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Dietary Interventions Tackling Vitamin D Deficiency among United Kingdom Children

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Abstract

Until recently, the burden of Vitamin D deficiency among UK children had largely depended on anecdotal reports and single-center studies leaving the epidemiological references by clinicians and scholars to mere conjectures. However, new studies on a national scale have shown the enormity of vitamin D deficiency among UK children and have spurred concerted efforts towards addressing the problems associated with the deficiency of this all-important vitamin. Different studies have been conducted to highlight the many clinical problems associated with vitamin D deficiency among UK children and to highlight some efforts to correct them. Some of the studies form the thrust of this write-up.

Subject Areas

Public Health

Keywords

Sunshine Vitamin, Fortification, Supplementation, Homeostasis, Ultraviolet Light, Ergocalciferol, Cholecalciferol

1. Introduction

Vitamin D is a fat-soluble nutrient that is highly necessary for good health, and its importance in children cannot be over-emphasized [1]. Physiologically, it is essential to maintain a balance between calcium and phosphorus metabolism in the body with ultimate improvement in immune functions, growth, and skeletal development in humans [2]-[4]. Vitamin D is derived from dairy products like milk, and yogurt; fish rich in omega-3 fatty acids such as mackerel, salmon, trout, sardines, and tuna; eggs, liver, and some species of mushrooms [1] [5]. Its two primary forms are ergocalciferol (D2) and cholecalciferol (D3) [1] [4]. It is often

famously referred to as "the sunshine vitamin" because it is synthesized when human skin is exposed at about a 90-degree angle to ultraviolet B (UVB) which produces up to 10,000 - 25,000 I.U of vitamin D3, especially in the summer [6] [7].

In children, vitamin D deficiency is a notable problem that should arouse the interest of public health physicians, nutritionists, and governments all over the world and its prevalence is high [8]. This has been a source of worry for many researchers concerning European children [9] [10]. Vitamin D deficiency among European children is high because their skin is inadequately exposed to sunlight, coupled with poor Vitamin D intake, and poor supplementation of vitamin D sources within the continent [8]. Vitamin D deficiency typically manifests as long bone pain that can disturb a child's sleep at night. Muscle weakness and pain, bone deformities like genu valgum and genu varum and retarded growth and delay in walking are common in a vitamin D deficient child. Seizures, cardiomyopathy and tetany may also manifest as a result of an imbalance in calcium homeostasis occasioned by vitamin D deficiency [9] [11]. Regrettably, some of these complications are long-term and arise from any neglected and untreated vitamin D deficiency among children [12]. It is, therefore, pertinent to know the magnitude of this public health issue and ways of ameliorating its dire consequences.

2. Burden of Vitamin D Deficiency in the UK and Europe

In the UK, it was discovered that 35% of children aged between 4 and 18 years had vitamin D deficiency [13]-[15]. Hitherto, anecdotal reports only suggested that it has a high prevalence and incidence among the UK children, but there were no nationally acceptable epidemiological data on it [16]. The prevalence of Vitamin D deficiency differs widely among many European countries and regions, and it is of grave concern [17]. This is because there is a wide disparity in culture, weather, places of abode, and dietary peculiarities among many European countries [9]. Poor exposure to UVB sunlight, most prevalent in winter season predisposes to Vitamin D insufficiency [7]. In contrast to many other European countries, the Nordic countries like Norway, Finland, and Sweden which lie on high latitudes do experience shorter days and longer nights at wintry periods and consequently have little exposure to ultraviolet light (UVB), consequently, many children grapple more with Vitamin D deficiency than other countries in Europe [18]. In a region of Russia that lies between latitudes 45 and 70 degrees Vitamin D deficiency affects 55.96% of the general population [19]. In Greece, Vitamin Deficiency in a study was 75% among adolescents between the ages of 13 and 18 years [20]. Furthermore, some studies in France and Germany showed the same pattern of low Vitamin D among children and adolescents [8]. Health promotion initiatives geared toward mitigating this deficiency are, therefore, a necessity.

3. Risk Factors for Vitamin D Deficiency

Many factors aggregate in the causation of Vitamin D deficiency in children [21]. Knowing these risk factors, therefore, is imperative to strategically prevent VDD,

and develop and adopt holistic interventions. Vitamin D deficiency can occur in children if they are made to consume strict vegetarian diets [22]. Most importantly, the source of Vitamin D is primarily through the exposure of human skin to ultra-violet B (UVB) which are short wavelength radiation of about 290-315 Nm and this photo-chemically reacts with 7-dehydrocholesterol (7-DHC) in the human body to produce Vitamin D [23] [24]. So, female children in purdah or those who cover their whole bodies in adherence to Islamic tenets can develop vitamin D deficiency [24] [25]. The use of sunscreens that have a Sun-Protection factor (SP-15) in some countries also can lead to vitamin D deficiency through the absorption of 99% of UVB sunrays [24]. In the UK, vitamin D deficiency is higher among babies of ethnic minorities compared to white babies as they spend less time outside with their mothers as white babies typically do [26]. Overcrowding in skyscrapers with scanty green spaces in some urban cities can limit children's exposure to sunlight; lack of recreational activities for sunlight exposure can also cause Vitamin D deficiency [27]. Some clinical states can considerably reduce the amount of Vitamin D absorption, metabolism, and overall utilization in the gastrointestinal system of humans. Inflammatory bowel conditions like Ulcerative colitis and Crohn's disease and auto-immune diseases like Coeliac can all lead to Vitamin D deficiency [28]. Children who reside in areas of poor sunlight like countries in the northern hemisphere may consequently have Vitamin D deficiency [29].

