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## REPORT

### Vitamin K

#### The Misunderstood Vitamin



Ask doctors what vitamin K does, and most will tell you it is involved in the clotting process... period!

As early as 1984, however, scientists reported that patients who suffered fractures caused by osteoporosis had vitamin K levels that were 70% lower than age-matched controls.<sup>1</sup> These findings were confirmed in later studies showing diminished bone mineral density in the presence of low serum vitamin K levels.<sup>2-4</sup>

The most frightening statistic showed that women with the lowest blood levels of vitamin K had a 65% greater risk of suffering a hip fracture compared to those with the highest vitamin K levels.<sup>5</sup>

One might wonder why vitamin K has such a powerful impact on bone density. The answer is quite simple. In order for calcium to bind to the bone matrix, a protein called osteocalcin is needed. Without adequate vitamin K, osteocalcin is unable to transport calcium from the blood and connect it to the bones.<sup>6</sup>

Tens of millions of Americans ingest calcium supplements to reduce their risk of osteoporosis and fractures. These vitamin K studies, however, show that people could still suffer the crippling effects of osteoporosis if they are vitamin K deficient because the calcium would remain in their blood and not bind to bone.<sup>7</sup>

The next question is what happens to calcium if it is not taken up to form bone mass. Regrettably, in a vitamin K deficient state, the body takes calcium that is meant to form strong bones and instead deposits it into the arterial wall, thereby contributing to the process of atherosclerosis. In fact, in response to a vitamin K deficiency, the body naturally accumulates enormous amounts of calcium in the arterial wall.<sup>8</sup>

This explains why so many aging individuals suffer from hardened calcified arteries, yet have brittle bones that are markedly depleted of calcium.

In a huge European human clinical trial (The Rotterdam Study), doctors evaluated vitamin K intake of 4807 subjects over a 7-10 year period. After adjusting for other risk factors, coronary heart disease risk was reduced with increased intake of vitamin K2. Those who consumed the most vitamin K2 had a 57% reduction in cardiac disease compared to those who consumed the least K2.<sup>9</sup>

What has scientists most excited is that vitamin K2 is proving itself to be superior to K1. Health enthusiasts will be pleased to learn that a new biologically-active form of vitamin K2 has been added to the supplement formulas used by most Foundation members today.

Vitamin K1 is obtained in the diet primarily from dark leafy vegetables (lettuce, spinach, and broccoli). Unfortunately, vitamin K1 is tightly bound to the chlorophyll in green plants, meaning that aging humans are not able to benefit much from ingested K1-containing plants.<sup>10</sup> While vitamin K1 is not absorbed particularly well from food, it is absorbed from supplements, provided that the supplements are taken with fat-containing meals.<sup>11-13</sup>

Vitamin K2 is found in much smaller quantities in the diet, primarily in dairy products. The highest level of dietary K2 is fermented soy natto.<sup>14</sup> Human studies show that vitamin K2 is absorbed up to ten times more than K1.<sup>15</sup> Japanese people consume large quantities of natto, which may help explain their lower rates of heart disease and osteoporosis compared to Western populations.

Not only is K2 absorbed better, but it remains biologically active in the body far more than K1. For instance, K1 is rapidly cleared by the liver within 8 hours, whereas measurable levels of K2 have been detected 72 hours after ingestion. This means that vitamin K2 is available to facilitate transport of calcium into the bone and to protect the arterial wall against calcification much longer than

## VITAMIN K IMPEDES ATHEROSCLEROSIS

In rabbits with high cholesterol levels, supplemental vitamin K2 decreased circulating cholesterol, suppressed the progression of atherosclerotic plaque, and impeded the thickening of the inner arterial lining (intima).<sup>16</sup>

In a rat model, supplemental vitamin K2 completely prevented calcification, whereas vitamin K1 had little effect.<sup>17</sup>

In a study of 188 postmenopausal women, a group known to be at high risk for rapid decay of arterial structure, a supplement containing only 1 mg of vitamin K1 or a placebo was administered over a three-year period. In the vitamin K group, age-related arterial stiffening (as measured by carotid intima-media thickness) was completely abolished, whereas the placebo group (not receiving vitamin K) experienced a 13% worsening of arterial elasticity during the study period.<sup>18</sup> (Please note that some vitamin K1 is converted to K2 in the intestine).

