

Correlation among Bone Health Profile, Vitamin D Status and Body Weight among Children and Adolescents in the Western Region of Saudi Arabia

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Abstract

Objective: Vitamin D deficiency related to obesity has significantly increased over the past 15 years and this has increased the risk for bone disease in children and adolescents. A sedentary lifestyle, with limited participation in outdoor activities, could exacerbate the effects of obesity on vitamin D deficiency. Therefore, the aim of our study was to evaluate the relationship between overweight/obesity and vitamin D deficiency among children in the western region of Saudi Arabia who have a relatively sedentary lifestyle due to high year-round temperatures.

Methods: We conducted a cross-sectional study including 218 participants (114 girls, 104 boys), 2 to 18 years old, evaluated in our ambulatory endocrine clinics in Jeddah, Saudi Arabia, between September 2015 and March 2016. Serum levels of vitamin D, phosphorus, calcium and alkaline phosphates were evaluated in relation to body weight.

Results: The mean age among children in our study group was 9.9 ± 3.9 years. A prevalence rate of vitamin D deficiency/insufficiency of 97.5% was identified (156/218 participants), with normal serum levels of vitamin D identified in only 4/218 participants (2.5%). Vitamin D levels were inversely related to body weight. High levels of alkaline phosphates were identified in 88.2% of participants, with levels of calcium and phosphorus being within normal ranges overall.

Conclusion: Based on our results, increased surveillance for vitamin D deficiency/insufficiency and alkaline phosphates levels in children who are overweight and obese should be considered. Moreover, as children and adolescents in the western region of Saudi Arabia typically have low sun exposure due to limited outdoor activities, vitamin D supplementation, as indicated by screening outcomes, could improve bone health outcomes in children who are overweight and obese.

Keywords: Vitamin D deficiency; Obesity; Bone health; Pediatrics

Introduction

The prevalence rate of obesity among children and adolescents has rapidly increased over the past 10 to 15 years, with an associated increase in the prevalence of vitamin D deficiency [1-4]. Considering that obesity is a risk factor for vitamin D deficiency [5-7] and that vitamin D is necessary for absorption of calcium in gut to maintain normal levels of serum calcium and phosphorus [8], then obesity is now considered as a risk factor for poor bone formation in children and adolescents. Vitamin D deficiency is further exacerbated by a decrease in the dietary intake of vitamin D and a low participation in outdoor activities [9]. The corollary effect of decreased outdoor activities on vitamin D deficiency could be a significant factor for children living in the western region of Saudi Arabia, where the temperature is high year round and a sedentary lifestyle is, therefore, the norm [10]. However, the possible correlation between a change in lifestyle, obesity, and vitamin D deficiency has only been considered in few studies [11-13]. Therefore, the aim of our study was to evaluate the relationship between overweight and vitamin D deficiency among children in the western region of Saudi Arabia who have a relatively sedentary lifestyle.

Methods

Participants

We are conducted a cross sectional study including 218 participants (114 girls, 104 boys), 2 to 18 years old, who were evaluated in our ambulatory endocrine clinics in Jeddah, Saudi Arabia, between

September 2015 and March 2016. Body weight was measured and used to classify participants based on the standard deviation of their body weight from age norm references, using the Boston Hospital Children Growth Calculator [14]. Serum levels of hydroxyvitamin D 25(OH)D, phosphorous, calcium and alkaline phosphates were measured using standard blood laboratory tests at King Abdul-Aziz University Hospital by using LIAISON[®] 25 OH Vitamin D assay, and Chemistry tests for calcium, phosphorus and ALP were done on Dimension instrument (Siemens Dimension RXL).

Our methods were approved by The Research Ethics Committee at King Abdul-Aziz University Hospital and participants, or their parent(s)/guardian(s), provided informed consent as appropriate for age.

Laboratory tests

The following normal ranges for serum levels of hydroxyvitamin

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D 25(OH) D, phosphorous, calcium and alkaline phosphates were used as a reference. For vitamin D, a serum concentration of 51-75 nmol/L was considered as the normal range, with insufficiency/deficiency defined by a concentration ≤ 25 -50 nmol/L. For calcium levels, a concentration of 2.2-2.62 mmol/L was considered normal, with hypocalcaemia defined as <2.2 mmol/L. For phosphorus, a concentration of 0.8-1.6 mmol/L was considered normal, with a high serum concentration defined as >1.6 mmol/L. For alkaline phosphates has normal range defined as 50-136 mmol/L and the high serum level was defined as >136 mmol/L.

