Examine.com

Bone Health Supplement Guide

Written by the editors of Examine.com

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Medical Disclaimer

This guide is a general-health document for adults over 18. Its aim is strictly educational. It does not constitute medical advice. Please consult a medical or health professional before you begin any exercise-, nutrition-, or supplementation-related program, or if you have questions about your health.

This guide is built on scientific studies, but study outcomes are never homogeneous: individual results do vary. If you engage in any activity or take any product mentioned herein, you do so of your own free will, and you knowingly and voluntarily accept the risks. While we mention major known interactions, it is possible for any supplement to interact with other supplements, as well as with foods and pharmaceuticals.

A product may not contain the exact compounds and amounts listed on its label. Before you decide whether to take it, investigate it and its manufacturer. More than isolated compounds, herbs are prone to batch-to-batch variability, which can alter their efficacy and safety.

For evidence supporting the claims mentioned in this guide, please visit Examine.com.

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How to Use This Guide

The Examine.com team has been publishing research on nutrition and supplementation since March 2011. Drawing from all we've learned, we've designed this Stack Guide to help you figure out which supplements can help you reach your health goal, and which can hinder you or just waste your money.

Core supplements have the best safety-efficacy profile. When used responsibly, they are the supplements most likely to help and not cause side effects.

Primary options may provide substantial benefit, but only in the right context. A primary option is not for everyone, but if you read the entry and find that you meet the criteria, consider adding the supplement to your stack.

Secondary options have less evidence for their effects. They could work or be a waste of money. Keep them in mind, but think twice before adding them to your stack.

Promising supplements are backed by tradition or by mechanistic, animal, epidemiological, or anecdotal evidence, but not yet by convincing human trials.

Inadvisable supplements are either potentially dangerous or simply ineffective, marketing claims notwithstanding. Do not add them to your stack. At best, they'll be a waste of money; at worst, they can cause you harm.

Now that you've been presented with various supplements worthy of your interest, the time has come to combine them based on your objective. We'll guide you in **assembling your stack**.

Then comes the **FAQ**, in which we cover common questions that may arise when assembling your stack.

Lastly, we include information on **precautions and troubleshooting**.

With all this combined, you should be able to identify and assemble the supplement stack best suited to your objective.

Core Supplements

Protein

Why it's a core supplement

Calcium is the main *mineral* but not the main *component* of your bones; by volume, your bones are about 50% protein. Unsurprisingly, the effect of dietary protein on bone health has been the subject of many randomized controlled trials and prospective cohort studies.

The consensus is that higher protein intakes can help maintain bone mineral density, or at least slow its decrease, especially in the presence of enough calcium. Luckily, higher protein intakes also enhance calcium absorption in the intestines (as does vitamin D).

Can higher protein intakes *increase* bone mineral density? In that respect, the evidence is less clear. There are plausible mechanisms through which this might occur, but running trials long enough to gather robust data will be difficult and expensive.

Any protein found in food or supplements is called dietary protein. Whole foods should be your first choice, but if your food intake fails to cover your daily protein needs, you could add a supplement, preferably a powder.

Whey protein and casein powders are both derived from milk protein (which is 20% whey and 80% casein). If you are neither lactose intolerant nor vegan, look for a whey protein concentrate that is at least 80% protein. Whey protein is cheap and very anabolic (good for building muscle). Micellar casein is more expensive but more anti-catabolic (good for preserving muscle). Since micellar casein digests slowly, it is often seen as the ideal protein to consume before sleep.

But what if you *are* lactose intolerant or vegan? Fortunately, you can still supplement protein powders. Whey protein isolates contain very little lactose. For vegans, two popular options are soy protein, a complete protein, and a 70:30 pea:rice protein blend, which is seen as the vegan alternative to whey protein due to their similar amino acid profiles. Depending on processing techniques,

the estrogenic isoflavone content can be greater in a soy protein isolate than in a soy protein concentrate, but it is still too small to elicit any significant hormonal response when as much as 200 g of soy protein isolate is consumed each day.

How to take it

In the United States, the Recommended Daily Allowance (RDA) for protein is 0.8 g per kilogram of body weight (0.36 g/lb/day). This is the minimum needed by sedentary adults to avoid some major health issues.

