Derna Academy Journal for Applied Sciences
E-ISSN: 3006-3159
DAJAS

Prevalence of Vitamin D Deficiency Among School Children in Tobruk City, Libya

Khadeejah Miftah Ali Al-Khurm[1*], Rihab Othman Abdulrraziq [2], Mohammed Mansour Saeid[3]

[1, 2, 3] Pediatric Department, Faculty of Medicine, Tobruk university, Tobruk, Libya.

*Corresponding author: E-mail addresses: Khadija.moftah@tu.edu.ly

Volume: 4 **Issue: 1** **Page Number: 26 - 33**

Keywords:
Vitamin D Deficiency, School children, Tobruk, Eastern Libya

Received: 20\05\2025
Accepted: 03\07\2025
Published: 04\07\2025

DOI: https://doi.org/10.71147/zaj3qc92

ABSTRACT

A recent cross-sectional investigation in Tobruk, Libya, has uncovered a public health crisis of vitamin D deficiency among its pediatric population. The study, which surveyed 540 school children aged 6 to 14, determined that an alarming 87% were deficient in this essential nutrient. This issue, a known global health concern even in sun-replete areas like North Africa, was found to be statistically more acute in females (89.0%) than in males (84.1%). The methodological approach involved random sampling from four health centers and quantification of serum 25-hydroxyvitamin D [25(OH)D] via chemiluminescence immunoassay, with deficiency defined by established clinical standards. Age-stratified data pinpointed specific high-risk groups: males aged 6–7 years (90.9% prevalence) and females aged 13–14 years (90.6% prevalence). Despite the severity of the deficiency, associated hypocalcemia was a rare finding, identified in only five cases. Given the critical nature of these results, the study concludes that immediate and targeted public health interventions are imperative. The high prevalence, particularly among young boys and adolescent girls, necessitates a multi-faceted strategy encompassing supplementation programs, food fortification, and educational campaigns on safe sun exposure to avert long-term health consequences in this vulnerable demographic.

1. INTRODUCTION

Vitamin D, a key calciotropic hormone, is integral to skeletal integrity by facilitating adequate bone mineralization and mass accrual. However, its physiological significance extends far beyond this classic function. Emerging evidence demonstrates its involvement in the complex modulation of somatic growth and macronutrient metabolism, primarily through its influence on the cell cycle and cellular proliferation (Samuel & Sitrin, 2008).

The multifunctional capacity of vitamin D is further highlighted by its critical impact on body composition, specifically in regulating myocyte development and function (Polly & Tan, 2014), as well as systemic metabolic pathways such as insulin signaling, adipogenesis, and adipocyte apoptosis (Szymczak-Pajor & Śliwińska, 2019).
Furthermore, the physiological scope of vitamin D includes significant immunomodulatory functions. By directly targeting key immune cells like macrophages, dendritic cells, and T-lymphocytes, it acts as a critical modulator of both innate and adaptive immune responses (Aranow, 2011). Consequently, a state of hypovitaminosis D is increasingly associated with the etiology of chronic, low-grade systemic inflammation (Prasad & Kochhar, 2016). In aggregate, through its influence on this diverse array of biological pathways, vitamin D status is established as a fundamental determinant of integrated growth, body composition, and metabolic homeostasis. This conceptual framework is substantially corroborated by preclinical data from animal models, which show simultaneous disruptions across these biological axes in a deficient state (Knuth et al., 2020).
The clinical and public health relevance of vitamin D's multifaceted role is amplified by the convergence of two global trends: the high prevalence of its deficiency (Roth et al., 2018) and the concurrent epidemic of non-communicable cardiometabolic diseases (Eckel, Grundy, & Zimmet, 2005). This intersection provides a strong impetus for investigating the relationship between vitamin D status and key indicators of metabolic health and physical fitness. As an accessible and modifiable factor, vitamin D presents a viable target for public health strategies, such as supplementation and food fortification, aimed at disease risk mitigation. The hypothesis that optimizing vitamin D levels can lead to favorable anthropometric and metabolic changes is supported by accumulating evidence. For instance, long-term observational studies of vitamin D-supplemented infants have reported positive outcomes, including increased lean mass, reduced adiposity, and a lower body mass index (BMI; kg/m ^{2}) (Hazell et al., 2017; Trilok-Kumar et al., 2015). This is reinforced by numerous other observational reports linking hypovitaminosis D in pediatric populations to a range of adverse health outcomes, such as stunting, underweight status (Mokhtar et al., 2018), diminished lean body mass (Foo et al., 2009), retarded linear growth (Gilbert-Diamond et al., 2010), childhood obesity (Plesner et al., 2018; Zakharova et al., 2019), and the early onset of puberty (Theodoratou, Tzoulaki, Zgaga, & Ioannidis, 2014).
It is imperative to acknowledge, however, that data from observational studies are inherently susceptible to confounding factors and the potential for reverse causation, which precludes the establishment of definitive causal links. The gold standard for rigorously assessing such relationships is the randomized clinical trial (RCT). Building on this principle, our research group previously conducted a phase 2 RCT that yielded promising preliminary results: a 6-month vitamin D supplementation regimen significantly enhanced height velocity in 113 vitamin D-deficient Mongolian adolescents (Ganmaa et al., 2017). Therefore, the present study was designed as a definitive phase 3 RCT to verify this finding in a comparable demographic. A secondary objective was to broaden the scope of inquiry to comprehensively evaluate the effects of sustained vitamin D repletion on other crucial developmental metrics, including BMI, body composition, and pubertal timing

