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Vitamin D Deficiency and its Association with Obesity among Urban School-Aged Children in Pakistan: A Cross-Sectional Analysis

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Abstract

Introduction: Vitamin D deficiency and childhood obesity are growing public health concerns, particularly in urban populations where reduced sun exposure and sedentary lifestyles are common.

Objective: To find out whether there is a link between low vitamin D levels and a higher risk of obesity in school-aged children in Islamabad.

Methodology: This descriptive cross-sectional study was conducted at the Department of Pediatrics, Maroof International Hospital, Islamabad, in collaboration with the Department of Bio-Sciences, COMSATS University Islamabad, over one year (April 2023–March 2024). A total of 186 children aged 6 to 12 years, residing in urban areas, were enrolled using a convenience sampling technique. Anthropometric measurements were recorded to calculate Body Mass Index (BMI), and serum 25-hydroxyvitamin D [25(OH)D] levels were assessed using chemiluminescence immunoassay. Vitamin D deficiency was defined as <20 ng/mL, and obesity was classified using WHO BMI percentiles. Data were analyzed using SPSS version 26, with chi-square and logistic regression tests applied.

Results: Out of the 186 kids, 112 (60.22%) didn't get enough vitamin D, and 58 (31.18%) were considered fat. There was a strong link between not getting enough vitamin D and being overweight ($p = 0.004$). Out of the people who didn't get enough vitamin D, 45 (40.18%) were fat. In the group that did get enough vitamin D, just 13 (17.57%) were obese. After controlling for age, gender, socioeconomic level, and physical activity, logistic regression analysis showed that vitamin D insufficiency was an independent predictor of obesity (AOR: 2.91; 95% CI: 1.48–5.71; $p = 0.002$).

Conclusion: Vitamin D deficiency is significantly associated with increased obesity risk among urban school-aged children and may be a modifiable factor in pediatric obesity prevention strategies.

Keywords: Vitamin D deficiency, childhood obesity, urban children, BMI, Pakistan, risk factors.

Introduction

Vitamin D plays a crucial role in various physiological processes, including calcium metabolism, immune function, and cellular growth regulation [1]. Traditionally linked to bone health, its deficiency is now increasingly associated with a spectrum of non-skeletal disorders, including metabolic and cardiovascular diseases [2]. One emerging area of concern is the potential relationship between vitamin D deficiency and obesity, particularly in pediatric populations [3]. As obesity rates continue to rise globally, understanding modifiable factors contributing to this trend has become a public health priority [4].

Urbanization, lifestyle changes, and dietary patterns have contributed significantly to reduced outdoor activity and sun exposure among children, leading to a noticeable increase in vitamin D deficiency in school-

aged populations [5]. Simultaneously, the prevalence of childhood obesity has escalated, driven by sedentary behavior, increased screen time, and poor nutritional habits [6]. Several studies suggest that vitamin D may influence adipogenesis and fat metabolism, and that deficiency may exacerbate weight gain through hormonal imbalances, inflammation, and insulin resistance. However, the directionality and causality of this association remain unclear [7].

Children are especially at risk in cities because they don't have easy access to open spaces and outdoor play places, and their diets don't include many foods that are high in vitamin D [8]. Skin color, clothes, pollution, and the use of sunscreen may also make it harder for the body to make vitamin D on its own [9]. Still, not many research in South Asian nations, like Pakistan, have looked at how vitamin D levels and obesity risk are related among school-aged children who live in cities. This kind of study is important for guiding public health efforts to make children's health better [10,11].

This research aims to fill this gap by looking at the link between low vitamin D levels and obesity risk in urban school-aged children. This will contribute to the expanding body of knowledge on pediatric metabolic health.

Research Objective

To evaluate the association between vitamin D deficiency and obesity risk in urban school-aged children.