4. Dietary Efforts to Tackle Vitamin D Deficiency

4.1. Vitamin D Dietary Sources

Undoubtedly, dietary intervention is the mainstay to obviate Vitamin D deficiency in children [30]. There are abundant sources of this essential Vitamin in children, especially in the UK. Rich amount of vitamin D can be derived from oily fish like mackerel, salmon, Tuna, and sardines are natural Vitamin D sources [31]. It is known that these fishes have a high amount of Vitamin D stored in their fatty tissues [32]. For this reason, it is justified that these fish should be added to children's diets as they increase children's Vitamin D content considerably [33]. Dairy products like milk and yogurt should, as a matter of necessity, be added to children's diets. Eggs too are important as the other rich sources of Vitamin D which should be served to children. Although the Vitamin D in egg yolk is lower than that in fatty fish, eggs remain a veritable source of Vitamin D in a child's diet [28].

4.2. Supplementation

Supplementation entails adding nutrients to somebody's diet to tackle a perceived deficiency and improve the wellness of the person in relation to the Sustainable Development Goals 3 [34]-[36]. Contextually, the pharmacologic efficacy, dosing, and safety profiles of the formulations are very germane for the overall benefits devoid of toxicity and untoward effects. Different individuals at different ages will require different dosages according to the peculiarities and severity of their

Vitamin D deficiencies [37]. The guide is to take recourse to the Recommended Daily Amount (RDA) concerning the age and severity of the deficiency. There is therefore a linearity in proportion to age. This means that an infant will require a lower amount of RDA than an older child of vitamin D [38]. Supplements can take various formulations like capsules, chewable tablets, or liquid drops [10]. Age, the child's preference, and health workers' recommendations will determine what a Vitamin D-deficient child will be offered [39] [40]. The ease of administration and dosage accuracy make liquid drops appropriate for infants while older children may be given chewable tablets or capsules [39]. Public Health England recommends 10 μg of Vitamin D daily for 1 - 4-year-old children while babies less than 1 year should have an RDA of 8.5 - 10 μ (340 - 400 I.U) Vitamin D supplement and newborn babies must be exclusively breastfed for six months [41]. For instance, Seven Seas Cod Liver Oil once-a-day capsule that is also rich in Omega-3 which enhances good health and development is a good supplement for vitamin D supply. Regular monitoring of Vitamin D levels after supplementation to assess the success of the intervention and to avoid toxicity is a compelling necessity [11]. Serum assays of Vitamin D levels in the child are the best ways for this monitoring [30]. It is of utmost consideration that supplementation is not allowed to exceed the tolerable upper limits as the UK Ministry of Health recommends. Relying strictly on supplements for Vitamin D requirements is fraught with its dangers. Supplements are only efficacious when taken by an individual for which they are recommended. However, the overall uptake average in the general population remains below 40% [14].

4.3. Vitamin D Fortification

This entails adding some important nutrients to food products that are popularly consumed in a population to enhance their nutritional contents and prevent or treat a suspected micronutrient deficiency [42] [43]. In Europe, many countries have adopted food fortification with Vitamin D to stave off its deficiency within their populations [8]. Although the WHO-FAO opine that when serial supplementation with micronutrients is adopted, it leads to a rapid correction of a deficiency in an individual or a whole community [44]. Fortification of common foods has an inherent capability to raise Vitamin D consumption in a target population and with the eventual benefit of preventing this deficiency [8]. Supplementation is not as efficacious comparatively, as food fortification has more compelling and long-lasting advantages [14]. Furthermore, food fortification is also more cost-effective as it focuses the process on the common staples consumed by the target population [14].

Monitoring and evaluating the improvement in Vitamin D levels in each population shows how effective fortification intervention is [45]. Food fortification with Vitamin D showed positive effects on preventing osteoporosis in adults and rickets in children [8]. Also, another study underscored the changes in Vitamin D analytes before and after Vitamin D food fortification which attested to its efficacy

[46]. However, food must be safely fortified with Vitamin D in the population [9]. Rigorous and painstaking assessments must be done to get the desirable fortification levels in conformity with the RDA which is devoid of toxicity to the populace [47]. Despite these advantages of fortification, the success of this intervention strategy is dependent on its acceptability by the target population [48] [49] Dr. Tian contend that the taste, willingness, and interest in consuming such fortified foods underpin the success of fortification strategies. Furthermore, for food fortification to be widely accepted, manufacturers must consider the texture, appearance, and taste of those fortified foods [50]. Awareness campaigns and education of would-be consumers will positively impact the uptake of fortified foods [49].