2. METHOD

Study Design and Setting: Tobruk City, Libya, served as the site of this cross-sectional investigation. The period of data collecting was March 1, 2024, through February 28, 2025. The study sought to determine the prevalence of vitamin D deficiency in school-age children and investigate potential variations by age and sex.

Participants and Sampling: We selected participants at random from four Tobruk City primary healthcare facilities. We chose a representative sample of schoolchildren, ages 6 to 14, at random from each centre. We made sure that each age category had a fair distribution of men and women. Children of any sex between the ages of 6 and 14 were eligible under the inclusion criteria. Children with genetic disorders that impair bone health, malabsorption problems, or pre-existing bone diseases were not included.540 children

Data collection: Each participant provided a single venous blood sample (5 mL) after we obtained their assent and the parents' or guardians' informed consent. The blood collection was managed by qualified medical personnel. We also noted each child's demographics, including age and sex.
Blood samples were kept at room temperature for up to an hour prior to being transferred to the laboratory for biochemical analysis. We separated the serum after centrifuging the samples. The primary measure of vitamin D status, serum 25-hydroxyvitamin D (25(OH)D) levels, were determined using the Macura analyses and the chemiluminescence immunoassay (CLIA) method in accordance with the manufacturer's instructions.

This method quantitatively determines the total 25(OH)D concentration. For a subset of participants with low vitamin D levels, we also measured serum calcium concentrations using standard lab procedures.
Definition of Vitamin D Deficiency: We defined vitamin D deficiency as a serum 25(OH)D concentration of less than 35 ng/mL, following widely accepted clinical guidelines and previous studies.

Statistical Analysis: We carefully entered all data into a Microsoft Excel spreadsheet and double-checked it to ensure accuracy and reduce errors. We used descriptive statistics, including frequencies and percentages, to summarize the prevalence of vitamin D deficiency in the overall sample and across different sex and age groups. For statistical analyses, we used SPSS software for Windows, version 27. We applied chi-square tests to check for significant differences in vitamin D deficiency rates between males and females and across various age categories. We considered a p-value of less than 0.05 to be statistically significant.

Ethical Considerations: This study received ethical approval from the ethical committee of Tobruk University (Number NBC:009.H.25.6). We obtained written informed consent from the parents or guardians of all participating children before including them in the study. Additionally, we acquired assent from the children when appropriate, based on their age and understanding. All procedures followed relevant ethical guidelines and regulations to ensure the well-being and privacy of the participants.

3. ETHIC APPROVAL

The ethical committee of Tobruk University granted ethical permission for this project (Number NBC:009. H.25.6). Before being included in the study, the parents or legal guardians of every participating child provided written informed consent. Children's assent was also acquired when it was suitable given their age and comprehension. Every treatment was carried out in compliance with applicable ethical standards and laws to protect the participants' privacy and well-being.