### HOW VITAMIN K PROTECTS ARTERIES FROM CALCIFICATION

Vitamin K controls calcium-regulating proteins that are present in vascular tissue. These vitamin K-dependent proteins (including osteocalcin and matrix G1a protein) have been shown to specifically inhibit vascular calcification, i.e. keep calcium out of the arteries.<sup>19-24</sup>

Activation of these calcium-regulating proteins depends on the availability of vitamin K. When there is not enough vitamin K to turn on these proteins, the result is deposition of calcium into atherosclerotic plaque, thus worsening cardiovascular disease risk and leading to a condition that the lay public sometimes refers to as “hardening of the arteries.” This helps explain why patients who take anti-coagulant drugs (like Coumadin®) that deplete vitamin K in the body suffer from accelerated atherosclerosis.<sup>25,26</sup>



Increasing evidence shows that the same calcification process involved in normal bone formation also occurs in the linings of arteries when there is not enough vitamin K available to activate calcium-regulating proteins (such as matrix G1a protein, a powerful inhibitor of arterial calcification). This means that the same biological mechanism used by bone to attract and bind calcium can also pathologically occur in the linings of the arteries in the presence of inadequate vitamin K.<sup>8</sup> This explains why patients with advanced atherosclerosis have both occluded and calcified (hardened) arteries that have lost their youthful elasticity. The inability of arteries to readily expand and contract with each heartbeat is a hallmark characteristic of hypertension.

In most individuals, vitamin K from dietary sources fills the need for proper coagulation. As people age, however, a sub-clinical vitamin K deficiency can pose severe risks to the vascular system.

### VITAMIN K2 INTAKE ASSOCIATED WITH REDUCED ARTERIAL DISEASE

In the most significant human study to date, a large group of people with no history of heart disease were followed from 1990-1993 until year 2000. The incidence of coronary artery disease, all cause mortality, and severe aortic atherosclerosis was studied in relationship to the amount of vitamin K1 and/or K2 ingested over the study period.

As can clearly be seen by the table above, those who consumed the most vitamin K2 showed significant disease reductions, compared to those who ingested the least K2.

In this study, intake of vitamin K1 from dietary sources was not related to these risk reductions, probably due to the poor bioavailability of K1 from plant foods. In their concluding remarks, the scientists who conducted this study stated that adequate intake of vitamin K2 could contribute to the prevention of coronary artery heart disease.<sup>9</sup>

### VITAMIN K AND BONE FRACTURE PREVENTION

A systemic review was made of all randomized controlled trials that gave adults either vitamin K1 or K2 supplements for at least six months. A total of 13 trials were identified with data on bone loss and 7 trials that reported fracture incidences.

All of these human trials except one showed that supplemental vitamin K1 or K2 reduced bone mass loss. Vitamin K2 in

EFFECTS OF HIGHER INGESTION OF VITAMIN K		
Reduction in All-Cause Mortality	Reduction in Coronary Artery Disease	Reduction in Severe Aortic Atherosclerosis
<b>26%</b>	<b>57%</b>	<b>68%</b>

particular was associated with increased bone mineral density.

In all 7 trials to evaluate fracture risk, vitamin K2 proved most effective, reducing the risk of vertebral fractures by 60%, hip fractures by 77%, and an astounding reduction for all non-vertebral fractures of 81%.<sup>27</sup>

For those taking calcium and vitamin D supplements to prevent osteoporosis, adequate vitamin K intake is essential to activating proteins that bind calcium to the bone. In the presence of inadequate vitamin K status, the calcium that would be used to maintain strong bones is instead deposited into the arterial wall where it accelerates the atherosclerosis process.

## SUMMARY

Since vitamin K was discovered in 1930, it was only thought to contribute to the liver's maintenance of healthy blood coagulation. Over the past 15 years, scientists have found that vitamin K plays a crucial role in arterial and bone health.

Recent studies indicate that vitamin K intake that is substantially above the government's recommended reference range can slow bone loss, reduce arterial stiffening, prevent heart attack, and reduce death rates in adult human populations.<sup>28-31</sup>

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