Most studies that observed a positive effect on bone mineral density used 1.4 g/kg/day (with a minimum of 90 g/day). It is unclear if higher doses are more effective, but they are highly unlikely to cause harm to your bones.

Daily protein intake

Body Weight	0.36 g/lb (0.8 g/kg)	0.54 g/lb (1.2 g/kg)	0.64 g/lb (1.4 g/kg)	0.91 g/lb (2.0 g/kg)
100 lbs (45 kg)	36 g	54 g	64 g	91 g
150 lbs (68 kg)	54 g	81 g	96 g	137 g
200 lbs (91 kg)	72 g	108 g	128 g	182 g
250 lbs (113 kg)	90 g	135 g	160 g	228 g

Adapted from *J Acad Nutr Diet*. 2016 Mar; 116(3): 501–28.

Unless you have a pre-existing condition that affects your liver or kidneys, the intakes in the above table will not harm those organs. However, if you have a BMI of more than 30, you may want to calculate your protein requirements based on your goal bodyweight rather than your current bodyweight, so as to avoid overeating.

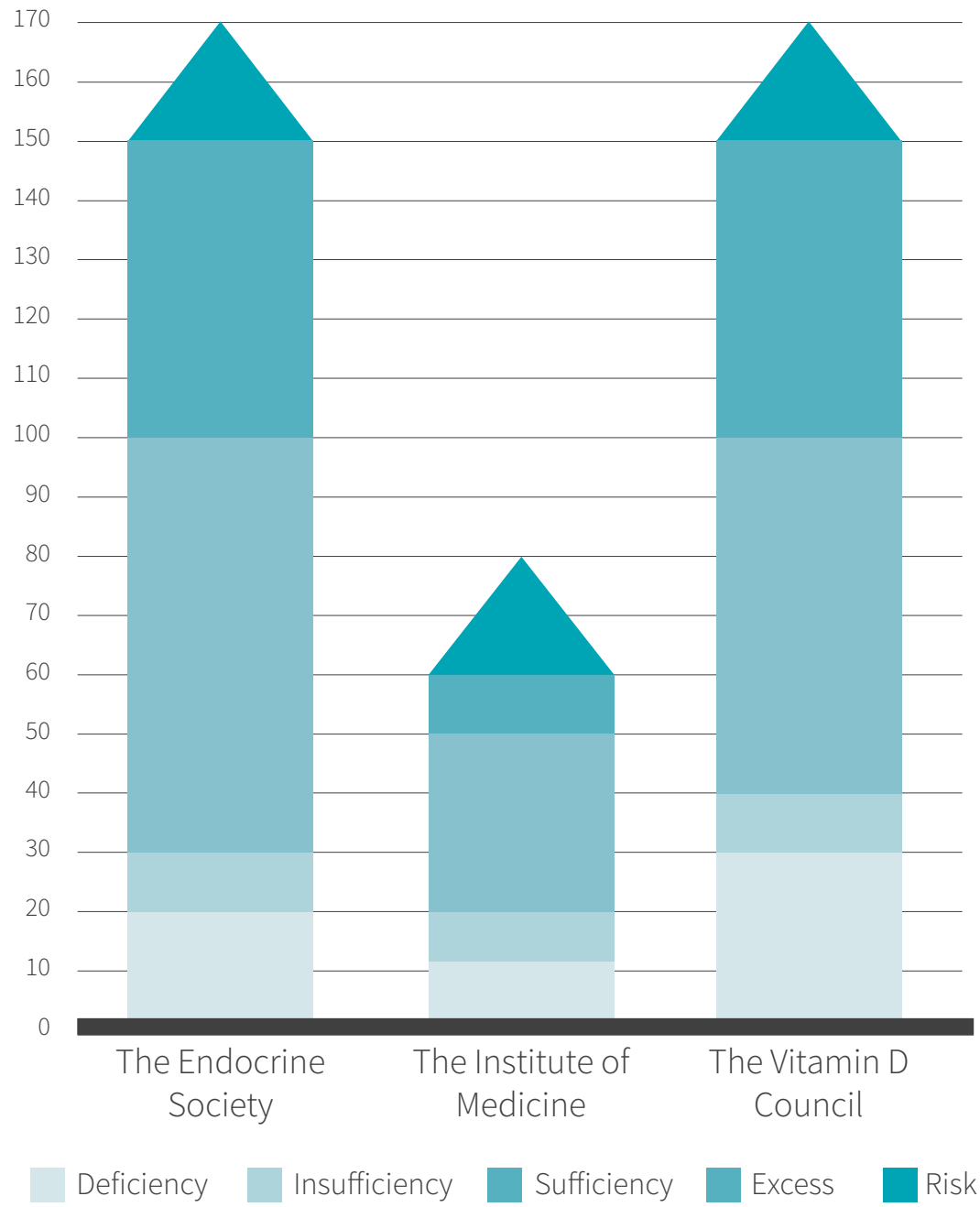
Spreading your protein intake over a few meals, starting with breakfast, will help ease digestion.