4. RESULT

At four health services in Tobruk city, 540 school-age children (6–14 years old) of both sexes—214 boys and 326 girls—were questioned. Samples of blood were taken for additional examination. Out of 540 patients, 470 patients (87%), 180 of whom were males (39.5%) and 290 of whom were females (60.3%), had laboratory evidence of low vitamin D (vitamin D <35 mg/dl). 5 of these patients have low serum calcium and low vitamin D, out of 470 cases of vitamin D deficiency (180 males, 39.6%, and 290 females, 60.3%).
Data in table 1 and figure 1 shows the prevalence of vitamin D deficiency (vitamin D <35mg/dl) among school children in Tobruk by geographical region and sex. The estimated prevalence of vitamin D deficiency in males is 39.6%. In contrast, the prevalence of vitamin D deficiency in female school children is 60.3%. The prevalence of vitamin D deficiency among school children in Tobruk, based on age group (years), is 90.9%, 80%, 86.3%, and 80% for males in the age groups (6-7), (8-10), (11-12), and (13-14) years. For females, the prevalence is 89.2%, 89.9%, 86.0%, and 90.6% in the same age groups. There were statistically significant differences between age groups. However, vitamin D deficiency is more common in children aged 6-7 years at 90.9% for males, while it is more common in children aged 13-14 years at 90.6% for females.
There were statistically significant differences between age groups however, vitamin D deficiency was more frequent in children aged (6-7) years 90.9% in males, vitamin D deficiency was more frequent in children aged (13-14) years 90.6% in females.

- **Table 1: Prevalence of Vitamin D Deficiency by Sex**

Sex	Vitamin D Deficiency Cases	Total Sample	Percentage
Male	180	214	39.6%
Female	290	326	60.3%
Total	470	540	87%

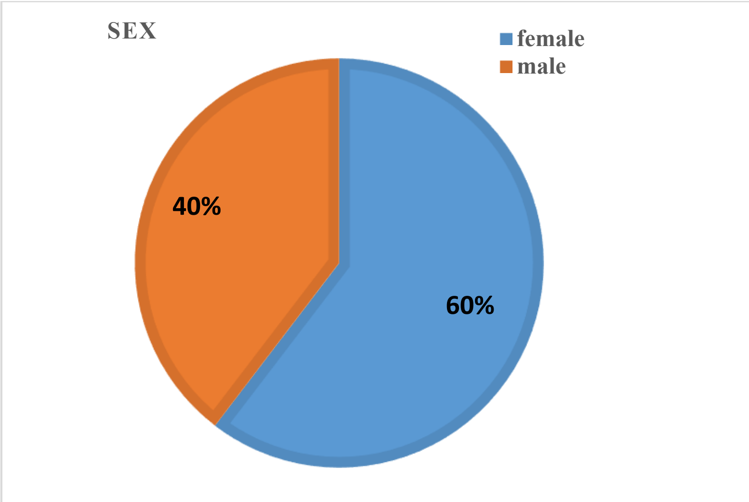

Figure 1: Distribution of, vitamin D deficiency in children according to gender

Table2. Prevalence of Vitamin D deficiency among school children in Tobruk in males according to age group.

Male Age	Number	Vitamin D deficiency	Percentage%
7-6years	55	50	90.9%
10-8years	90	72	80%
12-11years	44	38	86.3%,
14-13years	25	20	80%
Total	214	180	

