

Unveiling Vitamin K's Underrecognized Benefits for Bone Health

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STORY AT-A-GLANCE

- › Vitamin K is important for bone health beyond its role in blood clotting, with deficiencies linked to increased fracture risk and osteoporosis
- › Vitamin K works synergistically with vitamin D and may help support bone mineral density, underscoring the importance of maintaining adequate levels through diet or supplementation
- › The gut microbiome plays a significant role in vitamin K production, which impacts bone health by supporting the formation and maintenance of bone tissue
- › Vitamin K influences energy metabolism through osteocalcin, affecting insulin sensitivity and glucose metabolism — factors that research links to bone and metabolic health, including osteoporosis and diabetes risk
- › Strategies that may help support healthy vitamin K levels include consuming more food sources of both vitamin K1 and K2, being strategic about vitamin K2 supplement timing, and nourishing your gut microbiome with probiotics and prebiotics

Vitamin K is a fat-soluble vitamin that occurs in two forms, K1 (phylloquinone), found abundantly in green leafy vegetables, and K2. Vitamin K2 has several subforms, known as menaquinones, which are designated MK-4 through MK-13. These subforms differ primarily in the length of their side chains, which affects their distribution in the body, sources in the diet, and specific biological functions.



MK-7 through MK-13 are produced by various strains of bacteria in the gut, while MK-4 is primarily found in animal-based foods such as eggs, dairy products (like cheese and butter), and certain meats (especially liver).

Vitamin K1 and K2 play pivotal roles in various body functions, including bone health. In fact, being deficient in vitamin K is closely linked to an increased risk of fractures and osteoporosis, a condition characterized by weakened bones and a heightened susceptibility to breaks.

Studies highlight that individuals with optimal vitamin K levels exhibit greater bone mass and a lower incidence of fractures. For instance, research demonstrates that vitamin K is essential for the production of a protein that's vital for bone mineralization.¹

Additionally, vitamin K2 has been shown to work synergistically with vitamin D, enhancing bone mineral density and overall bone quality. These findings underscore the importance of maintaining adequate vitamin K levels through diet or supplementation to support bone health effectively.

Understanding Vitamin K's Bone-Strengthening Benefits

Vitamin K is a key player in maintaining bone strength and may help prevent arterial calcification, helping ensure that calcium is directed to where it's needed most — your bones and teeth, not your arteries.

- **Vitamin K1 (phylloquinone) supports vascular health and bone retention** — This form of vitamin K may help reduce calcification in blood vessels while helping bones retain calcium, which may help prevent unnecessary calcium buildup in the arteries.
- **Vitamin K2 (menaquinone) activates vitamin D and directs calcium** — K2 works by activating vitamin D-dependent proteins, allowing calcium to be efficiently transported out of the arterial system and into bones and teeth.²
- **Vitamin K is vital for the carboxylation of osteocalcin** — This is a process that enhances bone strength. It might sound complex, but it's actually a straightforward process. To understand this, you need to first know what osteocalcin is — this is a small protein produced by osteoblasts during bone formation.³
- **Carboxylation transforms osteocalcin into a functional hormone** — Carboxylation is a process wherein osteocalcin is transformed from a simple protein into a sophisticated hormone involved in bone metabolism and broader metabolic regulation.

When your body lacks sufficient vitamin K, the carboxylation of osteocalcin is impaired. This means that osteocalcin cannot effectively bind calcium to the bone matrix. Over time, this contributes to osteoporosis, where bones become porous and more prone to fractures.

- **Vitamin K deficiency may increase cardiovascular risk** — When calcium is not directed to your bones where it's needed most, it may not only decrease bone mineral density and increase fragility, but also raise the risk of cardiovascular conditions. This is because calcium accumulates in places like your blood vessels and arteries instead.
- **Common causes of vitamin K deficiency** — The underlying causes of vitamin K deficiency often stem from poor dietary intake, certain medical conditions, or the use of medications that interfere with vitamin K absorption. For instance, individuals with gastrointestinal disorders struggle to absorb this nutrient effectively. Additionally, long-term use of antibiotics disrupts gut bacteria, reducing your body's natural production of vitamin K.

To learn more about the differences between vitamin K1 and K2, read "[Vitamin K1 vs. K2 — Understanding Their Distinct Roles in Your Health](#)."

