

Harden My Heart: Calcium Supplementation and the Risk of Cardiovascular Disease

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For more than 20 years, older women were encouraged by their healthcare providers to supplement their diets with calcium and vitamin D₃ to reduce their risk of hip and other fractures. In recent years, evidence has been mounting that calcium supplementation, but not dietary calcium intake, is associated with increased risk of myocardial infarction and heart disease. At the same time, the validity of the recommendation to supplement the diet with calcium for bone health has been questioned. As of yet, there is no change in nonpharmacological clinical guidelines for bone and heart health. Patients, however, are asking if they should supplement diets that do not meet the recommended dietary allowance for calcium. We suggest they discuss their concern with their primary care provider. We present 2 cases from our family medicine practice to demonstrate an approach to answering the patient's queries based on the patient-oriented evidence available. We also present a brief review of the evidence supporting our recommendations, recognizing this is a hot topic of discussion. *Nutr Today*. 2016;51(1):18–24

tian nutritionists (RDNs) have been frustrated by challenges to several long-standing dietary recommendations and practices by studies reporting contrary or null findings and even unintended consequences related to these practices. In today's world, scientific dialogue is accessible to professionals and consumers alike, and consumers and patients ask questions that seem to have no clear answers. This article presents 2 cases where RDNs and physicians previously would have confidently recommended a patient increase calcium intake from food or dietary supplements. Healthcare professionals have been influenced by a 1992 article in the *New England Journal of Medicine* that concluded, "supplementation with vitamin D₃ and calcium reduces the risk of hip fractures and other non-vertebral fractures among elderly women."¹ Today, they are challenged by the dialogue surrounding the role of calcium in bone health and heart disease.

When Do You Change Practice?

As health professionals, we have been taught to be wary of the Semmelweis reflex within ourselves—a metaphor for the reflex-like tendency to reject new evidence or new knowledge because it contradicts established norms, beliefs, or paradigms, yet at the same time, it is imprudent to "throw out the baby with the bath water." The 2015 Dietary Guidelines Advisory Committee (DGAC) suggests that calcium and vitamin D are nutrients of concern because of underconsumption.² Reports suggest the typical adult patient consumes between 500 and 600 mg of calcium from food and drink per day. Patients report limiting their intake of foods high in calcium (10%-19% of daily value) because of personal taste preferences, religious or environmental beliefs, cost, or weight management. Others take medications, including corticosteroids, that impact bone health, or they have conditions that affect calcium absorption. Many patients have also been advised to supplement. While estimates of calcium supplement use in the United States are limited by the quality of self-reported data, published results from the 2003–2006 National Health and Nutrition Examination Survey cohort showed more than 50% of men older than 50 years and nearly 70% of women older than 50 years in the United States use calcium supplements.³ Should the RDN, physician, or other healthcare professional suggest they stop the calcium supplementation? We explore what advice might be given to these patients based

Myths Versus Facts in Nutrition

For many years, nutrition educators have used "myth versus fact" as a teaching tool. We have enjoyed helping consumers and patients sort out the silliness from the science. It is amazing what a search of the Internet on nutrition and/or weight loss myths will generate! As nutrition has become an increasingly popular subject, and found its way into newspaper and TV headlines, we are challenged to help consumers and patients recognize when the "headline" might not actually capture the essence of a study. Recently, nutrition educators and registered dieti-

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on patient-oriented evidence in the absence of clear guidelines. We encourage patients to discuss their need and/or interest in supplementation with their primary care provider. Registered dietitian nutritionists should be aware of the advice being given to their patients and be able to explain the discussions of the studies and data that have mixed results and are difficult to interpret.

CASE 1: OLDER WOMAN WITH A DIAGNOSIS OF OSTEOPENIA

Mrs J.H. is 61 years old and has recently received a diagnosis of osteopenia. The instructions printed on her bone density report includes the following statement: “hormonal therapy, dietary supplementation, and weight-bearing exercise may prevent further bone loss. Maintain an intake of 1500 mg of calcium daily with 600 IU vitamin D.”