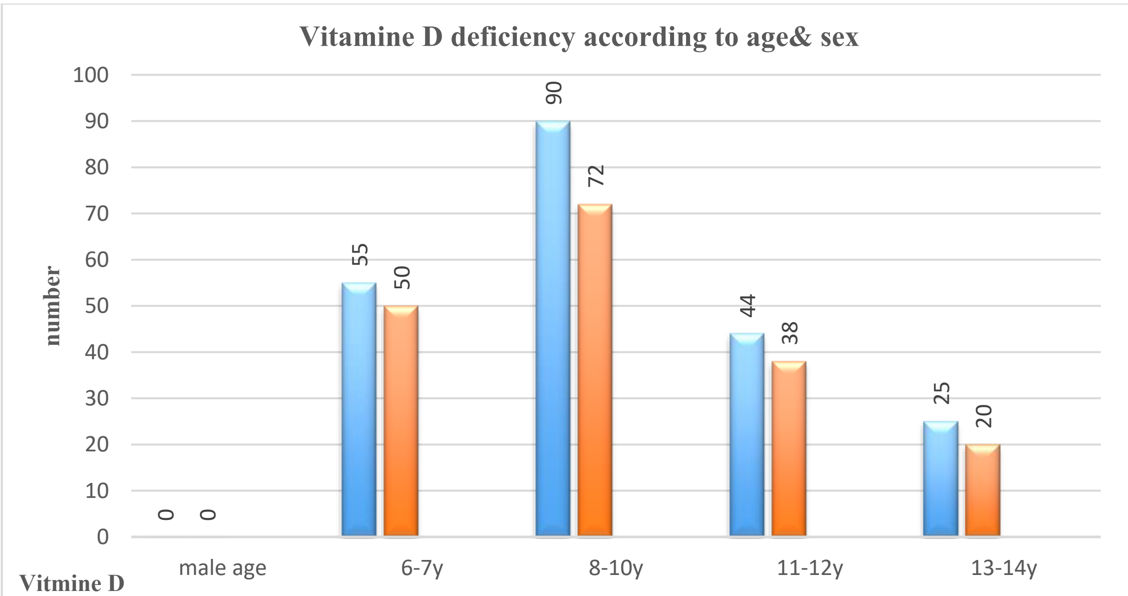

Figure 2: Distribution of, vitamin D deficiency in children in males according to age groups

Table3. Prevalence of Vitamin D deficiency among school children in Tobruk in females according to age group.

Female age	Numbers	Vitamin D	Percentage%
7-6years	56	50	89.2%
10-8years	109	98	89.9%
Years 11-12	86	74	86.0%,
Years 13-14	75	68	90.6%
Total	326	290	

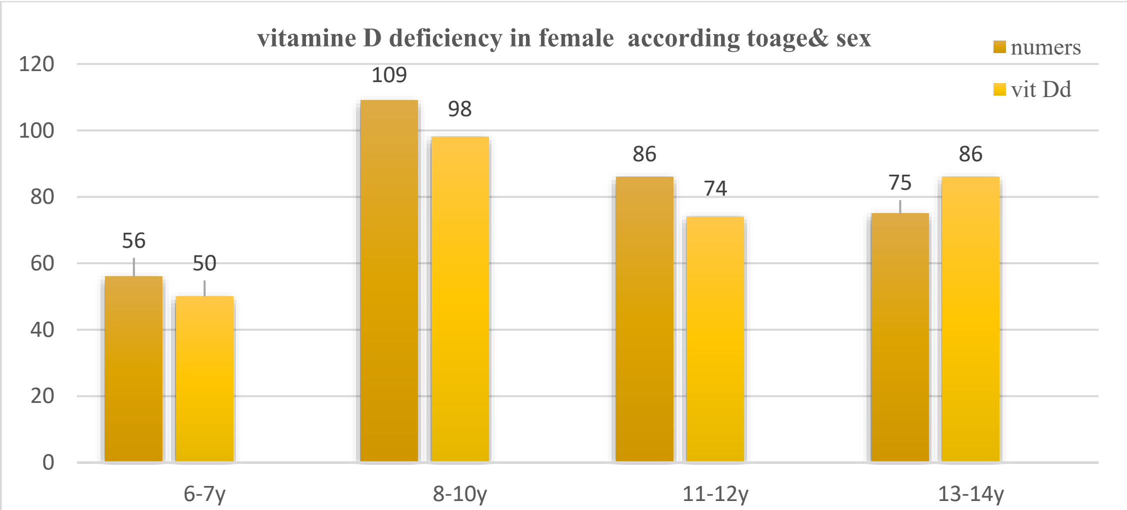

Figure 3: Distribution of, vitamin D deficiency in children in females according to age groups

5. DISCUSSION

The present study revealed a strikingly high prevalence of vitamin D deficiency (87%) among school-aged children in Tobruk City, Libya. This finding underscores a significant public health concern in this pediatric population and aligns with a growing body of evidence indicating a widespread global burden of vitamin D insufficiency, particularly in regions characterized by limited sunlight exposure or specific cultural practices that reduce skin exposure (Roth et al., 2018). The observed prevalence in Tobruk is notably higher than the rates reported in European and North American populations, where prevalence estimates typically range from 20% to 50%, influenced by factors such as age, ethnicity, and latitude (Roth et al., 2018). However, our findings are consistent with reports from other Middle Eastern countries, where factors such as reduced outdoor activity, cultural dress codes limiting skin exposure to sunlight, and potentially lower dietary vitamin D intake are considered significant contributing factors (Roth et al., 2018).