Materials and methods

Study Design and Setting

This descriptive cross-sectional study was conducted at the Department of Pediatrics, Maroof International Hospital, Islamabad, in collaboration with the Department of Bio-Sciences, COMSATS University Islamabad, over one year (April 2023–March 2024). A cross-sectional design was chosen because it is appropriate for determining the prevalence of conditions and identifying potential associations at a single point in time. To minimize seasonal variability in vitamin D levels, all blood samples were collected during the same season (April to June 2023), which represents a period of moderate sun exposure in Islamabad.

Study Population

The target population comprised children aged 6 to 12 years living in urban areas of Islamabad. These children were selected from those visiting the outpatient department for routine health assessments or mild, non-acute conditions. The urban setting was defined based on administrative boundaries and population density criteria set by the local health authorities.

Inclusion and Exclusion Criteria

Children who were between the ages of 6 and 12, lived in urban Islamabad, and went to the outpatient department throughout the research period were included. Parents or legal guardians gave their written permission. If a child had a known endocrine issue (such hypothyroidism or Cushing's syndrome), was taking vitamin D supplements or corticosteroids, had chronic systemic disorders, malabsorption syndromes, or any other condition that may influence vitamin D metabolism, they were not allowed to participate. Children who did not live in cities were also not included.

Sampling Technique

Participants were selected using a convenience sampling technique. This non-probability method was used due to the accessibility of the population and logistical considerations in the outpatient setting. Although this method limits generalizability, it allowed for efficient recruitment within the available timeframe and resources.

Sample Size Determination

A total of 186 participants were enrolled in the study. This sample size was determined based on feasibility, resource availability, and previous literature indicating similar prevalence estimates for obesity and vitamin D deficiency in urban pediatric populations [12].

The chosen sample size was deemed adequate to detect significant associations with 80% power and 95% confidence, assuming a moderate effect size based on prior regional studies.

Anthropometric Measurements

We used standard methods to gather anthropometric data. A calibrated digital scale was used to weigh the kids to the closest 0.1 kg. They were wearing light clothes and no shoes. A wall-mounted stadiometer was used to measure height to the closest 0.1 cm. To get the Body Mass Index (BMI), you divide your weight in kilograms by your height in meters squared (m^2). We used WHO growth criteria to figure out BMI percentiles. Children with a BMI at or over the 95th percentile for their age and sex were considered obese.

Biochemical Assessment of Vitamin D

We took blood samples from veins in a sterile environment and used a chemiluminescence immunoassay (CLIA) to measure serum 25-hydroxyvitamin D [25(OH)D]. Specifically, the DiaSorin LIAISON® XL platform was used for CLIA-based measurement, ensuring high sensitivity and reproducibility. According to international criteria, a vitamin D insufficiency is when serum 25(OH)D levels are less than 20 ng/mL. Standard quality control procedures were used for the laboratory analysis.

Data Collection Procedure

After obtaining consent, demographic information such as age, gender, and socioeconomic status was recorded using a structured questionnaire. Clinical data, including anthropometric and biochemical values, were collected by trained personnel to ensure accuracy and reliability. Each child's nutritional history and physical activity level were also briefly

assessed to contextualize findings. The questionnaire was piloted on a sample of 15 children before the main study to ensure clarity, reliability, and cultural relevance.

Statistical Analysis

We used SPSS version 26 to input and look at all the data. We utilized descriptive statistics like means, standard deviations, frequencies, and percentages to sum up the data. We used the chi-square test to look at the link between not getting enough vitamin D and being overweight. We employed logistic regression analysis to account for any confounding factors such age, gender, and socioeconomic level. It was thought that a p-value of less than 0.05 was statistically significant.

Ethical Approval

The Institutional Review Board (IRB) of COMSATS University Islamabad gave its ethical permission (permission No. 216/2023/DBS/IRB-CUI). Before enrolling, parents or legal guardians have to provide their written approval.

