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VITAMIN D DEFICIENCY AND ASSOCIATED FACTORS IN CHILDREN UNDER THE AGE OF 15

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[1,2,3,4](MBBS 3rd year)

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Abstract

Vitamin D is a vital nutrient that contributes significantly to childhood development, especially in promoting healthy bones, regulating calcium absorption, and supporting skeletal formation. Its deficiency remains a widespread nutritional issue, with children among the vulnerable populations. The present study was designed to investigate dietary and environmental factors that may increase the likelihood of vitamin D deficiency in children below 15 years of age. A cross-sectional survey involving 41 participants was carried out using a structured questionnaire distributed through Google Forms. Information was gathered on participants' demographic profiles, intake of vitamin D-rich foods, duration of outdoor sunlight exposure, and sunscreen practices. According to the collected data, 73.2% of children consumed milk on a daily basis, whereas 53.7% reported no fish consumption. In terms of outdoor activities, 85.4% of participants spent time outside, while 70.7% stated that they never applied sunscreen. Overall, the findings demonstrate differences in children's dietary patterns and sunlight-related practices, which may affect their vitamin D intake and natural production. The study underlines the need to improve parental awareness of proper nutrition, adequate sunlight exposure, and preventive strategies to maintain healthy vitamin D levels throughout childhood.

INTRODUCTION

One of the crucial vitamins in our body is VITAMIN D. Vitamin D plays an important role in the body's immunological functions, nutritional status, and physical and cognitive growth of children[1] Vitamin D is critical to bone mineral metabolism and to the growth and development of the skeleton. Optimizing vitamin D status could be one of the cornerstones for optimizing skeletal growth and achieving the maximum peak bone mass soon after the completion of adolescence[2]. There are not many natural food items that contain vitamin D; therefore, the amount of time in sunlight is the important source of vitamin D [3] Vitamin D deficiency has become very common in both adults and children, due to a lack of exposure to sunlight[4]Vitamin D is an essential fat-soluble vitamin for calcium maintenance homeostasis, for bone health and for preventing falls and fractures, and it has also

been related to hypertension, diabetes, metabolic syndrome, cancer, autoimmune and infectious diseases, among others. These conditions are major public health problems worldwide[5]. Vitamin D deficiency (VDD) prevalence is very high in pediatric population in developing countries including Pakistan. VDD contributes significantly to morbidity and mortality among children. VDD is the most common cause of nutritional rickets and growth failure in children[6] . We conducted a dietary and sunlight exposure–based survey among different age groups up to 15 years old with different weight ranges and variables related to the socioeconomic backgrounds children in Pakistan.

3.Vitamin D Physiology and Metabolism

3.1 Synthesis

Vitamin D is a fat-soluble steroid that exists in two forms: vitamin D_2 and vitamin D3 [7].While plants and fungi produce vitamin D_2 from ergosterol[8] while human skin produces vitamin D_3 from 7-dehydrocholesterol (7-DHC) when exposed to UVB radiation from the sun[9]. Vitamin D3 is made in the skin from 7-dehydrocholesterol under the influence of UV light. Vitamin D2 (Ergocalciferol) is derived from the plant sterol ergosterol. Vitamin D is metabolized first to 25 hydroxyvitamin D (25OHD), then to the hormonal form 1,25-dihydroxyvitamin D (1,25(OH)2D)[10] finally, 25(OH)D_3 is converted to its active form, 1,25-dihydroxyvitamin D_3 [1,25$(OH)_2D_3$], in the kidneys via CYP27B1. The primary function of 1,25$(OH)_2D_3$ is to maintain normal calcium levels and bone development by regulating phospho-calcium metabolism.[11]

3.2 Calcium Absorption and Bone Mineralization

Vitamin d is critical regulator of calcium and bone homeostasis while vitamin d has multiple effects on bone and calcium metabolism the regulation of intestinal calcium(ca) absorption efficiency is a critical function for vitamin d[12]It is well accepted that the intestinal absorption of calcium occurs by 2 distinct mechanisms,a saturable active transport process and a non saturable passive diffusion process.[13]

The primary role for 1,25(OH)2 D during growth is to increase intestinal calcium absorption so that sufficient calcium is available for bone mineralization. [14]Low calcium intake and vitamin D deficiency seem to be positively correlated with the prevalence of osteoporosis. [15]

4. Study and Methods

A cross sectional based study was conducted to access factors associated with vitamin d deficiency in children under 15 years of age.