Vitamin D

Why it's a core supplement

Suboptimal levels of vitamin D are common, especially in people whose exposure to sunlight (without clothes or sunscreen) is limited. Moreover, the darker your skin, the longer you need to expose yourself to sunlight to synthesize enough vitamin D.

Figure 1: Blood levels of vitamin D (in ng/mL)



To make things worse, very little vitamin D can be found naturally in foods (fatty fish being a notable exception). For that reason, in the United States and other countries, milk is commonly fortified with vitamin D. Why milk? Because milk is rich in calcium, which vitamin D helps your intestines absorb.

By helping your intestines absorb calcium, vitamin D can strengthen your bones; it can also, alas, facilitate the calcification of your arteries, but this effect can be counteracted by vitamin K. Vitamins D and K can increase synergistically the rate at which minerals (notably calcium and magnesium) accumulate in bones, which is another reason to take them together.

Vitamin D comes in two forms. Ergocalciferol (D_2) is obtained through the irradiation of some plants and fungi, whereas cholecalciferol (D_3) is the kind

of vitamin D your body synthesizes from the cholesterol in your skin under the action of the sun's ultraviolet B (UVB).

D_3 is both more stable and more bioavailable than D_2. As a supplement, it is usually derived from lanolin, a waxy substance secreted by the skin glands of woolly animals, but a vegan-friendly option (a lichen extract) is also available.

How to take it

Take 2,000 IU (50 mcg) of **D_3** with a meal containing fat, either year round or only during the colder, darker months, when you are least likely to synthesize enough vitamin D from sun exposure. If you spend a lot of time outside and live near the equator, supplementation is probably never a necessity.

Doses higher than 2,000 IU may be warranted in cases of severe deficiency or non-response at lower doses, as ascertained by a blood test. Keep in mind that, over months, 10,000 IU/day can become toxic.

Vitamin K

Why it's a core supplement

Vitamin K is an umbrella term for a variety of molecules with similar but distinct structures. Phylloquinone (K_1) is a molecule found in plants, whereas menaquinone (K_2) is a group of molecules found in animal products (mostly K_2 MK-4) and fermented foods (mostly K_2 MK-7).

The vitamins K and D increase separately and synergistically the rate at which minerals (notably calcium and magnesium) accumulate in bones. MK-4 and MK-7 appear to do so more reliably than K_1.