She is 5 ft 3 in tall and weighs 135 lb (body mass index, 23.9 kg/m²), and her waist circumference is 34 inches. She has been told she has prehypertension and borderline high low-density lipoprotein cholesterol and borderline low high-density lipoprotein cholesterol. She takes no medications but has been supplementing with 600 mg calcium carbonate and a daily multiple vitamin for years, although only when she remembers, a few times a week. She also now takes glucosamine chondroitin. She requested a consultation with an RDN to develop a meal plan that will help her “lose a little weight” and “eat healthy.” Her resting energy expenditure was measured at 1400 plus 140 calories from exercise and 400 calories from lifestyle and activity. She is basically sedentary. She reports being lactose intolerant, although she has never been tested.

Mrs J.H. has significant family history of heart disease. Her mother had a heart attack at age 49 years and died of cancer at age 57 years. Her father died in a single car crash. Although there was no autopsy performed, it was assumed that he had a heart attack or stroke before the crash. Her father’s brother had 3 children who experienced cardiovascular disease (CVD). A female cousin died at age 58 years of a sudden heart attack. Another female cousin received a diagnosis of congestive heart failure at age 61 years. Her male cousin had triple bypass surgery at age 64 years.

In her visit with the RDN, she agreed to a 1200-calorie meal plan: breakfast: 1 starch and 1 milk (1% acidophilus); morning snack: 1 fruit; lunch: 1 starch, 2 nonstarch vegetables, 1 fruit, 2 oz of meat, fish, or poultry; 1 fat; afternoon snack: 1 starch; dinner: 1 starch, 1 fruit, 2 nonstarchy vegetables; 3 oz of lean meat, fish, or poultry; 1 fat; and evening snack: 1 starch. She is trying to “eat clean,” which she described as eating foods in their natural state with lots of whole fruits and vegetables and unsalted nuts; as less “processed” (without artificial sweeteners, *trans* fats, high-fructose corn syrup, or food colors); and as home cooking. Despite their planning, the nutrient analysis shows her calcium intake

from food and beverages to average 860 mg/d. She is unwilling to try to get more calcium from food and wants to take a supplement.

CASE 2

Mr K.P. is a 72-year-old white man who presented to his family physician for routine follow-up of his polymyalgia rheumatica (PMR). He is 5 ft 8 in tall and weighs 160 lb (body mass index, 24.3 kg/m²) with waist circumference of 35 inches. He first received a diagnosis of PMR 5 years earlier by a rheumatologist and was treated with prednisone, a corticosteroid that reduced his symptoms. His PMR presented acutely with stiffness around the shoulders and hips, especially in the morning and after resting, generalized weakness, and fatigue. He could not raise his arms over his head. He responded almost immediately to the prednisone. Over the last 5 years, he has attempted several times to wean himself from the prednisone, but each time he gets to a dose of 5 mg, he has a flare of the pain and stiffness. His rheumatologist advised him after the third trial that he would likely remain on a low-dose prednisone regimen for the rest of his life and should be followed by his family physician.

Mr K.P. continues to read about his condition and medications used to treat it. He has read that adults on long-term steroid treatment are at risk of osteoporosis and should take a calcium supplement. He had been taking 500 mg of calcium carbonate daily, and his rheumatologist had said it “couldn’t hurt.” He wonders with all the headlines about calcium and heart disease if he should continue to do so. Since starting the steroids, his blood pressure also increased, and he manages it with a daily 10-mg dose of amlodipine besylate. His lipids are in the reference range. He has not had a bone density test. His most recent vitamin D level was 24 ng/mL. Mr K.P. works to keep his weight stable. He is an avid golfer and maintained his weight before the PMR diagnosis by walking the golf course. He continues to enjoy 5 rounds of golf per week but rides a cart. He does strength training at the hospital wellness center 1 to 2 days per week. He weighs daily and adjusts his food and beverage intake if he gains a few pounds. Prior to the PMR diagnosis, he consumed a large glass of 2% milk with his lunch. He was concerned about those calories, so he now drinks diet ginger ale with lunch and throughout the day, because he does not like the taste of water. Periodically, he feels “a bit green” in the morning. He tried a probiotic supplement but did not find it helpful. He did find that eating a low-fat yogurt with active cultures seems to help his gastrointestinal upset. He does experience some constipation. He feels fortunate that he has not experienced the ravenous appetite some of his friends had when on the same medication (eg, prednisone).