DATA COLLECTION TOOL

Data were collected using a structured, self-administered questionnaire developed through Google Formss The questionnaire was divided into three main sections.

4.1 DEMOGRAPHIC INFORMATION

Included variable details regarding the child age, gender, weight and height and skin type

4.2 SUN EXPOSURE:

Assessed duration of outdoor activities, exposure to sunlight and sun protective practices

4.3 DIETARY INATKE:

Evaluated the child consumption of vitamin d rich foods including milk, eggs and fish as well vitamin supplementation

4.4 ETHICAL CONSIDERATION:

Participation in the study was voluntary. Informed consent was obtained from parents and guardians before they completed the questionnaire. The collected data was used exclusively for research purposes.

4.5 STASTICIAL ANAYLYSIS: The collected data was obtained using descriptive and inferential statistical methods. Categorical variables were summarized as frequencies and percentages. Chi-square test were used to examine association between relevant categorical variables such as sun exposure and dietary habits. Statistical significance was considered at a p- value of less than 0.05.

5.RESULTS

The conducted survey has 4 major sections

1. Demographic information
2. Dietary intake of vitamin d rich foods
3. Duration of sun exposure
4. Use of sunscreen

5.1 DEMOGRAPHIC INFORMATION

This section presents the demographic characteristics of the participants who took part in the survey. The collected information includes gender, age, weight, and height. These variables were included to describe the study and provide an overview of the participants' nutritional background. Weight and height measurements were also considered to assess Body Mass Index (BMI).The distribution of participants according to these demographic characteristics is presented in the following tables and figures.

5.11 GENDER:

Two genders of children were observed in this survey

Frequencies of GENDER

GENDER	Counts	% of Total	Cumulative %
Male	12	29.3%	29.3%
female	29	70.7%	100.0%

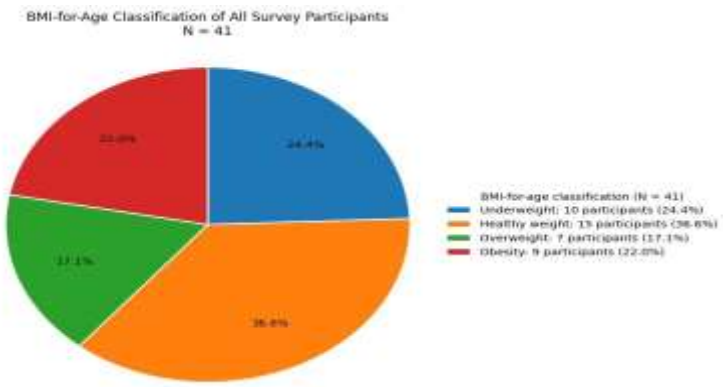
5.12 AGE

We divided all of the participants into 3 age groups

0-4 years old	8 children
5-9 years old	10 children
10-13 years old	23 children

5.13 BODY MASS INDEX:

Available height, weight and age was used to determined the variations in nutritional status of the surveyed children



