ORIGINAL ARTICLE

Vitamin D Deficiency Among Primary School Children in Mosul City, Northern Iraq

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ABSTRACT

Introduction: Although vitamin D deficiency among young children is widespread, deficiency status may vary among regions. Data on the prevalence of vitamin D deficiency among children in Mosul city are lacking. This study aimed to determine the prevalence of vitamin D deficiency among primary school children in Mosul city, North Iraq. **Methods:** This cross-sectional study was conducted in the government primary schools in Mosul city over the period from February to May 2019. Multistage random sampling technique was applied; four governmental primary schools in Mosul city were selected. A representative sample size of 1072 children, aged between 6 and 12 was enrolled, serum 25OHD was analyzed in all the participants. **Results:** Vitamin D deficiency (25OHD < 12 ng/ml) was found in 59.7% of children, vitamin D insufficiency (25OHD 12-19 ng/ml) was evident in 33.8% of children, whereas only 6.3 % of children had vitamin D sufficiency (25OHD ≥ 20 ng/ml). Boys had significantly higher levels of 25OHD compared to girls, ($p = 0.0001$). There was no significant difference in 25OHD concentrations in relation to parental education. There was a weak reverse significant correlation between body weight and 25OHD concentrations, ($r = -0.117$, $p = 0.000$). **Conclusion:** Only 6.3 % of primary school children in Mosul city had sufficient vitamin D status. Vitamin D supplementation to primary school children is essential.

Keywords: Primary school children, Vitamin D, Mosul city

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INTRODUCTION

Numerous studies have revealed that vitamin D deficiency is a worldwide health issue (1-4). In Middle East; a remarkable prevalence of vitamin D deficiency has been demonstrated in children (4, 5). Reports from Saudi Arabia, Kuwait and the United Arab Emirates and some cities in Iraq revealed the prevalence of vitamin D deficiency (4, 6-8).

Despite its abundant sunshine, allowing vitamin D synthesis around the year, the Middle East; records the lowest levels of 25(OH) D and the highest vitamin D deficiency rates worldwide. This significant public health problem affects individuals across all life stages, including children (9) Vitamin D deficiency was prevalent in 28.9% of Qatari children aged 5-10-year-old (10). Variable 25(OH) D deficiency was reported in 86.3% of children aged 4-15 years living in Jeddah (11). Most of the children (93.4%) In Bahrain had low vitamin D levels, Primary-school children in Bahrain were more vitamin D deficient than preschool children in Bahrain (12). Vitamin D deficiency was observed in 5.6% of Elementary School Children in Turkey whereas insufficient 25(OH)D levels were found in 18.6% of children (13). In Tehran, 25(OH)D level was below 20 ng/ml in 54% of girls and in 11% of boys among children aged 7–18 years (9).

The presence of vitamin D receptor in most cells and the expression of the 1α-hydroxylase enzyme CYP27B1 in various cells and the great number of genes under the control of 1α,25(OH)2D imply a wider role of the vitamin D beyond bone and calcium homeostasis. Furthermore, such potential effects on non-skeletal outcomes are in line with data about association studies between low vitamin D status and cardiovascular diseases, diabetes, metabolic syndrome; inflammatory, infectious, immune disorders and autism, and a variety of cancers. A low vitamin D status associated with increased mortality risks had been extensively reviewed (14-16).

Despite the known importance of vitamin D in many aspects of children's health (1, 2), and a very high prevalence of vitamin D deficiency in the majority of children and adolescents between 6 and 15 years of age (17). There is a lack of population-based studies in

Mosul city and gaps in studies in children, hinder the development of age-specific knowledge concerning the prevalence of this critical issue. This study aimed to determine the prevalence of vitamin D deficiency among primary school children in Mosul city, North Iraq

MATERIALS AND METHODS

Participants

The study was cross-sectional, aimed to estimate the prevalence of vitamin D deficiency among governmental primary school children aged 6 – 12 years old in Mosul city.

Mosul city is a chief city in the north of Iraq. Situated nearly 400 km to the north of Baghdad, it has "Left Bank" (The east side) and the "Right Bank" (The west side), as the two sides are labeled according to the direction in relation to Tigris. Mosul has a Mediterranean climate, with hot dry summers in June, July and August while it has rainy, comparatively cold winters in December, January and February (18).

The assessment was accomplished over the period from February to May 2019. Ethical approval was obtained from the ethical research committee of Ministry of Health and Environment, Nineveh health directorate, training center and human development, in its session numbered 183 which is audited on 3/4/2019. Signed informed consents were obtained from parents of all the included participants in this study.