He generally follows the DASH eating plan. His food pattern includes a breakfast of low-fat yogurt, small glass of

juice, 2 servings of a bread and 1 oz of cheese, coffee with sugar. His lunch is a sandwich with meat or egg filling, small bag of chips, banana, or a granola bar and banana. He enjoys a bourbon cocktail (2 servings) before dinner and has 3 to 7 oz of meat/fish/poultry, a large serving of potatoes, and a large serving of a vegetable or salad (but never spinach or other dark greens). He snacks and has dessert only occasionally. He and his spouse travel a good deal, and they try to eat a small picnic breakfast and lunch and eat dinner out in a nice restaurant. He kept a food log and brought with him the output from Supertracker (<http://www.choosemyplate.gov/tools-supertracker>). The report shows he typically consumes 2200 calories with approximately 600 calories coming from fat. He takes in on average 85 g of protein, 266 g carbohydrate, 20 g of dietary fiber, and 670 mg calcium and 4.4 µg vitamin D per day. Besides the PMR and some arthritic pain, Mr K.P. reports good health. His father died of heart disease at age 82 years, and his mother of lung cancer at age 75 years.

BACKGROUND

Calcium and Bone Health

The North American Menopause Society⁴ advises calcium supplementation to maintain skeletal health if a woman older than 50 years does not consume the recommended daily allowance of 1200 mg daily from food and beverages. The recommendations also note that many women take excessive calcium supplements, and most may need only 500 mg daily in addition to their diet to reach the recommended daily allowance.

Most recommendations for the use of calcium supplementation to decrease the risk of osteoporosis and associated fractures are based on randomized controlled trials (RCTs) that use bone mineral density as the primary outcome. However, meta-analysis of results from prospective cohort studies involving more than 200 000 men and women has shown no association between total calcium intake and hip fracture risk in either gender.⁵ These data suggest the assumption that improved bone mineral density lowers fracture risk may be incorrect.

One possible explanation for the lack of association between calcium supplementation and hip fracture risk is that calcium alone is not responsible for fracture prevention. A specific ratio of calcium and phosphate is necessary for proper bone mineralization. Phosphate deficiency may not only limit bone mineralization, but also can even augment bone resorption. Both calcium carbonate and calcium citrate can limit phosphate absorption, whereas vitamin D stimulates phosphate absorption.

Calcium, Vitamin D, and Fracture

Importantly, vitamin D supplementation alone is also not associated with a decreased risk of fracture, according to a

2014 Cochrane review. The same review concluded that the combination of calcium and vitamin D is associated with a small, but statistically significant, reduction in the risk of hip and other fractures.⁶ Guidelines from the Institute of Medicine (IOM) in 2011 reached the same conclusion, and the IOM continues to recommend a total calcium intake of 1200 mg daily and vitamin D intake of 600 to 800 IU daily to promote bone health and protect against osteoporotic fractures, especially in elderly individuals.^{7,8}

In 2013, the US Preventive Services Task Force released a statement on vitamin D and calcium supplementation to prevent fractures. The Task Force concluded there is inadequate evidence to assess the benefits and harms of daily supplementation with greater than 1000 mg calcium and greater than 400 IU vitamin D for primary fracture prevention in noninstitutionalized women.⁹

A recent systematic review evaluated studies of dietary calcium, milk or dairy intake, or calcium supplements with or without vitamin D and fractures in patients older than 50 years. While most studies found no association between dietary calcium or dairy intake and the risk of fracture, calcium supplements reduced the risk of total fracture by 11% and vertebral fracture by 14% but had no impact on the risk of hip or forearm fracture. However, the authors found evidence of bias toward calcium supplements in the published data, as the smallest studies were most likely to show the most significant effect for supplementation. In RCTs at lowest risk of publication bias, calcium supplementation showed no effect on fracture at any site. The findings were similar for calcium monotherapy and combination calcium with vitamin D.¹⁰

In contrast, the Women's Health Initiative investigated postmenopausal women not taking personal calcium or vitamin D supplements at baseline and demonstrated a 38% reduction in the risk of hip fracture following 5 or more years of calcium and vitamin D supplementation when compared with placebo.¹¹