5.2 DIETARY INTAKE OF VITAMIN D ENRICH FOODS

Dietary Consumption of Vitamin D-Containing Foods

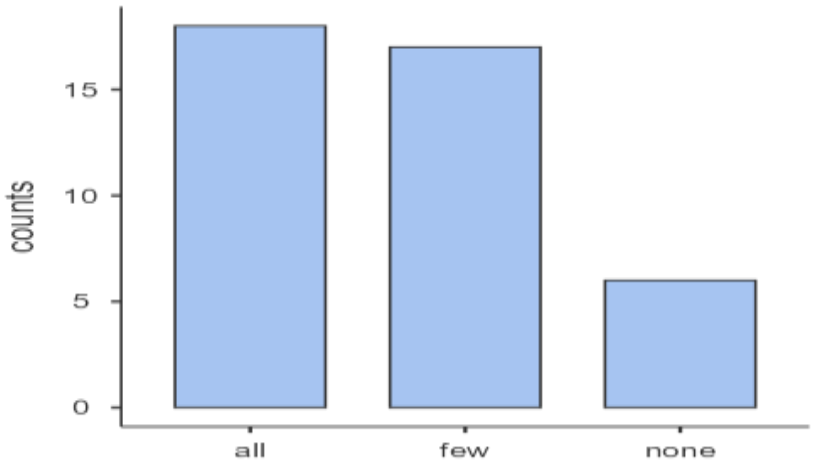
Among the 41 respondents, 30 (73.2%) reported daily milk consumption, while 10 (24.4%) consumed milk sometimes. Regarding egg consumption, 12 (29.3%) reported daily intake and 29 (70.7%) consumed eggs sometimes. Fish consumption was comparatively lower, with 19 (46.3%) consuming fish sometimes and 22 (53.7%) reporting never consuming fish.

When all three dietary categories were considered together, 19 respondents (46.3%) reported consuming all three food groups at least sometimes, whereas 21 (51.2%) consumed two food groups and one respondent (2.4%) consumed only one.

These findings indicate that although most respondents consume at least some foods containing vitamin D, fish consumption is relatively limited.

5.3 DURATION OF SUN EXPOSURE

"How many days per week do you spend in the sun"was asked to every participants and their information was calculated and is presented below in bar graph. N=41(children participated)



DAYS PER WEEK

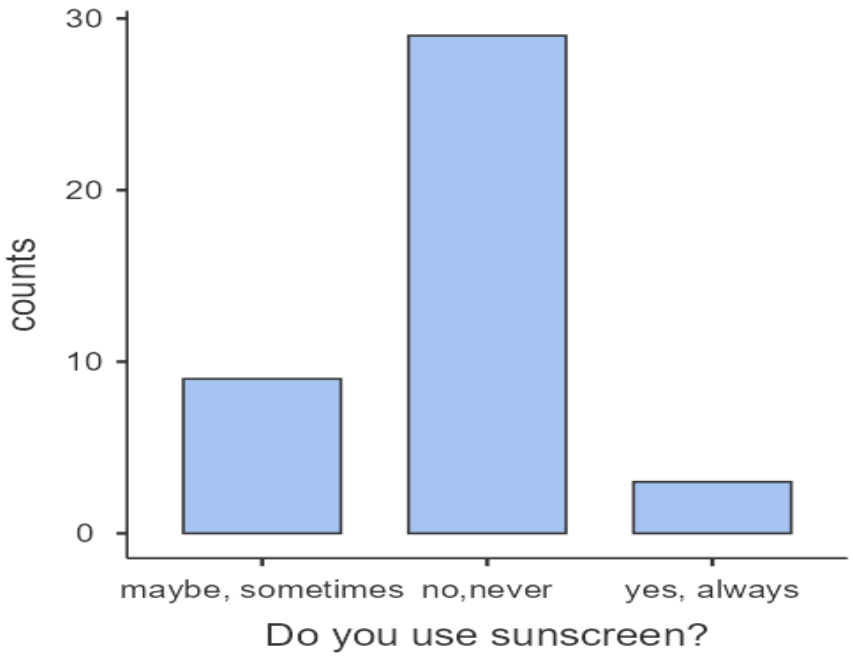
As shown in the bar graph, the majority of the participants 18(43.9 %) reported spending maximum time outdoor, 17 participants(41.5%) reported spending less time outdoor. 6 participants(14.6%) reported spending least equivalent to zero time outdoor.

A Chi-square goodness of fit tests was conducted to evaluate the distribution of sun exposure

The test confirmed that the distribution was statistical significant , χ^2 (2, N=41) =6.49, p= .039 indicating that the number of participants who spend no time outdoors is significantly lower than expected by chance.

