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Strategies to improve vitamin D status in children

It is well-established that prolonged and severe vitamin D deficiency, with or without dietary calcium deficiency, can lead to nutritional rickets in children¹. Emerging evidence suggests that vitamin D is also required for a range of biological functions beyond its classical roles in calcium accretion and bone mineralisation²⁻³. Vitamin D is hypothesised to affect the risk of cardiovascular diseases, cancer, respiratory infections and asthma, atopic disease and pregnancy and birth outcomes⁴⁻⁶. Dietary reference values and evidence-based dietary guidelines play a key role in protecting populations against vitamin D deficiency, and in the recent decade a number of agencies have set dietary reference values on the basis of the evidence for musculoskeletal health outcomes. However, the paucity of observational and intervention data in children, particularly preschool children, has meant that many agencies have set dietary reference values the same as for adults⁷. Results from a recent dose-response RCT conducted under the auspices of the ODIN Integrated Project (contract 613977) (www.odin-vitd.eu) during wintertime in white children aged 4-8 years living in Denmark estimated an EAR to achieve a serum 25(OH)D concentration of 40 nmol/L at 4 µg/day⁸. An intake of ~20 µg/day was required to maintain 25(OH)D concentrations >50 nmol/L in 97.5% of children in winter. These findings demonstrate the need for experimentally derived estimates of vitamin D requirements for all population subgroups.

Estimates from national nutrition surveys across Europe have indicated that vitamin D intakes among children generally fall below the 10 µg/day average requirement proposed by the US Institute of Medicine⁹⁻¹². Low intakes of vitamin D are also seen in countries with mandatory vitamin D fortification policies such as the US and Canada^{13,14}. However, the availability of large-scale, nationally representative data on vitamin D status in children is very limited and cross-comparisons by age are restricted. Data from a large sample of 2-year old children in the Cork BASELINE Birth Cohort Study (n=741) show that serum 25-hydroxyvitamin D [25(OH)D] concentrations were < 30 nmol/L and <50nmol/L in 5% and 27% of children, respectively, despite intakes below 4 µg/d in 71% of children⁷. In children aged 6 years in the Netherlands, serum 25(OH)D was < 25 nmol/L and < 50 nmol/L in 6% and 30% of children (n=4167), respectively¹⁵.

Vitamin D is not ubiquitous in the food supply, found naturally in few foods, and typically in low concentrations. Young children in particular represent an at-risk subgroup due to their limited food intake and fussy eating behaviour which may result in avoidance of food groups which are important sources of vitamin D¹⁶. It is therefore important to consider strategies to in-

crease vitamin D intake and status in children. The two approaches available to achieve this are nutritional supplement use and (mandatory and voluntary) fortification practices.

While nutritional supplements can be important contributors to vitamin D intake, the prevalence of supplement use varies between countries and between age groups, typically higher in young children and decreases with age^{11,17-19}. Though vitamin D supplement use is an effective strategy to increase intake and status, the current rates of supplement use are too low to bridge the gap between actual vitamin D intakes and current recommendations²⁰.

In light of this, the fortification of food with vitamin D has been suggested as a strategy for increasing intake with potentially the widest reach and impact in the population. Fortification may be voluntary or mandatory in nature and it is important that the fortification of foods with vitamin D achieves efficacy without compromising on safety. In the European Union, the addition of nutrients to foods is regulated through EC No. 1925/2006, which permits addition at the discretion of the food manufacturer. While EC 1925/2006 has provided for the setting of maximum safe levels of addition and several methods have been proposed^{21,22}, these have not been agreed upon or implemented. There are a very limited number of studies that have evaluated the role of fortified foods in increasing vitamin D intakes and status.

Vitamin D-fortified ready-to-eat cereals, fat spreads and milks are the main sources of added vitamin D in the diets of Irish schoolchildren, and in preschool children vitamin D-fortified yoghurts and young child formulae also play a prominent role^{11,23}. Data from large-scale, nationally representative Irish studies show that added vitamin D from fortified foods contributes up 31- to 46% of total daily vitamin D intake, depending on the age group^{11,19}. Addition of vitamin D to foods results in vitamin D intake of preschool children increasing from 1.0 µg/d to 1.9 µg/d, and the proportion of children with intakes < 5µg/d reducing from 90% to 77%, and the proportion of children with intakes <1µg/d reducing from 46% to 18%¹¹.

