Calcium Paradox, Vitamin D and Vitamin K2

Johanes C.Mose
Department of Obstetrics and Gynecology Faculty of Medicine Universitas Padjadjaran/
Dr. Hasan Sadikin General Hospital Bandung
Correspondence: Johanes C. Mose, Email: jcmose07@yahoo.com

Calsium supplementation during pregnancy is a routine standard practice for antenatal care recommended by WHO, FIGO, POGI as well as Indonesia Ministry of Health.

Calcium is one of essential micronutrients needed in human life, especially during pregnancy known for bone and teeth development, prevent osteoporosis, involved in blood coagulation, prevent haemorrhages during pregnancy and post partum periods, muscle contraction, prevent hypertension, preeclampsia, prematurity, IUGR, LBW, stunting, increase immunity, etc.

Prevalence of hypocalcemia varies from 60 % to 70.5 % in low-medium income countries (LMIC) and 30 % to 60 % in high income countries (HIC).

A systematic review study conducted in 2019 reported a prevalence of low calcium consumption less than 800 mg/day (normal consumption is around 1000-1200 mg/day) was 29 % in HIC and 82 % in LMIC, including Malaysia 377 mg/day and Indonesia < 400 mg/day.

Calcium metabolism in human body is very much depend on the normal level of vitamin D, magnesium and parathyroid hormone in blood. Vitamin D is mainly needed for the absorption of calcium in intestine. The combination of vitamin D and calcium supplementation is very much recommended.

Nevertheless back in 2010 there has been many publications concerning the use of calcium and vitamin D in combination corresponded with the increasing evidence of ischemic heart attack and stroke. On the other hand many countries with high calcium intake such as Finland, Sweden and Netherland still reported many cases of osteoporosis and bone fractures in their population. This facts are contradictory with the common knowledge of calcium actions and functions. This phenomenon was then labeled as Calcium paradox.

The Calcium Paradox was first used back in the 1980s and ’90s to refer to a problem that was discovered when surgeons were working out how to do heart transplant surgery.

They learned that if a calcium free solution is used to keep fluid pouring through the heart muscle during the transplant surgery, even for a short time if a calcium free solution is used, and then a solution containing a normal amount of calcium is used, the heart becomes severely damaged. Because what happens is that a massive influx of calcium rushes into the calcium depleted heart muscle cells in the transplant heart and it disrupts the function of the heart and causes major injury.

Now we know that this calcium paradox is not a paradox at all. It is simply based upon ignorance of the way in which calcium is utilized in the body. Calcium’s actions are not at all paradoxical. It is a team player. Calcium cannot do the many essential jobs that it does to keep virtually every cell in our bodies, not just our bones, functioning healthfully, unless calcium has the help of two team players, two vitamins: vitamin D and vitamin K2. We absorb calcium actively with the help of vitamin D.

When we don’t have enough vitamin D present, we absorb less than 15% of the calcium either from food or supplements. But vitamin D only helps us absorb calcium. That’s only half the story. Vitamin D does nothing to regulate where the calcium we absorb from our intestine goes once it gets inside the bloodstream. And for that we have to have vitamin K and specifically

vitamin K2 (menaquinone).

Vitamin K2 (MK7) has two mainly jobs, firstly is to activate the proteins that escort calcium into the bones. The vitamin K2 activated protein that puts calcium into bones is called osteocalcin. Secondly, vitamin K2 will activate proteins that block calcium from entering the subendothelial tissues and **keeps calcium out of blood vessels. That** is called matrix Gla protein (MGP).

So we need both vitamin D to help absorb calcium and enough vitamin K2 around to make sure that the calcium absorbed in bloodstream goes into tissues needed, those are bones and tooth and is kept out from arteries or other soft tissues.

If we just take supplements that contain only calcium or even contain calcium and vitamin D, when we don't have enough K2 around, then we are going to lose bone, promoting the development of osteoporosis, and calcium is going to be deposited in our blood vessels, causing them to harden or calcify (arteriosclerosis). And this will greatly increase the risk for hypertension, heart attack or stroke.

Dr Kate Rheaume-Bleue furthermore in her book also revealed the role of vitamin K2 in preventing tooth damage , heart disease, prostate cancer, liver cancer, DM, obesity, wrinkles, varices,etc. She insisted to give vitamin K2 at every administration of calcium and vitamin D.