Positive Effects of Calcium Supplementation on Disease-Oriented End Points

From a cardiovascular standpoint, calcium supplementation has a positive effect on multiple disease-oriented end points. In healthy postmenopausal women, calcium supplementation has been shown to increase high-density lipoprotein cholesterol by 7% and decrease low-density lipoprotein cholesterol by 6%.^{12,13} Calcium supplementation is also associated with a small reduction in systolic and diastolic blood pressure.¹⁴

Supporting the notion that calcium intake is associated with improved cardiovascular outcomes, several observational studies including the Iowa Women's Health Study—a prospective cohort study of nearly 35 000 postmenopausal women—found reductions of as much as 33% in the risk of ischemic heart disease in the group with the highest

calcium intake.¹⁵ Of note, in this study, only the women who had the highest dietary calcium intake enjoyed the decrease in their risk of ischemic heart disease. Importantly, those with high calcium intake resulting from supplementation did not see any benefit.

Corroborating these results, the Japan Public Health Center trial found that dietary calcium intake, particularly calcium from dairy products, was associated with a 30% reduction in the risk of ischemic stroke. The risk of ischemic heart disease was unchanged by calcium supplementation.¹⁶

Adverse Effects of Calcium Supplementation on Disease-Oriented End Points

The Auckland Calcium Study sought to clarify the issue with a secondary analysis of an RCT evaluating calcium supplementation in 1471 healthy postmenopausal women. The original study was designed to assess the effect of calcium citrate supplementation on bone density and fracture incidence. Secondary analysis of the data focused on vascular events, including myocardial infarction (MI), stroke, and sudden death. In the group receiving calcium supplementation, the risk of MI was more than doubled, with no change in the risk of the other event rates. In this study, the number of women needed to cause 1 MI in 5 years was 44, whereas the number needed to treat to prevent 1 symptomatic fracture was 50.^{17,18}

An even larger adverse effect on the risk of MI was seen in the Heidelberg cohort of the European Prospective Investigation Into Cancer and Nutrition Study (EPIC-Heidelberg). When compared with nonusers of any supplements, users of calcium supplements saw an 86% increase in their risk of MI. The same adverse effect was not seen with higher levels of dietary or dairy calcium intake. Both dietary/dairy groups had 30% reduced MI risk compared with those in the lowest dietary or dairy calcium intake group.¹⁹

Recent meta-analysis of 18 RCTs involving nearly 50 000 females older than 50 years failed to show a significant impact of calcium supplementation on the risk of coronary heart disease or all-cause mortality. In the small subset of women receiving calcium supplementation alone, a non-statistically significant increase in MI risk was noted. The authors suggest that vitamin D always be administered along with a calcium supplement, citing a better safety profile for the combination.²⁰

Besides the potential impact on cardiovascular risk, observational and small studies indicate that excessive calcium intake from food and/or dietary supplements may cause gastrointestinal symptoms such as constipation, increased risk of kidney stones, and increased risk of prostate cancer.

Adding Vitamin D to Diminish Cardiovascular Risk

A question that remained unanswered was whether the addition of vitamin D to calcium supplementation dimin-

ished the apparent adverse cardiovascular risk of calcium supplementation alone. The initial report of the Women's Health Initiative Calcium/Vitamin D Supplementation Study (WHI CaD Study)—a 7-year, randomized, placebo-controlled trial involving more than 36 000 women—was no adverse effect of calcium and vitamin D on any cardiovascular end point.^{11,21} At the time of this trial's randomization, however, 54% of the participants were taking personal (nonprotocol) calcium supplements, and 47% were taking personal vitamin D supplements, potentially obscuring both adverse and positive effects of the intervention.

The WHI CaD dataset was subsequently reanalyzed, focusing on the women not taking personal calcium supplements at randomization. That group saw a 22% increased risk of MI and a 16% increase in the composite end point of MI or stroke, when compared with the group receiving placebo. Death from all causes was not statistically different. In the group using personal calcium supplements at baseline, additional calcium or vitamin D supplementation did not alter cardiovascular risk. In this analysis, treating 1000 patients with calcium or calcium plus vitamin D for 5 years would cause an additional 6 MIs or strokes (number needed to harm = 178) and would prevent 3 fractures (number needed to treat = 302).²²