Fortified foods have been shown to make nutritionally significant contributions to vitamin D intakes, but intakes still do not meet average requirement for vitamin D intake. Food fortification may represent the best opportunity to increase the vitamin D supply at a population level, particularly if a range of foods are fortified to accommodate diverse eating patterns.

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Vitamin D status in children: recommendations, reality and options for improvement

Friday, 11 May 2018
07:30 to 08:30 am
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Chair:
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Department of Clinical Sciences, Pediatrics,
Umeå University, Sweden



Olle Hernell
Department of Clinical Sciences, Pediatrics
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Clemens Kunz
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Overview of vitamin D status in children

Vitamin D deficiency as a global health problem has recently caught renewed attention. Vitamin D is one of the fat-soluble vitamins; a nutrient provided by the diet but also by synthesis in the skin by sunlight (UV-B) exposure. A range of functions has been linked to vitamin D. Besides the well-known key role in calcium and phosphate metabolism and bone health with rickets and osteomalacia as main clinical deficiency symptoms, reduced muscle function, increased risk of immune-related diseases (asthma, type 1 diabetes mellitus), infectious diseases (respiratory infections, influenza), cardiovascular disease and cancer has been associated to insufficient levels of the vitamin. However, the evidence for these extra-skeletal functions are less well established, partly based on lack of controlled intervention studies and convincing effect of vitamin D supplementation.

Globally, sunlight exposure is the most important source of vitamin D₃. Populations living in areas with limited hours of sunlight are at increased risk for vitamin D deficiency and in such areas, the contribution of vitamin D from foods and supplements becomes more important. Children with dark-skinned complexion need 5 to 10 times more sun exposure to generate the same amount of vitamin D₃ compared to fair-skinned children and are therefore also at increased risk of deficiency when exposure to sun is limited. The strong recommendations on protecting the skin from sunshine by clothing and/or sunscreens to reduce the risk of skin cancer later in life is also a risk factor of vitamin D deficiency as is spending too much time indoors. Obesity in children may be another risk factor. Other risk factors are some gastrointestinal, liver and renal diseases. Foods in general contain relatively minor amounts of vitamin D, the major sources being fat fish, egg yolk certain fungi and vitamin D-fortified foods. Human milk is low in vitamin D and many countries recommend supplements, mostly as vitamin D drops, at a daily dose of at least 400 IU (10µg) during the first year of life. Many children may need to continue with daily supplements beyond the first year disregarding a diversified diet. Infant formulas are fortified with vitamin D, and as long as formula provides the exclusive nutrition, it will cover the infant's need. Within the European Union follow-on formulas are also fortified.

Vitamin D status is assessed by the concentration in serum or plasma of its metabolite 25(OH) D because it reflects the sum of vitamin D converted in the skin through sunlight exposure and from dietary sources. Optimal concentrations of S-25(OH) D are under debate. Some expert panels suggest concentrations of ≥ 75 nmol/L to be optimal, 37 to 50 insufficient, and < 37 nmol/L to denote deficiency, whereas others argue levels of ≥ 50 nmol/L to be sufficient, 30-50 nmol/L insufficient and < 30 nmol/L deficient. ESPGHAN concluded that for children concentrations > 50 nmol/L indicates sufficiency and < 25 nmol/L deficiency because children with rickets generally have S-25(OH) D < 25 nmol/L, although this may vary depending on for instance the calcium concentration. It is evident that the S-25(OH) D value used to define vitamin D deficiency affects the magnitude of problem.