A notable disparity in vitamin D status was observed between the sexes, with a significantly higher prevalence of deficiency among female participants compared to their male counterparts. This gender-based difference mirrors findings from a study conducted in Saudi Arabia, which also reported significantly lower vitamin D levels in girls compared to boys (Al-Daghri et al., 2017). Several factors may contribute to this observation. Cultural norms and dress practices that often necessitate greater skin coverage among females in this region could limit cutaneous vitamin D synthesis. Furthermore, potential variations in physical activity levels and time spent outdoors between male and female children may also play a role. Further investigation into these behavioral and cultural influences is warranted to better understand the underlying mechanisms contributing to this disparity.

Male and female participants showed different patterns when the prevalence of vitamin D insufficiency was analysed by age. The age group of 6–7 years old had the highest frequency of deficit among boys (90.9%). A number of reasons in early infancy, such as differences in nutritional intake, growth spurts that affect vitamin D requirements, and possibly less consistent sun exposure habits compared to older age groups, could be responsible for this finding. On the other hand, among female participants, the age range of 13–14 years old had the highest prevalence of vitamin D deficiency (90.6%). This result is in line with a study done in Egypt that found that adolescents were more likely to be vitamin D deficient (Hassan et al., 2017).

The rapid skeletal growth and increasing calcium demands during puberty may be the cause of the higher prevalence in females during adolescence, which could exacerbate pre-existing vitamin D insufficiency. Furthermore, lifestyle modifications such as a decrease in outdoor activities and changes in eating habits during puberty may also be a factor in this heightened susceptibility.

Interestingly, a small fraction of children with vitamin D insufficiency (5 cases) also had a slight co-occurrence of hypocalcaemia. Due to compensatory mechanisms that regulate calcium levels, early-stage vitamin D insufficiency may not always result in overt hypocalcaemia, despite the fact that vitamin D is essential for maintaining calcium homeostasis (Holick, 2007).

This research highlights that vitamin D deficiency can present with a variety of clinical manifestations, and that the lack of hypocalcaemia should not rule out the possibility of vitamin D insufficiency.

The health and wellbeing of school-age children in Tobruk will be significantly impacted by the startlingly high rate of vitamin D insufficiency found in this study. Because it is essential for calcium absorption and skeletal mineralisation, vitamin D is vital for bone health (Holick, 2007). Children who experience chronic vitamin D deficiency may experience delayed bone formation, a higher risk of fractures, and possibly long-term effects on their adult bone health (Lehtonen-Veromaa et al., 2002; Pekkinen, Viljakainen, Saarnio, Lamberg-Allardt, & Mäkitie, 2012).

Additionally, new studies indicate that vitamin D may have a wider impact on a number of physiological functions, such as immunological function (Aranow, 2011), cell development and differentiation (Samuel & Sitrin, 2008), and metabolic health (Prasad & Kochhar, 2016; Szymczak-Pajor & Śliwińska, 2019). Even while this cross-sectional study's breadth precludes examining these wider health implications, the significant incidence of insufficiency calls for additional research to examine any possible correlations with other health outcomes in this population.

According to the study's findings, public health initiatives to treat vitamin D insufficiency in school-age children in Tobruk City are desperately needed.

These treatments must to be comprehensive, including methods to boost vitamin D production by dietary consumption or supplementation as well as safe sun exposure techniques. Raising knowledge of the value of vitamin D, safe sun exposure recommendations that strike a compromise between reducing the risk of skin damage and the advantages of vitamin D production, and dietary sources of vitamin D requires educational efforts aimed at parents, kids, and educators. Additionally, local health authorities should think about implementing targeted vitamin D supplementation programs, especially for susceptible subgroups like younger children and adolescent girls.