Vitamin K belongs to the group of fat-soluble vitamins and naturally occurs in two main forms : vitamin K1 (phylloquinone) makes up 75-90% of all vitamin K consumed by human, and Vitamin K2 (menaquinone). The third form is Vitamin K3 (menadione) is a synthetic form of vitamin K2, mainly found in fermented food.

Vitamin K (especially K1) helps blood to clot and prevents severe bleeding. Vitamin K2 plays a key role in cardiovascular health, bone metabolism, and in regulating blood calcium levels.

Major dietary sources of Vitamin K1 are : green leafy vegetables (kale, spinach, salad greens, cabbage, broccoli, Brussel sprouts), and plant oils (canola, soybean, olive)

Vitamin K2 found in animal products and fermented food, and also produced by gut bacteria, such as : natto, cheese, full-fat dairy, meat (pork, beef, chicken), egg yolk, miso, sauerkraut, etc.

Vitamin K2 undergoes a unique process of synthesis and recycling within the human body, primarily in the intestinal tract and liver. Gut bacteria are responsible for converting vitamin K1 into K2, a process critical for the optimal functioning of this nutrient. Furthermore, vitamin K2 participates in a recycling process through the "vitamin K redox cycle," which allows a small quantity of the vitamin to be reused multiple times for various physiological functions. This conversion and recycling mechanism ensures that vitamin K2 can effectively be used by its target tissues. Specifically, K2 supports bone mineralisation, blood clotting, and cardiovascular health, highlighting its essential role in human nutrition and well-being.

However, there is a limit to the recycling of vitamin K2. The body doesn't store this nutrient, and in times of physical and emotional stress and rapid development, vitamin K2 gets depleted quickly. This, of course, is par for the course with pregnancy, where nutrient demands are high, and the need for an abundance of vitamins and minerals to support all areas of growth is also essential.

All humans, including mothers and newborn babies, synthesise Vitamin K2 in their digestive systems. Bacteria in the large intestine (colon) can make vitamin K2 (menaquinones). However, the amount synthesised is minimal compared to the amount obtained from foods.

The long time used of antibiotic will disturb the equilibrium of gut flora leading to dysbiosis

and deficiency in vitamin K2 as a neuroprotector against brain and cognition decline.

Vitamin K2 plays an important roles during pregnancy. There are some benefits of taking vitamin K2 during pregnancy, such as :

1. **Promotes skeletal health.**
   Vitamin K2 ensures adequate bone formation by properly metabolising calcium levels in the body. This means that vitamin K2 works synergistically with calcium to improve and maintain bone mineral density while providing the proper development of fetus's skeletal system. Vitamin K2 activates calcitonin and brings out calcium to bones and teeth. Deficiency in Vitamin K2 corresponds with the evidence of osteoporosis, IUGR, LBW baby and stunting later in infant life.
2. **Lowers the risk of bleeding disorders.**
   One important function of vitamin K2 in the body is to assist in blood coagulation (clotting). This is very important in order to prevent bleeding during pregnancy and post partum, as well as bleeding in the newborn baby.
3. **Ensures cardiovascular health.**
   Adequate vitamin K2 levels have a protective role in the cardiovascular system. Vitamin K2 helps prevent the calcification of blood vessels, which is a key aspect of maintaining cardiovascular health. By activating specific proteins MGP (matrix Gla protein), vitamin K2 inhibits calcium entering soft tissues like ligament and joint including the subendothelial tissue preventing arteries to be calcified , and the risk of arteriosclerosis, hypertension, heart attack and stroke. One study reported a 9% decreased the risk of heart attack at every taking 10 ug/day vitamin K2.
4. **Supports good and balanced gut microbiota and brain health.**
   Vitamin K2 regulates calcium balance and play an important role in fetal brain development. Researchers suggest that by preventing dysbiosis this vitamin K2 has other benefits too, such as easing morning sickness (emesis gravidarum) and protecting brain and cognitive functions, including thinking, memory, learning, and organizing skills.

The recommended daily intake of vitamin K2 during pregnancy and breastfeeding is around 90 microgram. Vitamin K intake should be primarily maintained through a healthy diet, rich in leafy greens, fermented foods, dairy and meat. (Dosage for man is about 120 microgram per day).

Taking steroids during pregnancy may decrease vitamin K2 levels and increasing risk of vitamin K2 deficiency. A retrospective study from 2023 found that women received antenatal corticosteroids showed a fivefold increase in the risk of developing a vitamin K2 deficiency.

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