A recent study based on vitamin D standardization program protocols estimated the prevalence of vitamin D deficiency among European populations to be 13.0% on average in the year, defined as S-25(OH)D concentration < 30 nmol/L, with 17.7% and 8.3% in those sampled during the extended winter (October–March) and summer (April–November) periods, respectively. Another study using 25(OH) D < 30 nmol/L as definition of deficiency showed a variation in children from 1% in the USA, 2% in Canada, 5% in Belgium to 73% in Afghanistan, 6 and 19% (boys and girls) in Israel) and 35% in Malaysia. In a Swedish study on 5-7 year-old children 3.7 and 17% of fair and dark skinned children, respectively had S-25(OH) D concentrations < 30 nmol/L. Although, there are only rare cases of nutritional rickets in European countries these occur mostly among dark-skinned immigrants and in some areas there is a trend towards increasing incidence of rickets, mainly among immigrant children from south Asia, Africa, and the Middle East.

Although, there is a problem with lack of consensus with respect to definition of vitamin D deficiency and sufficiency, and also with variation between methods used to analyze the metabolite, it can be concluded that vitamin D insufficiency is a problem among infants and children today, and that there are reasons to consider to what extent current national recommended intakes are met, and also if these recommendations need to be revised.

Do higher vitamin D recommendations lead to a better status?

Data from a current German cohort study

Purpose Vitamin D is a key component for the growth and development of children and adolescents, influencing a multitude of functions. Worldwide epidemiological and clinical studies have shown that minimum 25 OH D blood levels of ≥ 20.0 ng/ml, often defined as vitamin D sufficiency by international and national nutrition and pediatric organizations, are often not met in practice. In 2012 the D-A-CH (Germany, Austria, Switzerland) nutrition societies increased their vitamin D intake recommendations fourfold from 200 IU (5 µg) to 800 IU (20 µg) per day. Our study should contribute to answering the question as to whether the new recommendations for increased vitamin D intake improve the highly prevalent vitamin D deficiency status in German children and adolescents.

Data for our cohort (infants, children and adolescents) regarding sex, season, gender etc. are very rare in Germany. Although the KIGGS study covered the age from birth up to 17 years and is therefore comparable, the data have been collected from 2003 to 2006^{1,2}, long before the vitamin D recommendations were increased by the DACH societies. Besides, 25(OH)D data in different age groups and gender aspects are important as, for example, within the HELENA study only subjects at an age of 12,5 years and higher have been recruited³.

Methods Access to healthcare in Germany is very easy and many preventive services are provided. Blood was taken from healthy patients who mainly came for a check-up. Some patients mentioned minor functional complaints (occasional headaches, attention problems, muscle aches etc.). In those cases major diseases could be excluded. For this 6-year study (January 2009 to December 2014) carried out in Mülheim an der Ruhr, Germany, healthy children and adolescents (n=1929, age range 1 to 17 years, median age 11.0 years, 46.9% female) consulting a pediatric group practice (KIDS4.0) were recruited. Seventy-five percent of the study participants were of German or European (Caucasian) origin. The remaining 25% had mostly Turkish roots, two percent showed a worldwide distribution (Africa and Asia). Serum 25(OH)D determinations were performed using a competitive chemoluminescence immunoassay (CLIA, DiaSorin).

Results The median serum vitamin D values for each year from 2009 to 2014 were 18.4 ng/ml, 13.0 ng/ml, 20.8 ng/ml, 16.4 ng/ml, 19.4 ng/ml and 14.9 ng/ml. The summarized median 25(OH)D serum concentrations between the two time periods 2009-2012 and 2013-2014 after increasing recommendations for vitamin D intake did not show a significant difference (17.0 ng/ml versus 16.8 ng/ml).

Conclusions The increased D-A-CH recommendations for vitamin D intake had no influence on vitamin D levels in children and adolescents. The prevalence of vitamin D deficiency has not changed compared to previous studies.

Our data addresses an important issue, i.e. recommendations made by medical and nutritional societies. Guidelines should be made to finally improve the health of the population. However, this requires to make them aware to the general population. Recommendations are ineffective as long as scientific societies do not focus on reaching this primary goal. Our results suggest, that respective societies should ponder on the reasons why they fail in improving the health status of their addressees. A lack of simplicity and clarity - being indispensable for the implementation into everyday life - is characteristic for the recommendations currently available, be it from ESPGHAN, German Society for Pediatric and Adolescent Medicine (DGKJ) or German Nutrition Society (DGE).

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