All participants aged 6-12 years in the chosen classes of selected schools were included in the study. As reported in students' archive of the school, children with documented chronic disease were excluded from the study. Parents who refused to include their children in the study were also excluded.

Sampling Technique

There are 638 government primary schools in Mosul city, 340 in the left bank and 298 in the right bank. A representative sample size of primary school children in Mosul city was planned to be enrolled in this study. Multistage random sampling technique is designed, the first stage involves a geographical stratification into left and right side of Mosul city to involve both sides. The second stage includes gender stratification, to select boy schools and girl schools. Lot randomization was performed to select schools on each side. Classes in each school were officially labeled alphabetically started from class A as the first class in each grade, grading stratification, to choose a cluster of second class of each grade in the school, whereas in school with one class per grade; the available class was selected. Accordingly, four schools were selected: two in the left bank and two in the right bank, two for boys and two for girls. Finally, all the consent participants in the selected classes will be enrolled in the study.

From each student, a sample of blood for vitamin D estimation was analyzed; student growth parameters were measured. BMI specific for age and gender were assessed using WHO Growth reference data for 5-19 years (19). The corresponding WHO Growth chart cutoff percentiles were used, which result in classification of children into three categories; children with BMI < 3rd percentile which is equal to <-2SD and considered as thin, children with BMI between 3rd and 97th percentile and considered as normal, and children with BMI percentile > 97th percentile which is equal to > +2SD and considered as obese. Demographic data of the student's family was recorded using the student's archive in the school.

Sample Size Estimation

Minimal required sample size = D $[Z\alpha/2^2 * p*(1-p)/ MOE^2]$.

Where:

D is design effect = 2 was applied to account for increased variance caused by multistage sample technique.

"$Z\alpha/2$ is the critical value of the normal distribution at $\alpha/2$ (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96)",

P is the expected prevalence of vitamin D deficiency in children, from the previous researches in the region ranging from 50 – 80 % thus the prevalence of 60% was chosen.

MOE is the margin of error, 0.05 was chosen.

According to the above equation, the minimum required sample size = 738. Presumed non-response rate of 10 % (74), a sample size of 812 primary school participants is required to obtain the sample size.

Laboratory investigation

There are many definitions of vitamin D status according to various societies and organizations, most of these definitions recommended that a level of ≥ 20 ng/ml of 25(OH) D to be considered as sufficient or adequate vitamin D status which meet the needs of at least 97.5% of the population with regards to bone health. In contrast, a deficient level is < 12 ng/ml and a level between 12–19 ng/ml is insufficient level (3, 20-24).

Serum 25-hydroxyvitamin D level was analyzed, using VIDAS® 25 OH Vitamin D Total - BIOMERIEUX (France) kit which is used for the determination of serum 25-hydroxyvitamin D, by enzyme-linked fluorescent assay (ELFA) technique. Duplication of measurements was performed on a pilot sample (n = 35), resulting in 94.6% and 93.2% intra- and interassay precision, respectively.

Statistical Analysis

Data insertions were achieved using Microsoft Excel - version 2010. Statistics were executed via Minitab version 19 statistical packages. The descriptive statistics were described using the mean ± standard deviation

(SD) for measurable parameters that were normally distributed (using Anderson-Darling normality test).

Unpaired t-test for two means was employed in comparing parameters between two groups. Analysis of variance test (F-test) with Tukey's Pair-wise comparisons was employed for differences between the means levels of vitamin D among six classes. Pearson's (simple linear) correlation coefficient (r) was executed to estimate the magnitude and direction of the association between variables. Age, gender and BMI were included in the multivariate forward regression analysis model to minimize potential confounders' effect. A P value of ≤ 0.05 was considered statistically significant.

RESULTS

The 1072 enrolled participants constitute 0.3 % of the total primary governmental schools' participants (330 045) for the academic year 2018 – 2019.

The mean age ± SD of the 1072 participants was 8.5 ± 1.7 years, girls constituted 54.9 % of them. Normal BMI for age and gender; 3rd– 97th percentile; was found in 898 (83.8 %) of children. Approximately half (49.8 – 50.2 %) of the evaluated participants were from schools in each Mosul city bank. Less than 10% of parent's education fulfilled university or post graduate level, (Table I).

