Model to significantly increase time spent exercising (15) and improve lumbar and hip BMD (2). Important, many these studies are preliminary or early findings (2, 14), so future research will be able to flesh out the efficacy of public health interventions on osteoporosis and BMD loss, especially as an alternative to drug or supplemental therapies.

Conclusion

Although calcium supplementation has long been recommended as a standard therapy to prevent and mitigate BMD loss in elderly populations (4), calcium supplementation may not significantly improve BMD in the general population (4, 5, 6). Calcium supplementation, furthermore, may increase the risk of adverse cardiovascular, GI, and renal events (5, 6, 8, 10). More research is needed to fill current gaps about the generalizability of the benefits of calcium supplements in niche populations, but hopeful directions in osteoporosis research include the use of other drug or supplemental therapies besides calcium, as well as public health interventions to educate patients and increase activity. Fractures in an already fragile and aging skeleton can be devastating; of elderly patients who suffer a hip fracture, 20% will die within the year (9). Therefore, interventions to prevent, mitigate, and even reverse BMD loss with age are critical to improve elderly quality of life.

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