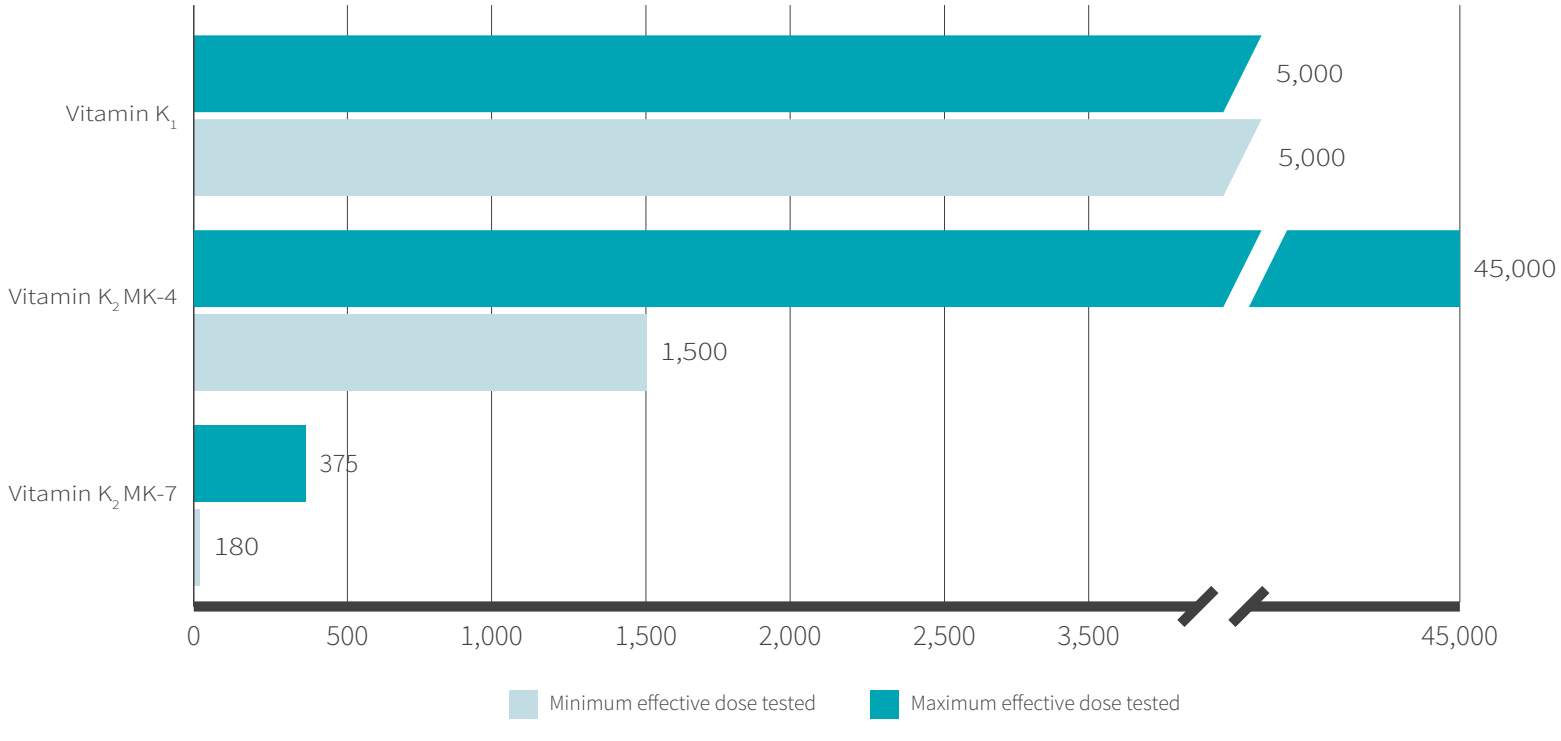
Several MK-4 trials looked at fracture risk and reported a decrease. One K_1 trial looked at fracture risk and reported a decrease, but without a concomitant increase in bone mineral density, so more research is needed to clarify the issue. No MK-7 trial has looked at fracture risk.

Vitamin K is usually safe, but it should not be supplemented by people taking anticoagulants (such as warfarin/Coumadin), a kind of blood thinner that works by hindering vitamin K's blood-clotting properties.

How to take it

Take your vitamin K supplement with a meal containing fat: 45,000 mcg of **MK-4** is your surest option, but 200 mcg of **MK-7** should also prove beneficial. You can take either or both.

Figure 2: Vitamin K dosage (in mcg)



MK-7 is present in high amounts only in natto (about 1,000 mcg per 100 g).

MK-4 is present in small amounts in fish (less than 1 mcg per 100 g of salmon), meat (about 1 mcg per 100 g of beef; about 10 mcg per 100 g of chicken), eggs (about 30 mcg per 100 g of egg yolk), and dairy products (about 15 mcg per 100 g of butter; about 5 mcg per 100 g of hard cheese; less than 1 mcg per 100 ml of whole milk).