6. CONCLUSION

This investigation establishes that hypovitaminosis D has reached epidemic proportions among the pediatric population of Tobruk City, Libya, with an overall prevalence of 87%. The data reveal significant sex- and age-specific disparities, indicating a multifactorial etiology likely rooted in a complex confluence of sociocultural, behavioral, and physiological determinants. These findings constitute a significant public health imperative, necessitating the immediate implementation of targeted interventional strategies.

It is recommended that public health authorities deploy a multi-pronged approach encompassing: 1) health literacy campaigns to promote safe solar exposure and improve dietary vitamin D intake, and 2) the strategic implementation of supplementation programs, with a focus on identified at-risk cohorts such as female adolescents. The primary objective of these interventions is the optimization of skeletal health and the potential mitigation of non-skeletal morbidities associated with vitamin D insufficiency in this vulnerable demographic.

To advance this field, two principal avenues for future research are proposed. First, further investigation is imperative to delineate the precise drivers of vitamin D deficiency within this specific regional context. Second, longitudinal studies are warranted to rigorously evaluate the long-term efficacy and impact of any implemented public health interventions.

. ACKNOWLEDGMENT

I wish to express my profound and sincere gratitude to my family. Their unwavering support, constant encouragement, and immense patience have been the foundation of my success throughout this arduous academic journey. This accomplishment would not have been possible without their unconditional love and steadfast belief in me. I am eternally indebted to them.

7. REFERENCES

Al-Daghri, N. M., Al-Saleh, Y., Aljohani, N. J., Al-Attas, O. S., Alokail, M. S., Alfawaz, H., ... & Chrousos, G. P. (2017). Vitamin D status correction and cardiometabolic risks in Saudi children and adolescents. *Nutrients, 9*(6), 546. doi:10.3390/nu9060546

Aranow, C. (2011). Vitamin D and the immune system. *Journal of Investigative Medicine, 59*(6), 881-886. doi:10.2310/JIM.0b013e31821b8755

Eckel, R. H., Grundy, S. M., & Zimmet, P. Z. (2005). The metabolic syndrome. *The Lancet, 365*(9468), 1415-1428. doi:10.1016/S0140-6736(05)66378-7

Foo, L. H., Zhang, Q., Zhu, K., Ma, G., Hu, X., Greenfield, H., & Fraser, D. R. (2009). Relationship between vitamin D status, body composition and physical exercise of adolescent girls in Beijing. *Osteoporosis International, 20*(3), 417-425. doi:10.1007/s00198-008-0667-2

Ganmaa, D., Stuart, J. J., Sumberzul, N., Ninjin, B., Giovannucci, E., Kleinman, K., & Rich-Edwards, J. W. (2017). Vitamin D supplementation and growth in urban Mongol school children: Results from two randomized clinical trials. *PLoS One, 12*(5), e0175237. doi:10.1371/journal.pone.0175237

Gilbert-Diamond, D., Baylin, A., Mora-Plazas, M., Villamor, E. (2010). Vitamin D deficiency and anthropometric indicators of adiposity in school-age children: a prospective study. *The American Journal of Clinical Nutrition, 92*(6), 1446-1451. doi:10.3945/ajcn.2010.29746

Hassan, N. E., El-Masry, S. A., Mehrez, M. A., El-Gerbed, N. M. A., & Foad, M. A. (2017). Vitamin D deficiency among healthy Egyptian adolescents. *European Journal of Clinical Nutrition, 71*(2), 195-199. doi:10.1038/ejcn.2016.179

Hazell, T. J., Gallo, S., Vanstone, C. A., Agellon, S., Rodd, C., & Weiler, H. A. (2017). Vitamin D supplementation trial in infancy: body composition effects at 3 years of age in a prospective follow-up study from Montréal. *Pediatric Obesity, 12*(1), 38-47. doi:10.1111/ijpo.12105

Holick, M. F. (2007). Vitamin D deficiency. *The New England Journal of Medicine, 357*(3), 266-281. doi:10.1056/NEJMra070553

