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COMMENTARY

Vitamin D deficiency in adolescents living at high latitudes: are we missing something in the recommendations?

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Vitamin D does not only play an important role in calcium and phosphorus homoeostasis, but its active form – 1,25 $(OH)_2D_3$ – is involved in a wide range of biological actions. These include inhibiting cellular proliferation and angiogenesis and inducing terminal differentiation. The vitamin D receptor is also present in most body cells (1).

It has been suggested that vitamin D deficiency is a risk factor for the development of several diseases, such as hypertension, autoimmune diseases, multiple sclerosis, type 1 diabetes, schizophrenia, depression, and, as commonly seen in children, asthma and allergy (2). Furthermore, vitamin D may also provide a protective role for the immune system and hinder cancer development (3). To prevent diseases and cancer, the 25(OH) level must probably be at least 75 nmol/L, instead of the general accepted level of above 50 nmol/L for children.

However, we do not know what risks are associated with recommending an increased reference limit for the concentration of 25(OH)D in children, as there is no information on what effects high levels may have on them. We do know that high vitamin D levels have been associated with increased mortality in adults (4).

In this issue of Acta Paediatrica, Karin Persson et al. (5) set out to study a possible association between vitamin D deficiency, vitamin D intake and food allergies in a Northern Swedish (65–67°N; polar circle 66°N) cohort of adolescents. They did this by comparing vitamin D levels in a group of 20 children with food allergies and a control group of 42 children without food allergies. Surprisingly, they found that the children in both groups were vitamin D deficient to the same degree. The intake of vitamin D was similar in both groups and in accordance with the Swedish recommendations of 7.5 μg/day for this age group. More than 80% of the adolescents had 25(OH)D levels <50 nmol/L, and none were above 75 nmol/L. Although this was a small study, it focuses attention on the importance of sunlight, which provides up to 90% of the vitamin D we need (6). It also shows that the dietary recommendations for vitamin D did not seem to be sufficient in this region.

Invited Commenatry for Persson K et al, Vitamin D deficiency at the Artic cricle- a study in food allergic adolecents and controls, pages 644–649.

It seems that the present Swedish recommendations are not adequate for people living at very high latitudes. For latitudes >35°, dermal transformation of 7-dehydrocholesterol to previtamin D_3 occurs mainly between the hours of 10 a.m. and 3 p.m. from May to September. Only UVB light (290–320 nm) can lead to the production of previtamin D, but the sun has to be > 50 above the horizon for UVB to penetrate the atmosphere. For example, in a Swedish Northern city like Luleå (65°N), the sun does not rise above 50 degrees anytime during the year – its highest point is 47.5° at 10 am on June 15 (http://www.sunearthtools.com/dp/tools/pos_sun.php). The amount of sunlight in these northern parts of the globe is insufficient to provide the levels of vitamin D that people need. This increases the importance of sufficient dietary and supplementary intake of vitamin D, together with visits to areas at lower latitudes that receive sufficient sunlight to generate production of previtamin D.

In a recent study of Irish, Danish and Finnish adolescent white girls living above 55°N, the recommended intake of 7.5 μg/day was only enough to reach suboptimal levels (25–50 nmol/L), whereas an intake of more than double that dose (mean 19 μg) was needed to keep the level above 50 nmol/L during the winter months (7). In a Tasmanian (42°S) study, about two-thirds of the adolescents examined had insufficient vitamin D levels (below 50 nmol/L) during winter and spring and one-third had insufficient levels during the summer. These findings persisted in adulthood (8). On the other hand, in a Canadian survey of more than 1400 healthy children aged 2–13 years in Calgary (51°N), the mean 25(OH)D level was 86.1 nmol/L, 37% had insufficient values (25–75 nmol/L) and 2% were deficient. There were more suboptimal values in the older age group (9–13 years). In the Canadian study, more than 90% had a vitamin D intake of <400 IU (10 μg) and 40% had an intake of <200 IU (9). These findings should be compared with the Persson et al.'s study of children living around the Arctic polar circle at 66°N in this issue (5), which suggests that vitamin D deficiency is greater in adolescents living at high latitudes.