Table II shows the status of the primary school children, which 640 (59.7%) of them had vitamin D deficiency (<12 ng/ml), while 362 (33.8%) of analyzed children had vitamin D insufficiency (12-19 ng/ml), whereas only 68 (6.3%) children had sufficient vitamin D status (20-100 ng/ml).

The mean 25OHD level in serum was 12.3 ± 8.2 ng/ml. Boys had significantly higher levels of mean 25OHD compared to girls: 14.1 ± 9.4; 10.8 ± 6.7 ng/ml respectively, p = 0.000 (Fig. 1).

The participants in the 2nd classes of the primary schools have a significantly higher level of vitamin D (14.4 ± 10.2 ng/ml, p = 0.000) than compared classes, (Table III). There was a weak reverse significant correlation between body weight and vitamin D level in the primary school participants (r = - 0.117, p = 0.000).

Table IV showed the association between school, BMI-for-age percentiles and parental education on the level of vitamin D in the study sampled participants. The schools in the right bank of Mosul city showed a higher level of vitamin D than those on the left bank (12.7 ± 8.0 vs 11.8 ± 8.4 ng/ml) however this difference was non-significant, p = 0.065. Male (p = 0.223) and female (p = 0.730) participants who were below 3rd percentile for BMI-for-age had lower mean vitamin D status than compared groups. However, this difference was not significant. There was no significant difference in mean levels of vitamin D concerning parental education.

The Multivariate regression analysis model signified an association between age and gender from one side and vitamin D status form the other side (Table V), while BMI remained a non-significant factor; p = 0.217.

Table I: Demographic characteristics of the study sampled primary school children in Mosul-Iraq, 2019.

Parameters	Mean ± SD	Range
Age (years)	8.5 ± 1.66	6 – 12
Paternal age (years)	41.9 ± 6.91	26 – 70
Maternal age (years)	36.4 ± 6.46	21 – 55
Gender	**No.**	**%**
Boys	483	45.06
Girls	589	54.94
Percentiles (BMI-for-age)		
< 3rd	74	6.90
3rd – 97th	898	83.77
> 97th	100	9.33
Site of the school		
Left bank of Mosul city (2 schools)	538	50.19
Right bank of Mosul city (2 schools)	534	49.81
Paternal education level		
Illiterate	46	4.29
Primary school	686	64.00
Intermediate and secondary schools	239	22.29
University and post graduate	101	9.42
Maternal education level		
Illiterate	89	8.30
Primary school	752	70.15
Intermediate and secondary schools	200	18.66
University and post graduate	31	2.89
Total	**1072**	**100.0**

Table II: Prevalence of vitamin D deficiency in primary school children

Vitamin D (ng/ml)	No.	%
Deficiency (< 12)	640	59.70
Insufficiency (12-19)	362	33.77
Sufficiency (20-100)	68	6.34
Potential toxicity (> 100)	2	0.19
Total	**1072**	**100.00**

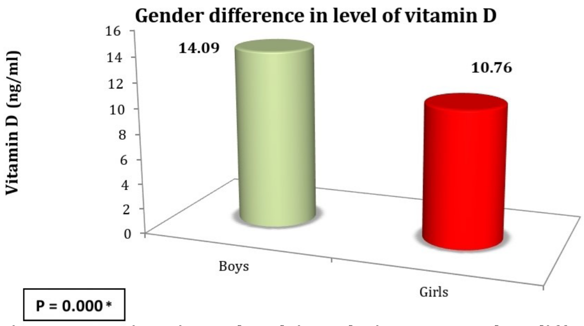

Figure 1: Vitamin D level in relation to gender difference among studied pupils (n = 1072). *independant t-test of two means was applied

Table III: The relationship between classes of primary school and levels of vitamin D

Classes of the school	No. of children	%	Vitamin D (ng/ml) Mean ± SD	p-value*
1st	136	12.69	13.58 ± 14.86 AB	0.000
2nd	213	19.87	14.37 ± 10.22 A	
3rd	213	19.87	11.72 ± 4.37 B	
4th	140	13.06	11.82 ± 7.69 B	
5th	191	17.82	11.01 ± 4.06 B	
6th	179	16.70	11.07 ± 3.79 B	
Total	**1072**	**100.00**	**12.26 ± 8.18**	---

* ANOVA-test (F-test) was applied. Means that do not share a letter are significantly significant.