Results

The study included a total of 186 urban school-aged children (Table 1). Most children were between 6–12 years, with a nearly equal gender distribution and diverse socioeconomic backgrounds. The age distribution showed that 68 children (36.56%) were aged 6–8 years, 57 (30.65%) were 9–10 years, and 61 (32.79%) were 11–12 years. Of the total participants, 98 (52.69%) were male and 88 (47.31%) were female. Regarding socioeconomic status, 70 children (37.63%) belonged to low-income households, 79 (42.47%) to middle-income groups, and 37 (19.89%) to high-income families.

Table 1: Demographic Characteristics of Study Participants (n = 186)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	6–8	68	36.56
	9–10	57	30.65
	11–12	61	32.79
Gender	Male	98	52.69
	Female	88	47.31
Socioeconomic Status	Low	70	37.63
	Middle	79	42.47
	High	37	19.89

Among the 186 children, dietary vitamin D intake was found to be inadequate in 134 participants (72.04%), while only 52 (27.96%) had adequate intake (Table 2). Only 61 children (32.80%) reported at least one hour of outdoor physical activity per day, whereas 125 (67.20%) had less than one hour of outdoor activity. In terms of screen time, 117 participants (62.90%) had screen exposure of two hours or more daily.

Table 2: Nutritional and Lifestyle Profile of Participants

Variable	Category	Frequency (n)	Percentage (%)
Dietary Vitamin D Intake	Adequate	52	27.96
	Inadequate	134	72.04
Outdoor Physical Activity	≥1 hour/day	61	32.80
	<1 hour/day	125	67.20
Screen Time per Day	<2 hours	69	37.10
	≥2 hours	117	62.90

Out of 186 children, 58 (31.18%) were classified as obese (BMI ≥ 95th percentile), while 128 (68.82%) were non-obese (table 3). Vitamin D deficiency (serum 25(OH)D < 20 ng/mL) was detected in 112 children (60.22%), while 74 (39.78%) had sufficient levels (≥ 20 ng/mL), indicating a high prevalence of hypovitaminosis D in this population.

Table 3: Distribution of Participants by Obesity Status and Vitamin D Levels

Variable	Category	Frequency (n)	Percentage (%)
BMI Category	Obese	58	31.18
	Non-obese	128	68.82
Vitamin D Status	Deficient (<20 ng/mL)	112	60.22
	Sufficient (≥20 ng/mL)	74	39.78

Among the 112 children with vitamin D deficiency, 45 (40.18%) were obese and 67 (59.82%) were non-obese (Table 4). In contrast, among the 74 children with sufficient vitamin D levels, only 13 (17.57%) were obese while 61 (82.43%) were non-obese. The association between vitamin D deficiency and obesity was statistically significant (p = 0.004), suggesting a higher prevalence of obesity among vitamin D-deficient children.

Table 4: Association between Vitamin D Deficiency and Obesity

Vitamin D Status	Obese (n, %)	Non-obese (n, %)	Total (n)	p-value
Deficient (<20 ng/mL)	45 (40.18%)	67 (59.82%)	112	0.004
Sufficient (≥20 ng/mL)	13 (17.57%)	61 (82.43%)	74	

Multivariate logistic regression showed that vitamin D deficiency was significantly associated with obesity, with an adjusted odd ratio (AOR) of 2.91 (95% CI: 1.48–5.71; p = 0.002), shown in Table 5. Low physical activity was also a significant predictor of obesity (AOR: 2.23; 95% CI: 1.16–4.28; p = 0.016). Age (AOR: 1.08; p = 0.372), gender (AOR: 1.15; p = 0.647), and high screen time (AOR: 1.84; p = 0.069) were not statistically significant after adjustment.