5. Evaluation of Vitamin D Using ABCD Tools

It is necessary to know the burden of Vitamin D deficiency and its prevalence in children before doing any dietary interventions [51]. Requisite data on typical foods children usually consume must be taken to know the shortfalls; blood chemistry also must be assayed to know the exact level of Vitamin D in the bloodstream and match these with clinical evaluation of Vitamin D deficiency symptoms like body weakness, skeletal deformities, history of fractures [52].

Anthropometric measurements entail the measure of physical parameters to measure the nutritional status of children being evaluated for Vitamin D deficiency [53]. The weight and height are measured and the body mass index is calculated therefrom using the formula: BMI = Weight/Height^2. These calculations will make us know the severity of the problem and the effectiveness of health promotion campaigns to tackle it [54]. Sex-specific and growth-specific growth charts measured in percentiles are compared to figure out the success of the dietary interventions when instituted over a certain period [53].

Biochemical assay is an unambiguous procedure of measuring the amount of nutrients in the body as a metabolite [55]. Mehramiz *et al.* [56] maintain that, to know if there is any deficiency, vitamin D assay in the serum is done by measuring the amount of 25-hydroxyvitamin D concentration. Measuring that 25(OH)D before and after a health intervention such as dietary change or fortification will show the changes in values and make us draw inferences on the success of the intervention. The intervention is adjudged successful if there is a steady rise in serum 25 (OH)D assay in linear proportionality to age [55]. Serum Vitamin D will be measured in pre- and post-dietary interventions [56].

Clinical evaluation is subsequently done for the tell-tale features and symptoms pathognomonic of Vitamin D deficiency. Some of these are: skeletal deformities, long bone pain, muscle weakness, and delayed motor milestones [57]. When carrying out a dietary intervention, clinical improvements and relief of symptoms are hallmarks of the effectiveness of the instituted interventions [19].

Dietary assessment involves intervention aimed at increasing eating those foods rich in Vitamin D, fortified foods, and supplements [58]. History of consumed Vitamin-D-rich foods is taken; and 24-hour recall of foods consumed will be

thoroughly assessed at regular intervals to assess compliance with the improved dietary changes prescribed [59]. The measure is adjudged effective when increased Vitamin D intake correlates positively with compliance with nutritional recommendations. Amount of vitamin D consumed an also be subjectively assessed through food records and food frequency questionnaires, which can assist assessors to know how to counsel a patient on ways of improving consumption of adequate and richer sources of vitamin D to correct any perceived deficiency [34]. Evidence of the impact is known through a comparison between Vitamin D consumption and compliance with nutritional recommendations pre- and post-interventions [18].

Summarily, anthropometric measurement positivity, higher levels of 25 (OH)D levels, reduction in clinical symptoms, and adherence to dietary recommendations all signify the success of the interventions [53]. Such efforts should be maintained for a considerable length of time to improve the prolonged skeletal health and holistic well-being of children [57]. Future studies should adopt all-encompassing study designs, extended follow-up duration, and larger sample sizes to ascertain health campaign's sustained effects in tackling Vitamin D deficiency in children. Successful interventions translate into growth velocity, higher levels of Vitamin D levels, resolution of clinical symptoms, and improved dietary consumption to holistically address Vitamin D deficiency [58].

6. Recommendations and Future Prospects

Robust strategies should be developed and implemented to obviate and address Vitamin D deficiency in children in the UK as a public health necessity [8]. Integrative approaches in policy formulation, health promotion campaigns that encourage supplementation, fortification, and consumption of diets rich in Vitamin D and teamwork among healthcare workers and policymakers are very important to unlocking successful interventional programs [14]. Awareness programs and regular health education focusing on this problem and ways of preventing them play a pivotal role in improving the benefits inherent in skeletal health [30]. Parents, and different cadres of healthcare professionals must be educated about the advantages of Vitamin D consumption and encouraged to key in to the programs to further inform the populace on the dangers of its deficiency [59]. They can also formulate a new paradigm shift in RDA and vitamin D deficiency risks in skeletal diseases [47]. Through these efforts, the barriers, fallacies, and myths militating against vitamin D normality, dispelling the morbid fear of skin cancer during exposure to sunlight and mitigating the deleterious UV radiation [14]. In a nutshell, sensitization and education programs will be effective tools for individuals, organizations, and cities to make concerted efforts towards improving health objectives for all people of different age grades.

7. Conclusion

Vitamin D deficiency among UK children is concerning as it relates to skeletal

deformities, susceptibility to infections, hypocalcemic seizures, and many long-term sequelae. Implementation of far-reaching strategies in public interest; raising awareness about the enormity of the clinical issues inherent in vitamin D deficiency, encouraging balanced diets, encouraging outside games, and recreational events for sun exposure, especially, among blacks and Middle East immigrants in the UK will reverse the situation. Food fortification, and focused supplementation programs will have overall beneficial outcomes. Early screening, diagnosis, and management of vitamin D deficiency holistically will have positive effects in the long run. Prevention of Vitamin D deficiency has numerous benefits both on an early, middle, and long-term basis.

Conflicts of Interest

The author declares no conflicts of interest.

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