K_1 is present mostly in leafy green vegetables: about 700 mcg in 100 g of kale, for instance. It can also be found in fish, meat, dairy products, and eggs, but only in very small amounts.

Due to their goitrogen content, cruciferous vegetables can reduce thyroid hormone production. If you tend to eat a lot of cruciferous vegetables, such as kale, make sure to also get enough iodine — through iodine-rich foods (such as cod, shrimp, milk, yogurt, or cottage cheese), iodine-fortified foods (such as iodized salt), or supplements (75–150 mcg/day).

Primary Options

Calcium

Why it's a primary option

Like magnesium, calcium (Ca) is one of the major mineral components of bone. A deficiency can lead to osteopenia and osteoporosis, two diseases characterized by dangerously low bone density.

Getting more than your Recommended Dietary Allowance (RDA)is not necessarily beneficial, however, and getting more than your Tolerable Upper Intake Level (UL) can be downright dangerous since it can lead to hypercalcemia. This disease, characterized by overly high calcium levels in the blood, can manifest as all kinds of health issues, from coronary artery calcification to mood disorders.

Hypercalcemia is more often caused by supplements than by a calcium-rich diet. If your diet is poor in calcium, look into dark leafy greens (also rich in vitamin K_1) or dairies. Milk-based protein powders (whey protein or casein) contain calcium, too, though less than milk itself — which often has the added advantage of being fortified with vitamin D to enhance calcium absorption.

Calcium may interact with several pharmaceuticals, notably diuretics (which increase calcium levels). It may increase the effects of digoxin. It may impair the absorption of bisphosphonates, levothyroxine, and calcium channel blockers. If you take any medication, talk to your doctor before you consider supplementing calcium.

How to take it

Calcium supplementation (500 mg/day) should only be considered after a dietary evaluation. Track what you eat for a week and compare the calcium content of your diet with the RDA for your gender and age. If, on average, you are getting less than 80% of your RDA, supplementation becomes a possibility, but you should first consider tweaking your diet.

Avoid taking calcium, iron, magnesium, and zinc at the same time in combinations of 800+ mg, since high amounts of these minerals will compete for absorption. Calcium may also impair the absorption of antibiotics, notably those in the tetracycline class (e.g., doxycycline) and quinolone class (e.g., ciprofloxacin), so take calcium and antibiotics at least six hours apart.

Excess calcium may cause constipation. Should it happen, lower your dose and/or take it with vitamin K (which can also reduce the risk of artery calcification) and/or vitamin D.