The problem in countries north or south of 35° latitude is that dermal transformation to vitamin D only occurs between late spring and early autumn during a relatively short period of the day (10). However, adolescents are a risk group regardless of latitude. In another European study of 1000 adolescents from nine European countries, including several from Southern Europe (Austria, Belgium, France, Germany, Greece, Italy Spain, Sweden and Turkey), only 18.9% had sufficient levels of above 75 nmol/L, 39% had levels between 50–75 nmol/L, 27% had deficient values of 25–50 nmol/L and 15 had severe deficient values of below 25 nmol/L (11).

The study by Persson et al. (5) focused on children who were healthy, apart from their food allergies. But what about risk groups, such as pregnant women, infants born to vitamin D-deficient mothers, children with chronic diseases, inactive or obese adolescents and individuals with dark skin? A recent U.S. study reported that the prevalence of vitamin D deficiency among healthy-weight, overweight, obese and severely obese children was 21%, 29%, 34% and 49%, respectively (12). And a study on the role of vitamin D deficiency in autism among children born to women of Somalian origin found that both the target and control groups were severely vitamin D deficient, with a mean 25 (OH)D level of below 20 nmol/L (13). This is a very disturbing finding.

Australia and New Zealand recently upgraded their vitamin D recommendations. These emphasize that sunlight is the most important source of vitamin D and that 25(OH) D levels should be at least 10–20 nmol/L higher at the end of the summer, to maintain levels above 50 nmol/L during the winter months (14).

The Endocrinology Society in the United States has recently published new guidelines that recommend a daily intake of at least 15 μg of vitamin D to maximize bone health (1), and Canada has adopted the same recommendation. This could probably only be achieved with daily vitamin D supplements. On the other hand, to raise the blood level of 25(OH)D constantly above 75 nmol/L, a daily intake of at least 25 μg (1000 IU) would be needed, which is a long way from where we are today. A recent systematic review of the global 25(OH)D status in both children and adults revealed a large gap in information when it came to children and adolescents, and the authors strongly encouraged new research to clearly define 25(OH)D status around the world (15).

In Sweden, the general recommendation is to give D_3 supplements to all children under the age of two. However, Sweden's close neighbour, Finland, recommends vitamin D supplements of 7.5 μg for all children under the age of 18 (www.fineli.fi), as a result of concerns about the consequences of the probable prevalent vitamin D deficiency in older children and teenagers.

A recent Irish study using weighted food records over a period of seven days found that the vitamin D intake of almost 600 children and teenagers was far from adequate. The median intakes were 1.9, 2.1 and 2.4 μg/day, for children aged 5–8, 9–12 and 13–17 years, respectively, despite the fact that 15–21% took vitamin D supplements. However, the study did not investigate 25-OH vitamin D levels (16). The study by Persson et al. (5) is interesting, not just because it measured the 25(OH)D level, but because it also evaluated the children's dietary intake of vitamin D. In this cohort, the dietary intake was sufficient, but not enough to reach an optimal 25(OH)D level. So, how does it help children when their vitamin D intake is adequate, but there is insufficient sunlight for dermal production?

Most of the discussions on vitamin D levels have, to date, focused on dietary intake. But as this study by Persson et al. (5) shows, the sun may play a critical role in keeping vitamin D levels above 50 nmol/L.

Furthermore, taking steps to prevent sunburn, because of the fear of skin cancer, may lead to vitamin D deficiency. Paradoxically, this can lead to an increased risk of skin cancer as the active form of 1,25 vitamin D can inhibit UV-induced cell death (17).

In a country such as Sweden, where the latitudes vary considerably, from 55°3′N at Malmö to 67°5′ at Kiruna, it may be sensible to provide different vitamin D recommendations in different parts of the country. This would compensate for the lack of dermal transformation of vitamin D at very high latitudes. Perhaps this information could take the form of a map, giving information on the optimal season and time for the sun to produce vitamin D in the skin. In addition, adolescents living at very high altitudes may be recommended a daily vitamin D supplementation of perhaps 15 μg. Future vitamin D studies in children and adolescents should not only emphasize dietary intake, but also take into account sun exposure.

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