5.4 USE OF SUNSCREEN

" do you use sunscreen" was asked to every participants and their information was calculated and is presented below in bar graph. N=41(children participated)



As shown in the bar graph, the vast majority of the sample - 29 participants(70.7%) reported that they "never" used sunscreen. A much smaller proportion, 9 participants(22.0%), indicated that they use sunscreen "maybe, sometimes" while, only 3 participants(7.3%) reported that they "always" use sunscreen

To determine if the distribution of these responses was statistically significant, a Chi Square Goodness - of - Fit test was conducted. The test confirmed a highly significant difference in the frequency of responses , χ^2 (2, N=41) = 27.1, p < .001.

This indicates that the overwhelming majority of "never" responses is not due to random chance, but a represents a definite trend of low sunscreen usage within this population.

6.CLINICAL MANIFESTATION

Vitamin D and calcium deficiencies are common worldwide, causing nutritional rickets and osteomalacia, which have a major impact on health, growth, and development of infants, children, and adolescents; the consequences can be lethal or can last into adulthood[16] The epidemiology of VDD is affected by various factors, including dark skin, southern latitude, limited sunlight exposure, impaired vitamin D metabolism, maternal VDD during pregnancy and prolonged breastfeeding without supplementation[17]Children with radio graphically confirmed rickets have an increased risk of fracture. Children with simple vitamin D deficiency are not at increased risk of fracture.[18]

Rickets is a bone disease characterized by abnormal serum calcium (Ca) and phosphate (Pi) levels that may cause the development of abnormalities in chondrocytes differentiation and maturation and, consequently, a defective mineralization of the growth plate[19]It predominantly affects longer bones, leading to poor bone growth and typical rickets bony deformities such as bow-legs and knock-knees[20]Florid signs of rickets are rare in adolescents, which usually manifest with vague symptoms such as headache and pain in the lower limbs. Severe rickets may also present with "rachitic rosary" due to the expansion of the costo-chondral junctions. Growth retardation, frontal bossing of the skull, craniotabes (soft skull bones), delayed tooth eruption, and widened fontanelle have also been reported[21,22]Bone deformities are the hallmark of rickets. They typically appear before the age of 18 months with the maximum frequency reported between the ages of 4 and 12 months. Rapid bone growth areas including costo-chondral junctions and long bone epiphyses are predominantly affected[23]Asthma remains a major cause of morbidity among school-age children worldwide, with deficiency of vitamin D increasingly recognized as a modifiable factor influencing immune regulation

and respiratory health[24]Excess adipose tissue predisposes to an enhanced inflammatory state and can contribute to the pathogenesis and severity of asthma. Vitamin D has anti-inflammatory properties and low-serum levels are seen in children with asthma and in children with obesity[25]

6.1 EXCESSIVE INTAKE OF VITAMIN D

Excess amounts of vitamin D are toxic. Because vitamin D increases calcium absorption in the gastrointestinal tract, vitamin D toxicity results in marked hypercalcemia (total calcium greater than 11.1 mg/dL, beyond the normal range of 8.4–10.2 mg/dL), hypercalciuria, and high serum 25(OH)D levels (typically >375 nmol/l [150 ng/mL])[26]