Vitamin K Plays an Essential Role in Enhancing Bone Health

A 2024 review investigated the multifaceted roles of both vitamin K1 and K2, as well as vitamin K-dependent proteins, in maintaining bone health, particularly emphasizing their interaction with vitamin D and their effects on calcium metabolism. The research examined how these vitamins may work together to support bone integrity, including in the context of osteoporosis.⁴

- **Vitamin K activates key bone-building proteins** — Vitamin K facilitates the carboxylation of osteocalcin and matrix Gla-protein (MGP), which are essential for binding calcium within the bone matrix. MGP is also a potent inhibitor of arterial calcification.
- **Vitamin K enables calcium-binding through carboxylation** — One of the researchers' key findings was that vitamin K acts as a necessary cofactor for enzymes that convert glutamic acid residues in proteins into gamma-carboxyglutamic acid residues.* This chemical transformation is important for osteocalcin to effectively bind calcium. According to the researchers:

*"The important effects of vitamin K on Ca and skeletal homeostasis are known to be mediated through its role as a cofactor for the γ -glutamyl carboxylase enzyme that promotes conversion of glutamate (Glu) residues to gamma-carboxyglutamic (Gla) residues in the post-translational carboxylation of osteocalcin (OC) and matrix Gla protein (MGP). This may have a significant impact on osteogenesis."*⁵

- **Vitamin K2 plays a key role in bone remodeling** — The review also revealed that vitamin K2 plays a significant role in bone remodeling. It assists in directing calcium to the bones and prevents its deposition in soft tissues, which leads to vascular calcification. This dual action supports both bone and cardiovascular health.*
- **Vitamin K and vitamin D work together to regulate calcium balance** — The research highlighted the synergistic relationship between vitamins K and D in regulating calcium homeostasis.

Vitamin D enhances calcium absorption in the gut, while vitamin K helps ensure that the absorbed calcium is appropriately utilized by the bones. This collaboration between the two vitamins may help support optimal bone density and reduce the risk of fractures.

*"Vitamin D exerts effects directly on osteoblasts by promoting osteoblast maturation and OC synthesis. The multiple effects of vitamin D on bone are associated with a high expression of the vitamin D receptor in several types of bone cells."*⁶

- **Researchers identified biomarkers for vitamin K status** — The ratio of carboxylated osteocalcin (cOC) to undercarboxylated osteocalcin (ucOC) was used to assess functional vitamin K levels in the body. A lower cOC-to-ucOC ratio indicated an inadequate vitamin K status, which was associated with increased bone loss and a higher risk of hip fractures.

The biological mechanisms underlying these findings involve vitamin K's role in activating proteins that regulate calcium placement in the body. By enabling osteocalcin and MGP to bind calcium effectively, vitamin K helps ensure that calcium is deposited in the bones rather than in the arteries or other soft tissues.

How Does Vitamin K's Influence Energy Metabolism and Blood Sugar Levels?

Another review published in the journal *Nutrients* explored the role of vitamin K in both bone health and energy metabolism. The research examined how vitamin K interacts with proteins involved in bone formation and how its deficiency could impact overall metabolic processes.⁷

- **Vitamin K is essential for both bone integrity and metabolic health** — The review cites research on individuals with varying levels of vitamin K intake, analyzing their bone integrity and insulin sensitivity. Findings suggest that adequate vitamin K levels may help support strong bones and healthy blood sugar regulation, pointing to this nutrient's potential relevance to osteoporosis and diabetes risk.*
- **Osteocalcin links vitamin K to both bone and glucose metabolism** — Activated osteocalcin contributes to bone strength and influences how the body regulates insulin and blood sugar levels. This dual function means that vitamin K deficiency could lead to both weakened bones and impaired glucose metabolism, heightening the risk of developing diabetes.

"[V]itamin K deficiency in the bone results in a lower production of OC and a low serum level of OC, predisposing to a state of glucose intolerance and diabetes mellitus that may then enhance bone matrix deterioration via the production of cross-linked advanced glycation end products (AGE), which have been further associated with bone fractures after adjustment of confounders.

We believe that as a whole, vitamin K deficiency plays an important role in glucose metabolism, ultimately leading to a disturbance of bone quality," the researchers reported.⁸

- **Vitamin K may help prevent arterial calcification and support cardiovascular health** — In addition to its effects on bone and energy metabolism, vitamin K was found to play a role in preventing the calcification of soft tissues, such as blood vessels.* This may help reduce the hardening of arteries, which is a significant risk factor for cardiovascular diseases. The research suggested that vitamin K helps direct calcium to the bones rather than letting it accumulate in the arteries.
- **Uncarboxylated osteocalcin (ucOC) is a marker of vitamin K deficiency** — The review identified specific markers for vitamin K deficiency, such as elevated levels of uncarboxylated osteocalcin (ucOC) in the blood. Monitoring these markers will help in early detection of

vitamin K insufficiency, allowing for timely interventions to maintain bone density and metabolic health.

