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Opinion

Vitamin K2 (Menaquinone-7) in Maintaining Bone Health and Building The "Bone Bank" in Children and Young Adults

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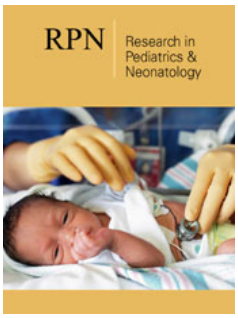

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Opinion

In the past decades, an increased interest in the roles of vitamin D and K has become evident, particularly concerning bone health and the prevention of bone fractures. Our recent epidemiological review [1] and a pilot study results [2] support evidence indicating a disturbing growth in the number of cases of low-energy fractures in healthy children and adolescents. Approximately one-third of all children suffer at least one fracture before 17 years old. Low-energy fractures, especially fractures of the forearm, are increasingly common in childhood and defined as fractures sustained from a fall from the patient's height or a fall during team sports.

Our 2018 pilot study considered vitamin D and K status in children with low-energy fractures and without fractures [2]. The study group compared 20 children (14 boys, six girls) aged 5 to 15 years old, with radiologically confirmed low-energy fractures, with the control group of 19 healthy children (9 boys, ten girls), aged 7 to 17 years old. There were no statistically significant differences in the serum calcium or total vitamin D levels between the two groups. However, we found a statistically significant difference in vitamin K status between the groups, expressed in the lower levels of carboxylation of the hormone osteocalcin in the group with low-energy fractures than without fractures. Vitamin K acts as an unequivocal cofactor for the formation of carboxylated or the biologically active form of osteocalcin, a bone-building protein. Our report has been the first information in the literature about children with low-energy fractures and their vitamin K status.

Although multiple risk factors may contribute to this growing health concern in children and adolescents, deficient or insufficient nutrition and nutrients, including calcium, vitamin D, and vitamin K, are leading considerations.

The particular role of vitamin K2, especially menaquinone-7 (MK-7), has been highlighted in the recent literature and distinguished from vitamin K1 in maintaining calcium homeostasis and a healthy skeletal system. Although vitamins K1 and K2 share carboxylation of glutamic acid residues in vitamin K–dependent proteins, a growing body of information suggests that the biological role of vitamin K2 is distinguishable from the natural function of vitamin K1. The different clinical outcomes with various forms of vitamin K likely occur due to the structural differences in the isoprenoid side chain that govern many facets of the actions of vitamin K, including absorption, transport, uptake, and binding by target tissues especially

bone, cardiovascular and central nervous systems. For example, the half-life of vitamin K1 and MK-4 is measured in hours, whereas the half-life of MK-7 is approximately three days. MK-7, in particular, is recognized as more effective than vitamin K1 in the activation of the bone-building hormone osteocalcin produced by osteoblasts with the help of vitamin D.

One study [3] evaluated the response to vitamin K2 (MK-7) supplementation in a population of healthy children and adults. Based on epidemiological studies, all healthy individuals have sufficient circulating vitamin K, combined K1 and K2, for its essential, life-sustaining requirement for clotting factor synthesis. Still, the same healthy levels of vitamin K sustaining healthy blood coagulation result in high concentrations of undercarboxylated K-dependent non-essential proteins, for example, osteocalcin, found in otherwise healthy children. These findings suggest that the current daily intake of vitamin K may be insufficient, and the revised recommended daily allowance is required to support carboxylation and activation of non-essential vitamin K–dependent proteins. Vitamin K2, which is of bacterial origin, in distinction to plant-derived K1, is found increasingly insufficient in our daily nutrition due to the food processing and refrigeration, preventing beneficial bacteria growth.

Our epidemiological and clinical research provides a new nutritional paradigm for efficient carboxylation of proteins like osteocalcin. This paradigm calls for co-supplementation with fat-soluble vitamins D and especially vitamin K2. The new proposed healthy regimen may prevent low-energy fractures among children and young adults and contribute to building the "bone bank," therefore helping to prevent the development of osteoporosis later in life.

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