Magnesium

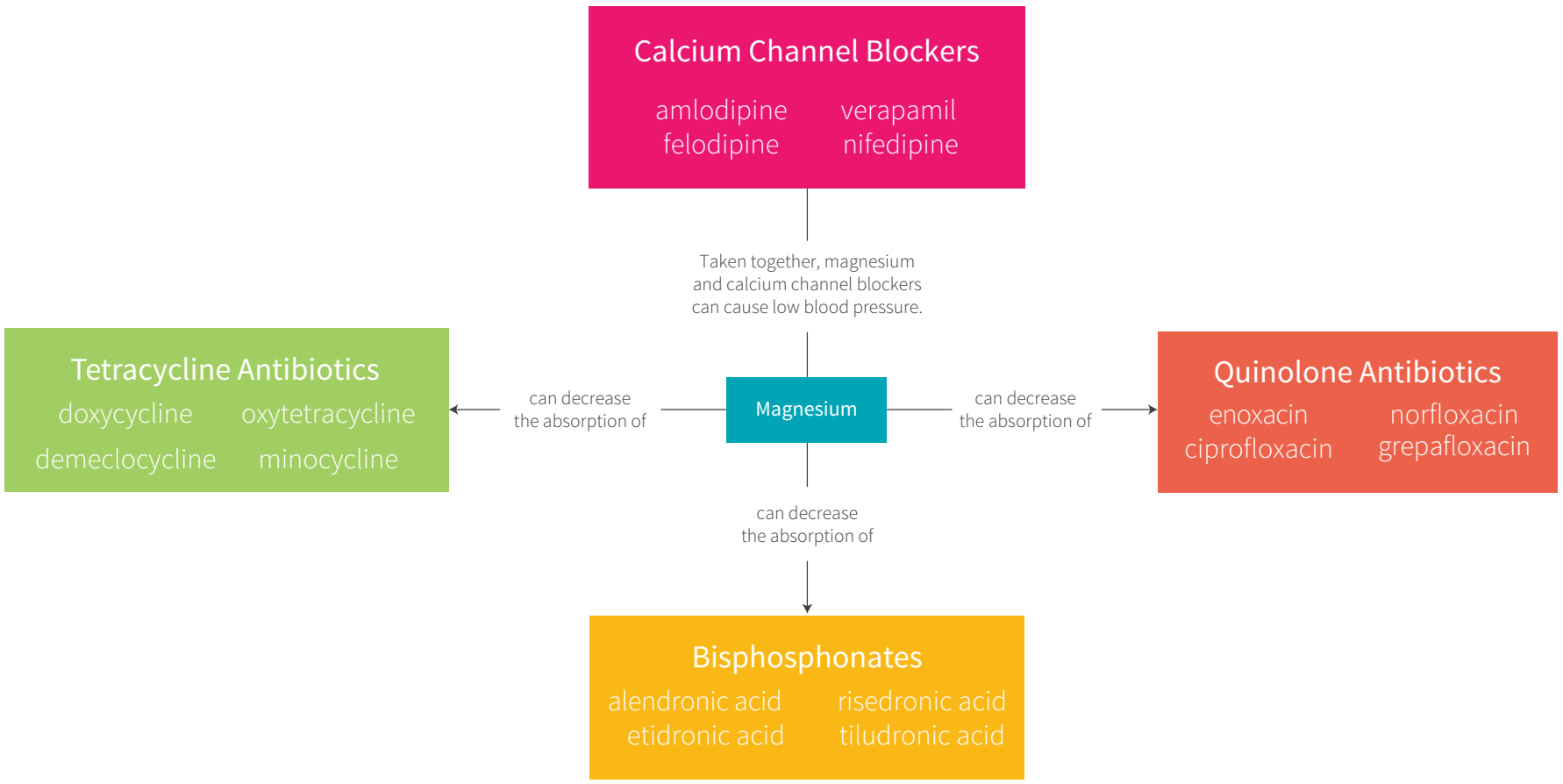
Why it's a primary option

Like calcium, magnesium (Mg) is one of the major mineral components of bone. Low levels in the blood are associated with bone loss; conversely, high levels are associated with greater bone mass in old age. Magnesium is lost through sweat, so deficiencies are more common in athletes, but they are not unknown in the general population.

If your diet is poor in magnesium, you should look into magnesium-rich foods (such as fish, nuts, beans, and green leafy vegetables) before turning to supplementation.

Magnesium is usually safe, but it may impair the absorption of some pharmaceuticals, notably bisphosphonates. Magnesium acts synergistically with calcium channel blockers to lower blood pressure, creating a risk of hypotension (i.e., low blood pressure). If you take any medication, talk to your doctor before you consider supplementing magnesium.

Figure 3: Drug interactions with magnesium



How to take it

The standard dose is 200 mg of elemental magnesium once a day, though up to 350 mg can be used. Because magnesium might have a sedative effect, it is often supplemented before bed.

Commonly supplemented forms include citrate, gluconate, and glycinate. To increase absorption, magnesium gluconate should be taken with a meal; other forms can also be taken on an empty stomach. Magnesium oxide is better avoided: it has low bioavailability, which can cause intestinal discomfort and diarrhea.

Avoid taking calcium, iron, magnesium, and zinc at the same time in combinations of 800+ mg, since high amounts of these minerals will compete for absorption. Magnesium may also impair the absorption of antibiotics, notably those in the tetracycline class (e.g., doxycycline) and quinolone class (e.g., ciprofloxacin), so take magnesium and antibiotics at least 6 hours apart.

Secondary Options

There is currently no secondary option.

Promising Supplements

Cissus Quadrangularis

In Ayurvedic medicine, *Cissus quadrangularis* is used to relieve joint pain and promote bone healing. It has modest anti-inflammatory properties and may induce growth factors in connective tissues, including bone, but this latter effect is supported mostly by animal and *in vitro* evidence; convincing human evidence is still lacking.