- **Low vitamin K intake is linked to a higher risk of fractures** — Individuals with low vitamin K intake were found to have a higher incidence of hip and vertebral fractures across different populations. The research underscored the importance of maintaining adequate vitamin K levels through diet or supplementation to significantly reduce the risk of such fractures.*

Your Microbiome Also Influences Your Bone Health

In related news, a 2024 review published in the Gut Microbes journal explored how the gut microbiome, which is the community of microorganisms living in your intestines, works in collaboration with vitamin K2 to maintain strong and healthy bones, highlighting how these microorganisms contribute to bone density and the overall integrity of your skeletal system.⁹

- **Gut bacteria naturally produce vitamin K2** — The research focused on understanding how variations in the gut microbiome affect the risk of developing bone-related conditions such as osteoporosis. It was found that certain beneficial gut bacteria species, like Bacteroides and Lactococcus lactis, produce vitamin K2 and help maintain adequate levels of this nutrient.*
- **Dysbiosis lowers vitamin K2 levels, weakening bones** — One of the key findings was that disruptions in the gut microbiome, a condition known as dysbiosis, decreases your vitamin K2 production,¹⁰ compromising bone strength and increasing your risk of fractures and osteoporosis.*

Vitamin K2 produced by gut bacteria activates proteins that are essential for bone formation and mineralization, and maintaining a balanced and healthy gut microbiome is essential for ensuring the proper synthesis of vitamin K2.

- **Probiotics and prebiotics enhance bone health** — The review also discussed the role of probiotics and prebiotics in enhancing bone health. Probiotics are live beneficial bacteria that are consumed through fermented foods or supplements, while prebiotics are non-digestible food ingredients that promote the growth of these healthy bacteria.¹¹

Incorporating probiotics and prebiotics into your diet supports your gut microbiome, leading to increased production of vitamin K2 and improved bone density.

- **The gut microbiome supports calcium and vitamin D absorption** — The study also highlighted the interconnectedness between the gut microbiome and other aspects of bone metabolism, such as hormone regulation and immune system function.

Your gut bacteria influence the absorption of calcium and vitamin D as well, both of which are vital for bone health. Additionally, a healthy gut microbiome helps modulate the immune system, reducing inflammation that negatively impacts bone integrity.

- **Antibiotics disrupt vitamin K2 production** — The review also pointed out that antibiotic treatments, which disrupt the gut microbiome, lead to a significant reduction in vitamin K2 production.¹² This not only affects bone health but also emphasizes the importance of being cautious when taking antibiotics, to preserve the beneficial bacteria responsible for maintaining bone integrity.

For a deeper dive into vitamin K's role in bone and heart health, read "[Vitamin K 101 — Essential Basics for Bone and Heart Health](#)."

Egg Yolks Are Your Best Source of Vitamin K2 as MK-4

Egg yolks are among the highest dietary sources of MK-4, a vital form of vitamin K2 that plays an important role in bone health, cardiovascular function, and calcium regulation. Including egg yolks in your diet significantly contributes to your MK-4 intake, supporting various aspects of your health.

- **Egg quality is important** — You need to be careful about your egg sources as most commercial egg sources — even free-range organic — have high PUFA levels as they are fed grains like soy and corn.
- **Chickens should be fed low-PUFA grains for optimal egg quality** — Ideally, chickens should be fed rice, barley, and split peas. I personally eat six egg yolks a day from chickens who are fed this and have 80% less linoleic acid than regular chickens.

Below is a comprehensive overview of egg yolks as a top source of MK-4, along with additional dietary sources and considerations.