Dietary Calcium and Risks

A 2015 meta-analysis of prospective cohort studies found that total calcium intake was associated with a significantly increased risk of CVD mortality, but only in studies with a mean duration of follow-up of more than 10 years (relative risk [RR], 1.35; 95% confidence interval [CI], 1.09–1.68). Overall, dietary calcium intake was not associated with all-cause, CVD, or cancer mortality. In studies with a mean follow-up duration of less than or equal to 10 years, however, dietary calcium intake was associated with a lower risk of all-cause mortality (RR, 0.84; 95% CI, 0.70–1.00). When the effect of supplemental calcium was evaluated, no association with CVD or cancer mortality was seen, but risk of all-cause mortality was decreased (RR, 0.91; 95% CI, 0.88–0.94). In these studies, dietary calcium intake was assessed by Food Frequency Questionnaire or dietary recall.²³

Dietary Calcium Versus Supplemental Calcium

One hypothesis to explain the apparent differential effect of dietary calcium versus supplemental calcium on the risk of MI and CVD hinges on the relative impact of each on serum calcium levels. The increase in ionized calcium following equivalent doses of a dairy product is one-sixth of that seen following ingestion of a soluble calcium supplement, such as calcium citrate or gluconate. Moreover, the differences in serum calcium following supplement ingestion are greater than the differences found in observational

studies to be associated with vascular pathology, cardiovascular events, and cardiovascular mortality.^{13,24,25}

Food and Beverage Sources of Calcium and Vitamin D and Other Nutrients of Concern

Although some experts have suggested that adults need not worry about their calcium intake, the 2015 DGAC has noted that calcium is among the nutrients that are underconsumed relative to the estimated average requirement or adequate intake levels set by the IOM. The DGAC characterized vitamin A, vitamin D, vitamin E, vitamin C, folate, calcium, magnesium, fiber, and potassium as shortfall nutrients. In addition, for adolescent and premenopausal females, iron was listed as a shortfall nutrient. Of the shortfall nutrients, calcium, vitamin D, fiber, and potassium are considered to be of public health concern because in the scientific literature inadequate intakes are linked to adverse health outcomes (<http://health.gov/dietaryguidelines/2015-scientific-report/02-executive-summary.asp>).² A reasonable approach at this time is to calculate calcium intake and supplement only to fill the gap. Because there are a limited number of foods that are high or good sources of calcium, food frequency quizzes can be used to estimate intake. Foods fortified with calcium should be included in this estimate. An electronic calcium calculator can be found at www.iofbonehealth.org/calcium-calculator, and a chart with steps to calculate calcium intake is at <http://nof.org/articles/542>.

If Calcium Supplementation Is Needed

The emerging “rule of thumb” seems to be that supplementation should not exceed 500 mg per dose and no more than 900 mg/d. The upper tolerable intake for calcium for adults older than 50 years is 2000 mg/d. Although many multiple vitamin/mineral preparations have only small amounts of calcium in them, the amounts vary widely and need to be considered when calculating supplement need. Until guidelines are clarified, RDNs should be aware of the advice their patients are receiving from their primary care or specialty physician.

The 2 most commonly recommended calcium supplements are calcium carbonate (40% elemental) and calcium citrate (21% elemental). Calcium carbonate and supplements containing fat-soluble vitamins should be taken with food. Calcium carbonate usually is less expensive than calcium citrate, and some, but not all, studies show calcium carbonate is better absorbed by older adults and by those taking multiple medications. When selecting a calcium supplement, the patient should follow label instructions and note serving sizes. They can select their supplement based on tolerability, including ease of swallowing. Calcium carbonate may increase risk of constipation. Chews, liquids, and powders may be easier to swallow than tablets

or capsules. The patient should discuss any potential interactions with other medications. Additional information can be found at www.consumerlab.com. Because it is unlikely that most patients would have a shortfall of more than 500 mg of calcium, the concern that only approximately 500 mg of calcium can be absorbed at one time is less relevant than in the past. Cost of calcium supplements varies greatly and may relate to factors other than quality.