Inadvisable Supplements

Coral Calcium

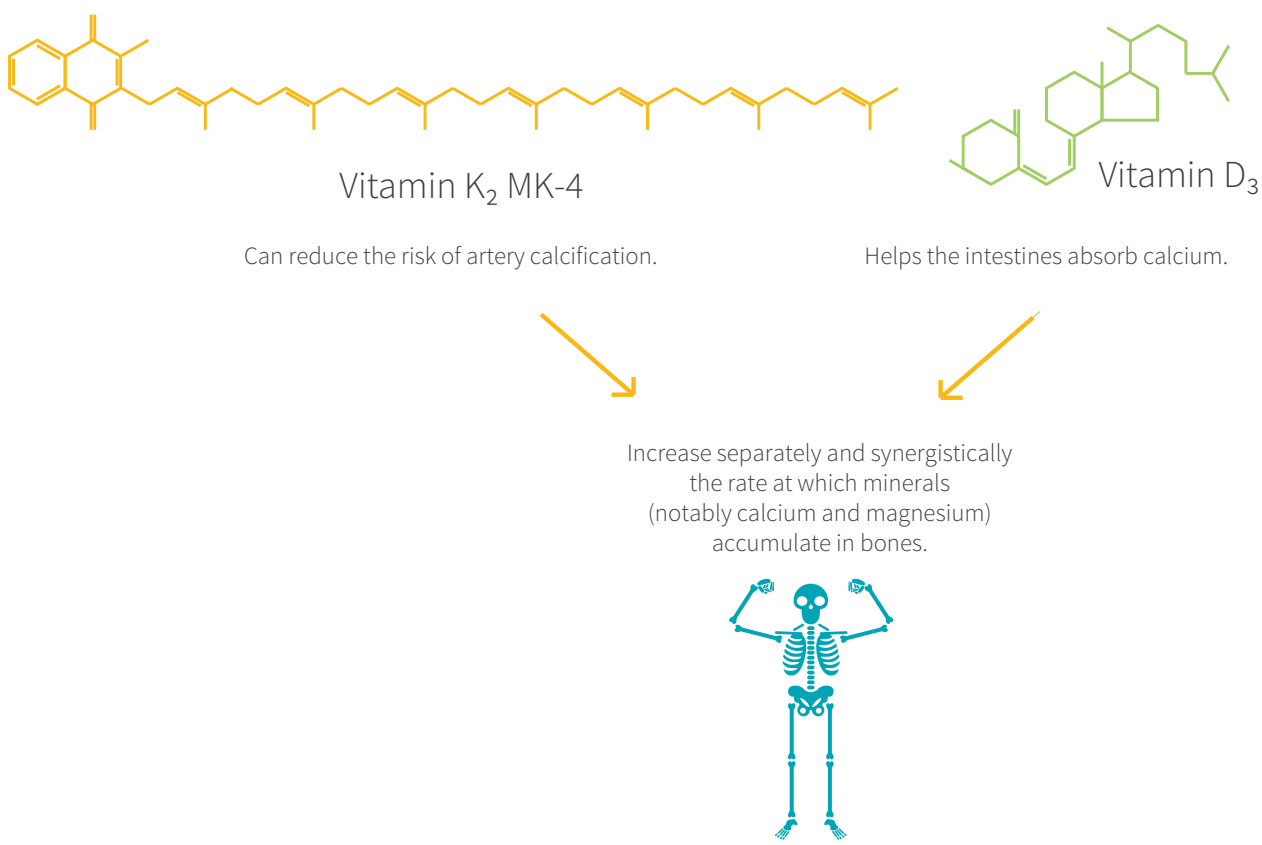
Aside from calcium carbonate, coral calcium contains magnesium and other trace minerals, but only in very small amounts. Coral calcium is more expensive than calcium carbonate on its own, yet it has not proven to be more effective, and contamination by lead and mercury is a concern. Coral calcium is sourced from fossilized coral, but living corals can also be damaged during the dredging and mining of coral reefs. For your health as well as the planet's, you would do well to shun coral calcium supplements.