Summary Table: Nutrient Comparison in Egg Yolks vs. Other Sources		
Nutrient	Egg Yolk Content (per large yolk)	Other Top Sources
MK-4 (Vitamin K2)	~15 mcg	Chicken liver (~13 mcg/100g), Beef liver (~11 mcg/100g), Butter (~15 mcg/100g)
Choline	~147 mg	Beef liver (~418 mg/100g), Soybeans (~116 mg/100g), Salmon (~56 mg/100g)
Vitamin D	~37 IU (0.925 mcg)	Fatty fish (~400-600 IU/100g), Fortified dairy (~100 IU per serving)
Vitamin A	~245 IU	Beef liver (~6,582 IU/100g), Sweet potatoes (~19,218 IU/100g)
Selenium	~15.4 mcg	Brazil nuts (~544 mcg/100g), Tuna (~108 mcg/100g)
Vitamin B12	~0.6 mcg	Clams (~84 mcg/100g), Beef liver (~70 mcg/100g)
Riboflavin (B2)	~0.2 mg	Beef liver (~4.5 mg/100g), Almonds (~1.1 mg/100g)
Folate (B9)	~24 mcg	Beef liver (~145 mcg/100g), Spinach (~194 mcg/100g)
Biotin (B7)	~10 mcg	Liver (~100 mcg/100g), Almonds (~60 mcg/100g)

6 Key Steps to Enhance Bone Health Through Vitamin K

- To help support healthy vitamin K levels and optimal bone and overall health, consider the following:
- 1. Add more green leafy veggies into your diet** — They are some of the best sources of vitamin K1. Collard and turnip greens, kale, spinach, broccoli, Brussels sprouts, cabbage, and lettuces are good choices.¹³

- 2. Boost your natural vitamin K2 production** — Enhance your body's natural vitamin K2 levels by incorporating fermented foods such as natto and fermented vegetables cultivated with specific bacterial cultures. Additionally, consume grass fed animal products like egg yolks, liver, and grass fed dairy to support K2 production.
- 3. Consider vitamin K2 supplementation** — Research suggests that vitamin K2 — ideally 180 to 200 micrograms daily in the MK-7 form — may work synergistically with vitamin D3 and magnesium to support absorption and effectiveness, helping strengthen bones while supporting healthy calcium balance in the arteries.

Current guidance pairs 180 mcg of K2 with 5,000 IU of vitamin D3, so talk to a healthcare provider about what combination and dose make sense for you rather than following a fixed protocol.

Timing may also help. Some research suggests taking vitamin K2 with the day's fattiest meal, since it's fat-soluble, may improve absorption and support osteocalcin activation. Consistent timing may help maintain steadier vitamin K2 levels for bone and heart health.

- 4. Balance key nutrient cofactors** — Getting sufficient calcium, magnesium, vitamin D3, and vitamin K2 — through diet and, where appropriate, supplementation — may help these nutrients work together to build and maintain bone density, promoting proper calcium utilization and bone matrix formation for optimal bone health.
- 5. Support your gut microbiome** — Maintain a healthy intestinal environment to naturally boost vitamin K2 production. Focus on whole, unprocessed foods and consider targeted probiotic supplementation tailored to your microbiome.
- 6. Focus on bone-building exercises** — Regular weight-bearing movement may help stimulate bone formation, while K2 may help support proper calcium deposition. Walking, resistance training and bodyweight exercises work together with K2 to help strengthen your skeleton. Some research suggests combining exercise with vitamin K2 may offer added benefit beyond supplementation alone, though direct comparative studies are limited.

**These findings are from research conducted in clinical settings and may not directly apply to human health.*

Frequently Asked Questions (FAQs) About Vitamin K and Bone Health

Q: What's the main role of vitamin K in bone health?

A: Vitamin K helps direct calcium into bones, making them stronger and reducing the risk of fractures. It's also thought to help prevent calcium from building up in arteries, which may support heart health.

Q: Do I need both vitamin K2 and vitamin D?

A: Yes, they work together. Vitamin D helps your body absorb calcium, and vitamin K2 helps direct it toward bone-building instead of arterial accumulation.

Q: Can vitamin K2 help prevent osteoporosis?

A: Some research suggests vitamin K2 may help support bone mineral density by activating osteocalcin, a key protein for bone formation, though clinical trial evidence on whether it reduces fracture risk remains mixed.

Q: How much vitamin K2 should I take daily?

A: Research suggests 180 to 200 mcg of vitamin K2 (MK-7) daily, taken with a meal containing healthy fats to help improve absorption, may support bone and heart health — talk to a healthcare provider about what's appropriate for you.

Sources and References

- ¹ [Metabolism, Volume 70, May 2017, Pages 57-71](#)
- ² [Integr Med \(Encinitas\). 2015 Feb;14\(1\):34–39](#)

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- ¹³ Harvard, The Nutrition Source, Vitamin K, March 2023