Statistical Analysis

All data were entered, coded, and analyzed using statistical package for social science (SPSS, version 16). The distribution of the data was evaluated for normality, with log-transformation used as required. The correlation between body weight (kg) and levels of Vitamin D, Ca (calcium), Phos (Phosphorous), and ALP (Alkaline Phosphates) was evaluated independently for each variable. Qualitative variables were reported as proportions, with the mean \pm standard deviation calculated of quantitative variables. An independent sample *t*-test was used to evaluate vitamin D levels between males and females. For all analyzes, a *p*-value <0.05 was considered significant.

Results

Relevant characteristics of our study group and measured serum levels are reported in Table 1. Our study group consisted of 114 girls (52.3%) and 104 boys (47.7%), with a mean age of 9.9 ± 3.9 years (95% confidence interval (CI), 9.3 to 10.4 years). Serum levels of 25(OH) D ≤ 25 -50 nmol/L, indicative of vitamin D insufficiency/deficiency, were identified in 97.5% of participants, with a normal serum level of 25(OH)D identified in only 2.5% of participants (mean level, 26.4 ± 10.4 nmol/L). In regards to calcium, levels were normal in 91.7% of participants (199/217), with 18 (8.3%) having hypocalcemia (mean level, 2.33 ± 0.1 mmol/dl). Serum levels of PHOS were normal level 69.4% of participants (150/216), with hyperphosphatemia identified in 30.6% (66/216). Serum levels of ALP were assessed in 153 participants, with 11.8% showing normal levels, with 88.2% of participants having high serum levels of ALP (mean level, 241.6 ± 85.8 mmol/dl).

The inverse relationship between levels of ALP and PHOS is shown in Figure 1. The majority of participants had a high serum level of ALP, with a significant positive correlation between ALP levels and the standard deviation of weight from norm-reference values ($P=0.007$, $R=0.248$). In contrast, PHOS levels were inversely correlated to the log-transformed weight values ($P=0.046$, $R=0.144$). The inverse relationship between body weight and serum levels of vitamin D is shown in Figures 2 and 3.

Variables	Categories	n (%)
Sex	Male	104 (47.7%)
	Female	114 (52.3%)
Vitamin D	Low (≤ 50)	156 (97.5%)
	Normal (>50)	4 (2.5%)
Calcium	Low <2.2	18 (8.3%)
	Normal (2.2–2.62)	199 (91.7%)
PHOS	High >1.6	66 (30.6%)
	Normal (0.8–1.6)	150 (69.4%)
ALP	High >136	135 (88.2%)
	Normal (50–136)	18 (11.8%)

Table 1: Sex distribution of our study group and measured serum levels of vitamin D, calcium, phosphorous and alkaline phosphates levels.

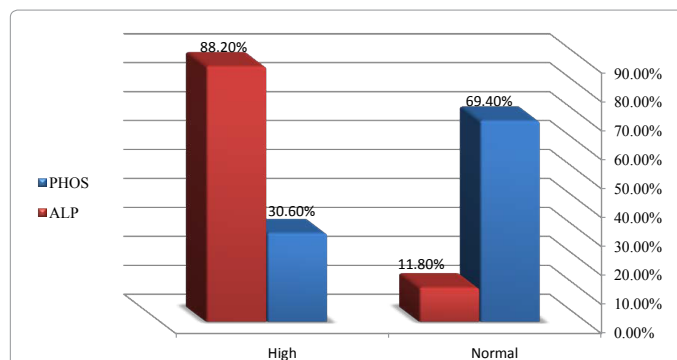


Figure 1: Bar graph showing the prevalence of f high serum level ALP and normal serum level PHOS among the participants.

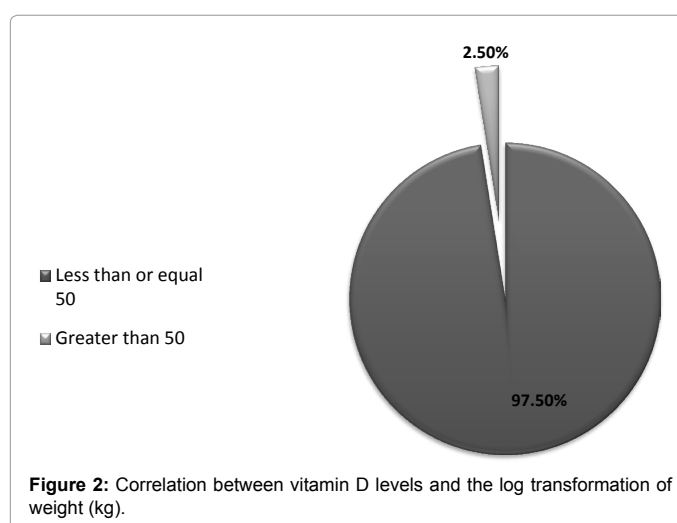


Figure 2: Correlation between vitamin D levels and the log transformation of weight (kg).