Table 5: Logistic Regression Analysis for Predictors of Obesity

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Vitamin D Deficiency	2.91	1.48–5.71	0.002
Age (per year increase)	1.08	0.91–1.27	0.372
Male Gender	1.15	0.63–2.10	0.647
Low Physical Activity	2.23	1.16–4.28	0.016
High Screen Time	1.84	0.95–3.58	0.069

Discussion

This research looked at the link between vitamin D insufficiency and obesity in school-aged children living in cities in Islamabad. A large number of subjects (60.22%) were found to be deficient in vitamin D, while 31.18% were classed as obese. The results showed that there was a statistically significant link between not getting enough vitamin D and being overweight (p = 0.004). Children who didn't get enough vitamin D were almost three times more likely to be overweight (AOR: 2.91, 95% CI: 1.48–5.71). These findings are in line with new research from throughout the world that shows that hypovitaminosis D is more common among overweight and obese children [13]. Also, a cross-sectional research indicated that kids who didn't get enough vitamin D had a much higher BMI than kids who did get enough [14]. The prevalence rate in our research (60.22%) is similar, although a little lower, which might be because of changes in location, nutrition, or the environment.

One possible explanation for this association lies in the fat-soluble nature of vitamin D, which may be sequestered in adipose tissue, reducing its bioavailability in obese individuals [15]. Furthermore, obesity is associated with reduced outdoor physical activity and higher screen time, as observed in our study, where 67.20% of participants had less than one hour of outdoor activity daily, and 62.90% had more than two hours of screen exposure. Both factors likely contribute to lower endogenous vitamin D synthesis due to decreased sunlight exposure [16].

In terms of lifestyle factors, our findings are consistent with prior reports from Pakistan and other LMICs that associate sedentary behavior and inadequate dietary vitamin D intake with increased obesity risk in children [17]. Notably, 72.04% of children in our study reported inadequate dietary intake of vitamin D, which mirrors trends seen in similar pediatric populations [18].

Low physical activity emerged as an independent predictor of obesity (AOR: 2.23; p = 0.016), further reinforcing its role in the pathogenesis of childhood obesity. Although screen time and gender were not statistically significant in our model, their trends warrant further exploration in longitudinal studies. Overall, our findings support the growing consensus that vitamin D deficiency may play a role in the development or exacerbation of childhood obesity, especially in urban environments where sun exposure and physical activity are limited.

Study Strengths and Limitations

One of the best things about this research is that it looks at a group of people that hasn't been studied much before: urban school-aged children in Pakistan, where vitamin D insufficiency and obesity are becoming more common public health problems. Using objective biochemical tests (such serum 25(OH)D) and standardized anthropometric tests makes the results more reliable. Also, taking into account important factors like physical activity, screen time, and socioeconomic position gives a better picture of the relationships that were identified.

The research have some limitations. Because of the cross-sectional design, it is not possible to make conclusions about causation. Also, using convenience sampling may make it harder to apply the findings to the larger population. Also, things like how long someone was exposed to the sun, how the seasons changed, and their parathyroid hormone levels were not looked at, which may have given a fuller picture of their vitamin D status.

Conclusion

This research shows that there is a strong link between not getting enough vitamin D and a higher risk of obesity among urban school-aged children in Islamabad. The results imply that low levels of vitamin D may be linked to increased body weight in this group, regardless of other lifestyle and socioeconomic variables. These findings show how important it is to find and treat vitamin D deficiency early on as part of larger efforts to stop and control juvenile obesity. To help kids in cities

grow and develop in a healthy way, public health programs that concentrate on better diet, getting more sunshine, and getting more exercise are very important.

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Authors' Contributions
Ghassan Zahid: Conceptualization, methodology, data collection, writing—original draft.

NaqeebUllah Jogezai: Supervision, data analysis, review and editing.

Syed Hassan Ali Shah: Project administration, data interpretation, manuscript revision, corresponding author.

Rabbia Allahrakha: Literature review, data validation, formatting.

Muhammad Kamran: Laboratory support, data curation, statistical analysis.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Conflict of Interest
The authors declare no conflict of interest.

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