Beyond Calcium and Vitamin D Intake for Osteoporosis Prevention

Although diet and nutrition play a significant role in creating and maintaining bone density, other lifestyle factors including tobacco use, alcohol consumption, weight management, and weight-bearing exercise need to be considered as well.²⁶

CASE 1 REVISITED

Mrs J.H.’s dietary intake of calcium remains below the recommended target, and it does not appear that she will be able to meet the dietary reference intake with dietary sources alone. While she does not have established CVD, her family history is certainly worrisome. Currently, there are no formal guidelines to inform the RDN’s recommendations; however, available evidence suggests the following points should be discussed with the patient: (1) there is little evidence to support the use of calcium supplements to prevent fractures; (2) calcium supplementation is associated with increased risk of MI; the same amount of calcium obtained from dietary sources does not show the same association; if supplements are necessary to meet Mrs J.H.’s daily calcium goal, the minimum dose necessary should be advised; and (3) an acute increase in serum calcium levels with supplements may be a factor in the increased MI risk; splitting the total daily supplement dose into multiple, smaller doses may be prudent.

CASE 2 REVISITED

Mr K.P. is at increased risk of osteoporosis because of his chronic use of corticosteroids. His age and hypertension increase his risk of CVD, although he does describe an otherwise healthy lifestyle. His rheumatologist’s suggestion that a calcium supplement “couldn’t hurt” may not be the best advice. His diet still has room for improvement in calcium content, and it is likely that he can meet his dietary reference intake with dietary changes alone. The RDN would explain to Mr K.P. that use of calcium supplements is associated with an increased risk of MI and may be aggravating his intermittent constipation. The RDN will congratulate him on his continued weight-bearing exercise that helps limit his risk of osteoporosis. Mr K.P. reviews a list of foods (Table) that provide calcium and says

TABLE Calcium Content of Selected Foods and Beverages^a (From http://ods.od.nih.gov)		
Food/Beverage	Calcium (mg)	% Daily Value
Yogurt, plain, nonfat, 1 cup	415	42
Sardines, with bones, 3 oz	325	33
Yogurt, fruit flavor, 1 cup	313–338	31–38
Cheddar cheese, 1.5 oz	307	31
Soy milk, calcium fortified, 1 cup	299	30
Milk, 2%, 1 cup	293	29
Collard greens, cooked, 1 cup	265	27
Orange juice, calcium fortified, 1 cup	261	26
Tofu, firm, ½ cup	253	25
Pink salmon, canned with bones, 3 oz	180	18
Cottage cheese 1% milk fat 1 cup	138	14
Frozen yogurt, soft serve, ½ cup	103	10
Edamame 1 cup	100	10
Ready-to-eat calcium-fortified cereal, 1 cup	100–1000	10–66
Kale, cooked, 1 cup	95	9
Baked beans, 1 cup	85	8
Almonds, 1 oz (24 nuts)	75	7
Broccoli, cooked, 1 cup	42	4
^a US Food and Drug Administration defines a good/high source as meeting 10% to 19% daily value.		

he is confident that he can eliminate his calcium supplement and focus on meeting his dietary calcium needs from foods and beverages.

SUMMARY

This is a brief overview of a complex issue that demonstrates 1 way primary care providers, using patient oriented evidence, can address the questions patients pose to them about meeting their calcium needs. Calcium intake has been linked to both increased and decreased risk of CVD, creating considerable uncertainty. In addition, researchers have questioned the benefit of calcium intake for bone health in older adults. Even so, it is our belief at this time that the potentially detrimental effects should be balanced against the benefits of calcium on the bone and nutritional health. Registered dietitian nutritionists and other health-

care providers should review patient education materials, including bone density reports, provided to patients to ensure they match current evidence that suggests patients obtain most of their calcium from dietary sources, supplementing only to meet, but not exceed, recommendations. There are no current guidelines that address the mounting evidence that calcium supplementation—but not dietary calcium intake—is associated with increased risk of MI. One hypothesized mechanism focuses on the abrupt elevation of serum calcium levels after supplement ingestion, suggesting this may be a more potent trigger for vascular calcification. However, a small-scale human study²⁷ and recent investigation using a pig model²⁸ have not supported this hypothesis.

For individuals truly unable to meet their reference daily intake for calcium through dietary sources, a prudent recommendation would be to use the lowest dose of supplement necessary to meet their daily requirement of 1200 mg, splitting the dose into multiple smaller doses taken throughout the day. Healthcare professionals can encourage patients to maintain a healthy body mass index, be physically active, avoid tobacco products, and if they drink alcohol do so in moderation.