Holick, M. F., Binkley, N. C., Bischoff-Ferrari, H. A., Gordon, C. M., Hanley, D. A., Heaney, R. P., ... & Weaver, C. M. (2011). Evaluation, treatment, and prevention of vitamin D deficiency: An Endocrine Society clinical practice guideline. *The Journal of Clinical Endocrinology & Metabolism, 96*(7), 1911-1930. doi:10.1210/jc.2011-0385

Knuth, M. M., Mahapatra, D., Jima, D., Kapa, L., Perkins, C., El-Nachef, W., ... & Damoiseaux, R. (2020). Vitamin D deficiency serves as a precursor to stunted growth and central adiposity in zebrafish. *Scientific Reports, 10*(1), 16032. doi:10.1038/s41598-020-72622-2

Lehtonen-Veromaa, M. K. M., Möttönen, T. T., Nuotio, I. O., Irjala, K. M. A., & Viikari, J. S. A. (2002). Vitamin D and attainment of peak bone mass among peripubertal Finnish girls: A 3-y prospective study. *The American Journal of Clinical Nutrition, 76*(6), 1446–1453. doi:10.1093/ajcn/76.6.1446

Mokhtar, R. R., Holick, M. F., Sempértegui, F., Griffiths, J. K., Estrella, B., & Hamer, D. H. (2018). Vitamin D status is associated with underweight and stunting in children aged 6-36 months residing in the Ecuadorian Andes. *Public Health Nutrition, 21*(11), 1974-1985. doi:10.1017/S1368980017002816

Pekkinen, M., Viljakainen, H., Saarnio, E., Lamberg-Allardt, C., & Mäkitie, O. (2012). Vitamin D is a major determinant of bone mineral density at school age. *PLoS One, 7*(7), e40090. doi:10.1371/journal.pone.0040090

Plesner, J. L., Dahl, M., Fonvig, C. E., Nielsen, T. R. H., Kloppenborg, J. T., Pedersen, O., ... & Holm, J. C. (2018). Obesity is associated with vitamin D deficiency in Danish children and adolescents. *Journal of Pediatric Endocrinology and Metabolism, 31*(1), 53-61. doi:10.1515/jpem-2017-0246

Polly, P., & Tan, T. C. (2014). The role of vitamin D in skeletal and cardiac muscle function. *Frontiers in Physiology, 5*, 145. doi:10.3389/fphys.2014.00145

Prasad, P., & Kochhar, A. (2016). Interplay of vitamin D and metabolic syndrome: A review. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 10*(2), 105-112. doi:10.1016/j.dsx.2015.02.014

Roth, D. E., Abrams, S. A., Aloia, J., Bergeron, G., Calvo, M. S., Cashman, K. D., ... & Whiting, S. J. (2018). Global prevalence and disease burden of vitamin D deficiency: A roadmap for action in low- and middle-income countries. *Annals of the New York Academy of Sciences, 1430*(1), 44-79. doi:10.1111/nyas.13968

Samuel, S., & Sitrin, M. D. (2008). Vitamin D's role in cell proliferation and differentiation. *Nutrition Reviews, 66*(Suppl. 2), S116-S124. doi:10.1111/j.1753-4887.2008.00094.x

Szymczak-Pajor, I., & Śliwińska, A. (2019). Analysis of association between vitamin D deficiency and insulin resistance. *Nutrients, 11*(4), 794. doi:10.3390/nu11040794

Theodoratou, E., Tzoulaki, I., Zgaga, L., & Ioannidis, J. P. A. (2014). Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. *The BMJ, 348*, g2035. doi:10.1136/bmj.g2035

Trilok-Kumar, G., Kaur, M., Rehman, A. M., Kärki, K., Al-Saffar, N., Singh, R., ... & Sachdev, H. P. S. (2015). Effects of vitamin D supplementation in infancy on growth, bone parameters, body composition and gross motor development at age 3-6 years: follow-up of a randomized controlled trial. *International Journal of Epidemiology, 44*(3), 894-905. doi:10.1093/ije/dyv116

Zakharova, I., Klimov, L., Kuryaninova, V., Nikitina, I., Malyavskaya, S., Dolbnya, S., ... & Kasyanova, A. (2019). Vitamin D insufficiency in overweight and obese children and adolescents. *Frontiers in Endocrinology, 10*, 103. doi:10.3389/fendo.2019.00103