Assembling Your Stack

Incorporating Core Supplements

With a meal containing fat, take vitamin D_3 (50 mcg / 2,000 IU) and vitamin K (4,500 mcg of MK-4 and/or 200 mcg of MK-7). Make sure you consume at least 1.4 g of protein per kilogram of body weight per day (0.64 g/lb/day) or at least 90 g/day, whichever is higher.

Figure 4: Vitamins that increase bone mineralisation



Incorporating Options

For people suffering from a mineral deficiency

Before you consider adding calcium (500 mg) or magnesium (200–350 mg) to the core supplements, track what you eat for a week. If, on average, you are getting less than 80% of your Recommended Dietary Allowance (RDA) for either mineral, supplementation becomes an option, though first you should try eating more calcium-rich and/or magnesium-rich foods.

FAQ

Can I add to my stack a supplement not covered in this guide?

Supplement your current stack for a few weeks before attempting any change. Talk to your doctor and research each potential new addition in advance. Check for known negative interactions with other supplements in your current stack, but also for synergies. If two supplements are synergistic or additive in their effects, you might want to use lower doses for each.

Can I modify the recommended doses?

If a supplement has a recommended dosage range, stay within that range. If a supplement has a precise recommended dose, stay within 10% of that dose. Taking more than recommended could be counterproductive or even dangerous.

Should I take my supplements with or without food? And at what time?

Answers are provided in each supplement entry whenever the evidence permits. Too often, however, the evidence is either mixed or absent. Besides, a supplement's digestion, absorption, and metabolism can be affected differently by different foods. Fat-soluble vitamins (A, D, E, K), for instance, are better absorbed with a small meal containing fat than with a large meal containing little to no fat.

Starting with half the regular dose can help minimize the harm a supplement may cause when taken during the day (e.g., tiredness) or in the evening (e.g., insomnia).

What's the difference between elemental calcium/magnesium and other kinds of calcium/magnesium?

"Elemental" refers to the weight of the mineral by itself, separately from the compound bound to it. For instance, ingesting 100 mg of calcium citrate means ingesting 21 mg of elemental calcium, whereas ingesting 500 mg of magnesium gluconate means ingesting 27 mg of elemental magnesium.

Product labels display the elemental dosage. On a label, "210 mg of calcium (as calcium citrate)" means 210 mg of elemental calcium (and 790 mg of citric acid), whereas "27 mg of magnesium (as magnesium gluconate)" means 27 mg of elemental magnesium (and 473 mg of gluconic acid).

Which dietary protein is best for bone health?

Most studies used dairy protein, yet the protein in our bones is mostly type-I collagen. It follows that supplemental type-I collagen (often sold as "beef protein powder") should be optimal for bone health — and indeed, animal models appear to support this notion.

The few relevant human studies to date, however, had mixed results. Not only that, but they cumulated factors (they gave collagen with calcium, vitamin D, dietary changes …), making it impossible to determine which factor did what and to what extent. Until better human studies come along, collagen's superiority over other proteins (for bone health) will stay theoretical.

Don't dietary proteins *reduce* bone density?

An increase in protein intake can lead to an increase in urinary calcium, which led to the belief that protein impaired calcium absorption. Today, we know the contrary is true. When you ingest more protein, you absorb more of the calcium in your food, so less calcium ends in your feces. Later, your body gets rid of the calcium it doesn't need, so more calcium ends in your urine, but not as much as would have otherwise ended in your feces. Therefore, an increase in protein intake leads to an overall decrease in calcium excretion, which points to an increase in calcium retention.

Precautions and Troubleshooting

Stack components are seldom studied together. The safest way to add supplements to your daily routine is one at a time, at least a couple of weeks apart, to better assess the effects (and side effects) of each new addition. Start at half the regular dose for a week, then slowly increase to the regular dose if you are not experiencing the desired effects.

Since minerals and vitamins (especially the fat-soluble vitamins: A, D, E, and K) can accumulate in the body, it is best to consider supplementation only after a dietary evaluation. Track what you eat for a week; if, on average, you are getting less than 80% of your Recommended Dietary Allowance or Adequate Intake, supplementation becomes an option, though first you should try eating more foods rich in the desired vitamin or mineral.