REFERENCES

1. Chapuy MC, Arlot ME, Duboeuf F, et al. Vitamin D₃ and calcium to prevent hip fractures in the elderly women. *N Engl J Med*. 1992;327(23):1637–1642.
2. 2015 Dietary Guidelines Advisory Committee, United States Department of Health and Human Services (USDHHS), United States Department of Agriculture (USDA). Scientific report of the 2015 Dietary Guidelines Advisory Committee. Part A: executive summary. health.gov Web site. <http://health.gov/dietary-guidelines/2015-scientific-report/02-executive-summary.asp>. Updated February 2015. Accessed October 10, 2015.
3. Bailey RL, Dodd KW, Goldman JA, et al. Estimation of total usual calcium and vitamin D intakes in the United States. *J Nutr*. 2010;140(4):817–822.
4. Shifren JL, Gass ML, NAMS Recommendations for Clinical Care of Midlife Women Working Group. The North American Menopause Society recommendations for clinical care of midlife women. *Menopause*. 2014;21(10):1038–1062.
5. Bischoff-Ferrari HA, Dawson-Hughes B, Baron JA, et al. Calcium intake and hip fracture risk in men and women: a meta-analysis of prospective cohort studies and randomized controlled trials. *Am J Clin Nutr*. 2007;86(6):1780–1790.
6. Avenell A, Mak JC, O'Connell D. Vitamin D and vitamin D analogues for preventing fractures in post-menopausal women and older men. *Cochrane Database Syst Rev*. 2014;4:CD000227.
7. Institute of Medicine. *Dietary Reference Intakes for Vitamin D and Calcium*. Washington, DC: National Academies Press; 2011.
8. Rosen CJ, Taylor CL. Common misconceptions about vitamin D—implications for clinicians. *Nat Rev Endocrinol*. 2013;9(7):434–438.
9. U.S. Preventive Services Task Force. Vitamin D and calcium supplementation to prevent fractures in adults: U.S. Preventive Services Task Force Recommendation Statement [online]. <http://www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/vitamin-d-and-calcium-to-prevent-fractures-preventive-medication>. Accessed August 24, 2015.
10. Bolland MJ, Leung W, Tai V, et al. Calcium intake and risk of fracture: systematic review. *BMJ*. 2015;351:h4580.