7.PREVENTION

Vitamin D deficiency rickets is characterized by mineralization impairment in bone and cartilage of children caused by vitamin D deficiency in the body due to limited sunlight exposure and vitamin D intake. Vitamin D supplementation is recommended in developed countries. Low calcium intake is a risk factor for vitamin D deficiency rickets. For treatment, native vitamin D is used in developed countries[27]For infants 0–6 and 6–12 months of age, the adequate calcium intake is 200 and 260 mg/d, respectively. For children over 12 months of age, dietary calcium intake of <300 mg/d increases the risk of rickets independent of serum 25OHD levels. For children over 12 months of age, the panel recommends the following classification of dietary calcium intake. Sufficiency, >500 mg/d. Insufficiency, 300–500 mg/d. Deficiency, <300 mg/d[28] Dental caries represents one of the most prevalent health problems in childhood. Numerous studies have assessed that vitamin D deficiency is highly related to dental caries in primary and permanent teeth in children.Vitamin D deficiency during pregnancy may cause intrauterine enamel defects, and through childhood is accompanied by insufficient activity of antibacterial peptides, decreased saliva secretion, and a low level of calcium in saliva[29] Nutritional Rickets can have a major impact on the health of infants, children, and adolescents, with ramifications that persist into adulthood. The morbidity and mortality associated with Nutritional rickets can be devastating, with substantial but poorly recognized consequences for society and health economics. Features of NR and osteomalacia include: 1) hypocalcemic seizures and tetanic spasms; 2) life-threatening hypocalcemic cardiomyopathy; 3) bone pain and muscle weakness; 4) limb and pelvic deformities; 5) failure to thrive; 6) developmental delay; and 7) dental anomalies[30]

8.DISCUSSION

The main goal of this survey was to evaluate the environmental and dietary factors contributing to the the risk of Vitamin D deficiency.

8.1 SUN EXPOSURE VS SUN PROTECTION

Vitamin D concentrations increase with sun exposure. Vitamin D synthesis depends on factors including age, skin pigmentation, amount of skin exposed, time of year, and time of day. It has been stated that at least 20% of the body surface needs to be exposed to UVB for vitamin D concentrations to increase[31]. Data has shown that majority of children(85.4%) spend time outdoor, however the alarming point was observed that no measures were taken regarding sun protection. A statistically significant 70.7% of participants reported that they “never” use sunscreen while only 7.3% “always” use sunscreen. This shows a dangerous disconnect between sun exposure and sun protective health behaviour. Sunscreens reduce the intensity of UVR affecting the epidermis, thus preventing erythema and sunburn. Many sunscreen agents approved by the US Food and Drug Administration are organic chemicals that absorb various wavelengths of UVR, primarily in the UVB range; many are also effective in the UVA range[32]

8.2 Dietary Intake of Vitamin D Enrich Foods

As data shows that sun protective measures were absent, through diet it may be able to compensate for potential vitamin d synthesis.Natural dietary vitamin D sources are limited (e.g., fish, egg, and mushrooms)[33]and for many, the main sources are fortified foods (e.g., cow milk and infant formula).

As such, the toddler stage of development (age 1–3 y) represents a time when young children may be at a higher risk of vitamin D deficiency because they no longer consume infant formula or take vitamin D supplements.[34] A failure to achieve adequate vitamin D status during childhood can impair growth[35]

8.3 Nutritional Status (Bmi)

we found a potential inverse association between elevated childhood obesity and 25(OH)D levels, which suggested that obese children need to pay attention to their 25(OH)D levels, and vitamin D supplementation may be necessary when needed[36]

8.4 LIMITATIONS OF STUDY

This study is not without limitations. First, the sample size (N=41) is relatively small, which limits the statistical power of our tests. Second, the data was collected via a self-reported survey (or parent-reported, given the ages), which is subject to recall bias; participants may overestimate their healthy behaviors or underestimate their sun exposure.

9.CONCLUSION

Vitamin D is essential for the healthy growth and development of children, particularly for maintaining bone health and proper calcium metabolism. The findings of this study highlight several dietary and environmental factors that may contribute to the risk of vitamin D deficiency among children under 15 years of age. Although the majority of participants reported daily milk consumption and regular outdoor exposure, fish consumption was relatively low, with more than half of the participants reporting that they never consumed fish. However, the relatively small sample size and the absence of laboratory measurements of serum vitamin D levels limit the conclusions that can be drawn regarding the actual vitamin D status of the participants. Furthermore, sunscreen usage was generally uncommon among the surveyed children. These findings emphasize the importance of maintaining a balanced diet containing vitamin D-rich foods, ensuring appropriate sunlight exposure, and promoting awareness among parents regarding childhood nutritional requirements and sun protective measures. Vitamin D supplementation should also be considered when clinically indicated

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