Table IV: The effect of the site of school, percentiles and parental education on the level of vitamin D in the study sampled pupils

Items	No. [n = 1072]	Vitamin D (ng/ml) Mean*	SD	p-value*
Site of the school				
Left bank of Mosul city	538	11.8	8.37	0.065
Right bank of Mosul city	534	12.7	7.97	
BMI-for-age percentiles (BOYS)				
< 3rd	25	11.9	4.43	0.223
3rd – 97th	400	14.4	10.04	
> 97th	58	12.8	4.61	
BMI-for-age percentiles (GIRLS)				
< 3rd	49	10.2	3.63	0.730
3rd – 97th	498	10.9	7.18	
> 97th	42	10.3	3.83	
Paternal education level				
Illiterate	46	11.8	3.60	0.231
Primary school	686	12.5	7.89	
Intermediate and secondary schools	239	12.4	10.42	
University and post graduate	101	10.7	3.54	
Maternal education level				
Illiterate	89	11.6	4.69	0.327
Primary school	752	12.4	7.672	
Intermediate and secondary schools	200	12.4	10.68	
University and post graduate	31	9.9	3.43	

* ANOVA-test (F-test) was applied except for the site of the schools where independent t-test was performed.

DISCUSSION

Data on the prevalence of vitamin D deficiency among children are still lacking (25). Hypovitaminosis D still occur in sunny areas, with rates ranging between 30–90%, considering a desirable serum 25OHD of 20 ng/ml (26, 27). Current research in the Middle East, primarily in the Arabian Gulf region, has displayed remarkably low serum vitamin D values across age and gender (5). A Level that is less than 20 ng/ml was described to be present in 76.9% in Erbil city (7). A comparatively higher rate of Vitamin D insufficient status of below 20 ng/ml was found in 93.5% among studied primary school children. In addition to the well-known causes of vitamin D insufficiency, including a deficient vitamin D food and supplemental therapy, this higher rate of Vitamin D insufficient status can be explained by the presence additional local factors like the effects of dietary and financial constraint as well as the lengthy residence in houses during ISIS period and post ISIS unstable period of family's recommendations and dietary rehabilitation. The physical and social harm ensuing during ISIS occupation of Mosul and throughout the consequent military fighting (liberation) was significant, and its influence is doubtful to be erased in a short period (28). Vitamin D deficiency can differ among countries; these variances may be due to different feeding practices and lifestyle aspects among the residents (4).

Serum 25OHD deficient level below 12 ng /ml was found in 59.7% of enrolled children, consistent with other studies (29). Denoting that vitamin D deficiency status is a global issue. There was no significant difference between schools of the two banks of the city, reflecting the similarity of factors affecting vitamin D status in both locations.

Boys had significantly higher levels of 25OHD concentration than studied female, in accordance with other investigators (5, 30, and 31), this might be due to assumed more outdoor activity of males, with excess sun light exposure duration (26). Clothes are a principal blocker to sun exposure, leading to the reduction of 25OHD synthesis; females with eastern style wearing and those wearing hijab have lower levels of 25OHD (30). The participants in the 1st and 2nd classes of the primary schools had a higher level of vitamin D, data from the Middle East also have revealed that 25OHD decreases with age in children (5), in agreement with our finding.

There was no significant difference in levels of 25OHD in relation to paternal education, which suggests that the information regarding vitamin D requirement did not reach the parents or it was not applied. Moreover, it supports the finding of other researchers who found that vitamin D awareness needs to be emphasized by the provision of trained school teachers to alert participants and parents about vitamin D deficiency (31). Concordant with other research, a significant reverse correlation between body weight and vitamin D status was evident among studied children (32). In the other hand, there was no significant difference in 25OHD level in relation to BMI categories. Other investigators reached the same conclusion (9) therefore, the relationship between BMI and hypovitaminosis D is still debated (33).

Prior to this study, data about vitamin D status among primary school children in Mosul City was lacking, and this was the most important and vital point in this study. The study also highlights the need for vitamin D supplementation for the primary schools' children, which call for local support from related institutes like ministry of health, ministry of education, and local government. Furthermore, this study acts as a baseline study for future comparison research if the interventional supportive process is applied.

The 1072 enrolled participants constitute 0.3% of the total public primary schools' pupils (330 045) of the academic year 2018 – 2019. Although the sample was large and representative, the cost of investigation was the main limitation in front of the hope of including a larger sample of equal or more than 1% of local primary school children.

CONCLUSION

Serum 25OHD deficient level was found in two-third of primary school children in Mosul city, which warrants an emphasis on routine supplementation of vitamin D to primary school children.

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