11. Prentice RL, Pettinger MB, Jackson RD, et al. Health risks and benefits from calcium and vitamin D supplementation: women's Health Initiative Clinical Trial and Cohort Study. *Osteoporos Int*. 2013;24(2):567–580.
12. Rajpathak SN, Xue X, Wassertheil-Smoller S, et al. Effect of 5 y of calcium plus vitamin D supplementation on change in circulating lipids: results from the Women's Health Initiative. *Am J Clin Nutr*. 2010;91(4):894–899.
13. Reid IR, Mason B, Horne A, et al. Effects of calcium supplementation on serum lipid concentrations in normal older women: a randomized controlled trial. *Am J Med*. 2002;112(5):343–347.
14. Griffith LE, Guyatt GH, Cook RJ, Bucher HC, Cook DJ. The influence of dietary and nondietary calcium supplementation on blood pressure: an updated metaanalysis of randomized controlled trials. *Am J Hypertens*. 1999;12(1 pt 1):84–92.
15. Bostick RM, Kushi LH, Wu Y, Meyer KA, Sellers TA, Folsom AR. Relation of calcium, vitamin D, and dairy food intake to ischemic heart disease mortality among postmenopausal women. *Am J Epidemiol*. 1999;149(2):151–161.
16. Umesawa M, Iso H, Ishihara J, et al. Dietary calcium intake and risks of stroke, its subtypes, and coronary heart disease in Japanese: the JPHC study cohort I. *Stroke*. 2008;39(9):2449–2456.
17. Bolland MJ, Barber PA, Doughty RN, et al. Vascular events in healthy older women receiving calcium supplementation: randomised controlled trial. *BMJ*. 2008;336(7638):262–266.
18. Radford LT, Bolland MJ, Mason B, et al. The Auckland Calcium Study: 5-year post-trial follow-up. *Osteoporos Int*. 2014;25(1):297–304.
19. Li K, Kaaks R, Linseisen J, Rohrmann S. Associations of dietary calcium intake and calcium supplementation with myocardial infarction and stroke risk and overall cardiovascular mortality in the Heidelberg cohort of the European Prospective Investigation Into Cancer and Nutrition Study (EPIC-Heidelberg). *Heart*. 2012;98(12):920–925.
20. Lewis JR, Radavelli-Bagatini S, Rejnmark L, et al. The effects of calcium supplementation on verified coronary heart disease hospitalization and death in postmenopausal women: a collaborative meta-analysis of randomized controlled trials. *J Bone Miner Res*. 2015;30(1):165–175.
21. Jackson RD, LaCroix AZ, Gass M, et al. Calcium plus vitamin D supplementation and the risk of fractures. *N Engl J Med*. 2006;354(7):669–683.
22. Bolland MJ, Grey A, Gamble GD, Reid IR. Calcium and vitamin D supplements and health outcomes: a reanalysis of the Women's Health Initiative (WHI) limited-access data set. *Am J Clin Nutr*. 2011;94(4):1144–1149.
23. Asemi Z, Saneei P, Sabihi SS, Feizi A, Esmailzadeh A. Total, dietary, and supplemental calcium intake and mortality from all-causes, cardiovascular disease, and cancer: a meta-analysis of observational studies. *Nutr Metab Cardiovasc Dis*. 2015;25(7):623–634.
24. Reid IR, Bolland MJ, Grey A. Does calcium supplementation increase cardiovascular risk? *Clin Endocrinol (Oxf)*. 2010;73(6):689–695.
25. Bristow SM, Gamble GD, Stewart A, Kalluru R, Horne AM, Reid IR. Acute effects of calcium citrate with or without a meal, calcium-fortified juice and a dairy product meal on serum calcium and phosphate: a randomised cross-over trial. *Br J Nutr*. 2015;113(10):1585–1594.
26. Body JJ, Bergmann P, Boonen S, et al. Non-pharmacological management of osteoporosis: a consensus of the Belgian Bone Club. *Osteoporos Int*. 2011;22(11):2769–2788.
27. Burt MG, Mangelsdorf BL, Srivastava D, Petersons CJ. Acute effect of calcium citrate on serum calcium and cardiovascular function. *J Bone Miner Res*. 2013;28(2):412–418.
28. Phillips-Eakley AK, McKenney-Drake ML, Bahls M, et al. Effect of high-calcium diet on coronary artery disease in Ossabaw miniature swine with metabolic syndrome. *J Am Heart Assoc*. 2015;4(8):e001620.

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- There is only one correct answer for each question. A passing score for this test is 13 correct answers. If you pass, you can print your certificate of earned contact hours and access the answer key. If you fail, you have the option of taking the test again at no additional cost.
- For questions, contact Lippincott Williams & Wilkins: 1-800-787-8985.

Registration Deadline: February 28, 2018

Continuing Education Information for Registered Dietitians and Dietetic Technicians, Registered:

The test for this activity for dietetic professionals is located online at <http://alliedhealth.ceconnection.com>. Lippincott Williams & Wilkins (LWW) is a Continuing Professional Education (CPE) Accredited Provider with the Commission on Dietetic Registration (CDR), provider number LI001. Registered Dietitians (RDs) and Dietetic Technicians, Registered will receive 1.5 continuing professional education units (CPEUs) for successful completion of this program/material, CPE Level 2. Dietetics practitioners may submit evaluations of the quality of programs/materials on the CDR website: www.cdrnet.org. LWW is approved as a provider of continuing education for the Florida Council for Dietetics and Nutrition, CE Broker # 50-1223.

Continuing Education Information for Nurses:

Lippincott Williams & Wilkins, publisher of the *Nutrition Today* journal, will award 2.5 contact hours for this continuing nursing education activity.

The test for this activity for nurses is located at <https://nursing.ceconnection.com>. Lippincott Williams & Wilkins is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation.

This activity is also provider approved by the California Board of Registered Nursing, Provider Number CEP 11749 for 2.5 contact hours. Lippincott Williams & Wilkins is also an approved provider of continuing nursing education by the District of Columbia, Georgia, and Florida CE Broker #50-1223. Your certificate is valid in all states.

Disclosure Statement:

The authors and planners have disclosed no financial relationships with this article.

Payment:

- The registration fee for this test is \$24.95.

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