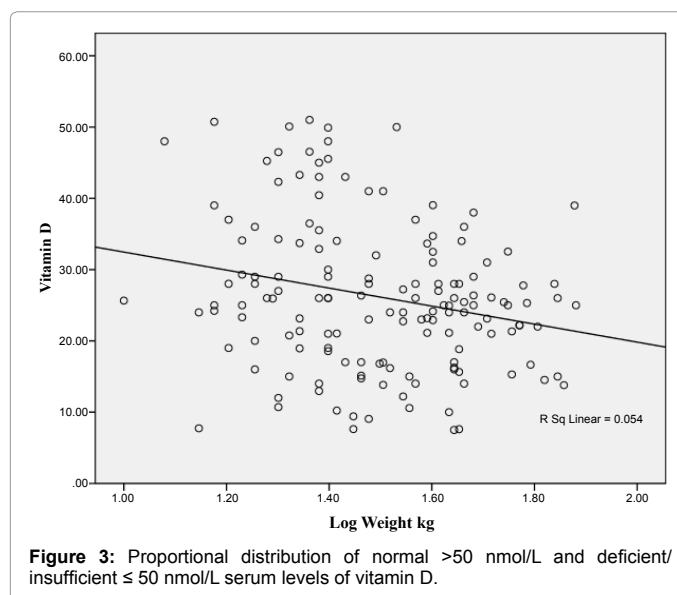


Figure 3: Proportional distribution of normal >50 nmol/L and deficient/insufficient ≤ 50 nmol/L serum levels of vitamin D.

Discussion

The high prevalence rate of vitamin D deficiency among children and adolescents in Saudi Arabia and the Middle East is a significant public health concern [15-19]. There is evidence that the rising incidence

obesity in children may be contributing to the increasing prevalence of vitamin D deficiency/insufficiency in this population, where 22.2% of children are considered as being overweight, 8.9% obese and 2% severely obese [20]. A similar trend between increasing childhood obesity and vitamin D deficiency/insufficiency has been reported worldwide, 78% of children in France considered to have low serum levels of vitamin D, 65% in Finland, 42% in Boston (United States) [10,21-25], 42% in Beijing, 47% in Greece, 46.2% in Iran and 29% in Switzerland [26-29]. A large United States based study of 12292 children and adolescents, 6 to 18 years old, evaluated between 2003 and 2006 (National Health and Nutrition Examination Survey), identified a prevalence rate of vitamin D deficiency of 2% among children and adolescents with a healthy body weight, 29% among those who were overweight and 34% among those who were obese [30]. A study of 148 children (87 boys and 61 girls), 6 to 13 years old, in Saudi Arabia reported a vitamin D deficiency in 96.7% of females and 78.2% of males, with overall normal serum levels of calcium and phosphorus, but high levels of ALP [31]. Our findings are comparable to these previously reported prevalence rates. A study of 187 children with rickets and osteomalacia (64 boys and 123 girls), 3 months to 16 years old, in Saudi Arabia reported that the rising in serum ALP is a sensitive marker for screening the rickets and osteomalacia.

The climate in western region of Saudi Arabia is hot through all seasons and, consequently, children tend to limit their outdoor activities with the low exposure to sunlight exacerbating vitamin D deficiency/insufficiency. A similar relationship between restricted outdoor activities and a high prevalence of vitamin D deficiency was reported among 402 children, 7 to 12 years old, in Malaysia where parents are concern about their children's safety when playing outside the home [8]. The importance of outdoor activities was raised by the American Academy of Pediatrics who recommended limiting television and computer use to <2 h per day for young children to encourage outdoor play activities [32]. These outdoor activities should be proper for their age groups, i.e., by age 2, toddlers in our study should be able to walk and run. They might be able to kick a ball and jump in place with both feet. By age, 3 and 4 toddlers can be balance briefly on one foot, kick a ball forward, throw a ball overhand, catch a ball with stiff arms, and pedal a tricycle. By age 6-18, these age groups, i.e., football, running, and basketball, can perform some common activities [33].

Conclusion

In our study, we report a high prevalence of vitamin D deficiency/insufficiency among children and adolescents in the western region of Saudi Arabia, with this deficiency positively correlated to increased body weight. Moreover, low serum levels of vitamin D were associated to high serum levels of ALP. Increasing awareness regarding the risk for vitamin D deficiency through targeted public education initiatives could provide an effective way to improve vitamin D levels, and overall bone healthy, in children and adolescents in the western region of Saudi Arabia, rather than relying on screening and supplementation programs that are costly and may not be accessible by all children and adolescents. Promotion of outdoor activities and of a healthy diet is necessary components for achieving sufficient vitamin D levels for bone health in pediatrics.

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