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Vitamin D Status of Healthy School Children from Western Saudi Arabia

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Abstract: This study was conducted to evaluate vitamin D in healthy school children from Makkah area. A total of 148 healthy school children (87 boys and 61 girls) were included in this study. Vitamin D as 25-hydroxyvitamin D [25 (OH)-D] was measured as indication of vitamin D status. Serum 25 (OH)-D less than 20 ng/ml was considered as vitamin D deficient subject. Other biochemical indicators were also measured as calcium, phosphorus, alkaline phosphatase and parathyroid hormone. The mean age of the subjects was 10.1 years. Overall serum vitamin D was 10.5 ng/ml, which was significantly higher in male group than female. About 96.7% and 78.2% of females and males were deficient in vitamin D, respectively. No sufficient vitamin D female subject was recognized. The prevalence of vitamin D deficiency in children school from Makkah was very high and the deficiency was higher in females than males. The main reason for vitamin D deficiency was the restriction to sunlight exposure.

Key words: Hypovitaminosis D, calcium, phosphorus, alkaline phosphatase, parathyroid hormone

INTRODUCTION

Vitamin D is a fat-soluble vitamin that is naturally present in very few foods, added to others and available as a dietary supplement. It is also produced endogenously when ultraviolet rays from sunlight strike the skin and trigger vitamin D synthesis (Misra *et al.*, 2008). Vitamin D is essential for promoting calcium absorption in the gut and maintaining adequate serum calcium and phosphate concentrations to enable normal mineralization of bone (Donath and Amir, 2005). Also, vitamin D has other roles in human health, including modulation of neuromuscular and immune function and reduction of inflammation. Many genes encoding proteins that regulate cell proliferation, differentiation and apoptosis are modulated in part by vitamin D (Deluca *et al.*, 2011).

Vitamin D deficiency can result from inadequate irradiation of the skin, insufficient dietary intake of the vitamin, or impairments in metabolic activation (hydroxylation) of the vitamin (Combs, 1998). Other factors potentially affect vitamin D status include genetic factors, adiposity and factors affecting the cutaneous synthesis of vitamin D such as skin pigmentation, age, season, latitude, melanin concentration, clothing and use of sunscreens (SACN, 2007).

Although hypovitaminosis D is a critical health problem, limited studies on vitamin D status in Arab countries have been performed. Masri and his colleagues (2005) reported that 33.5% of Jordanian women sample of 821 aged 20 to 89 years had vitamin D deficiency and 50.3% of the sample had vitamin D insufficiency. On the other hand, Al-Qaq (2000) observed clinical signs of vitamin D deficiency in 38 infants aged 3 to 4 months who were at high risk of developing nutritional rickets. The signs included bowing of the legs, wide anterior fontanelle, development delay and convulsions.

In Lebanon, Gannage-Yared *et al.* (2000) performed a study in 316 young people aged 30 to 50 years. It appears that 72.8% of this population is affected by vitamin D insufficiency and that it is significantly more common in women than in men (83.9% versus 48.5%). In another study, Fuleihan and his colleagues (2001) showed that 52% of the Lebanese school children aged 10 to 16 years were vitamin D insufficient.

Although Saudi Arabia receives abundant sunlight during the year, vitamin D deficiency is fairly common, especially in pregnant women, lactating mothers and their infants, because of minimal exposure to sun. Young children are kept indoors until they are independent, approximately up to two years of age, as their mothers are of the opinion that sun is harmful to the child (Elsammak *et al.*, 2010).

To the best of our knowledge, there are no detailed studies performed on the evaluation of vitamin D status in Makkah area (Western Province of Saudi Arabia). Therefore, the objectives of this study are to investigate the prevalence of vitamin D status among school children boys and girls, as well as determination the level of other biochemical indicators directly related to vitamin D status such as serum calcium, phosphorus, Parathyroid Hormone (PTH) and Alkaline Phosphatase (ALP).

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MATERIALS AND METHODS

Subjects: A sample of 148 healthy school children (87 boys and 61 girls) was recruited from health care clinical unit present in their schools. The samples were taken from 2 schools in Makkah city. The age of children was between 6-13 years. Exclusion criteria include hepatic or renal diseases, metabolic bone disease, malabsorption, type I and II diabetes, hypercortisolism, malignancy, immobility for more than one-week and medications influencing bone metabolism. Children were excluded if they were on vitamin D supplements before testing. Blood samples from the children were taken after having their parents consent.

Subjects were classified into 3 categories according to their vitamin D status: vitamin D deficiency is defined as a 25-hydroxyvitamin D [25 (OH)-D] level of less than 20 ng/ml (50 nmol/L), insufficiency of 25 (OH)-D is defined as a level of 25-hydroxyvitamin D of 21 to 29 ng/ml (52 to 72 nmol/L) and a level of 30 ng/ml or greater (more than 75 nmol/L) can be considered as sufficient vitamin D group (Holick, 2007). Sever deficiency of vitamin D can be recognized when 25 (OH)-D is less than 10 ng/ml (NIH, 2008). The latter group is not considered in the research.

Children's parents were asked to complete the questionnaire which consists of children exposure to sun light and their intake from foods rich in vitamin D such as milk, milk products, egg and cereals fortified with vitamin D.

Blood samples collection and biochemical analysis: One blood sample was taken from each student. Blood samples were saved in ice bag and moved to the laboratory where the separation of serum occurred at the sampling day. Separation blood samples were done in normal centrifuge at 4500 rpm for 6 minutes. The available serums were saved in freezer under -18°C for biochemical tests.

Two different instruments were used to fulfill the biochemical analysis. Chemistry tests for calcium, phosphours and ALP were done on Dimension instrument (Siemens Dimension RXL, German). On the other hand, hormone tests (vitamin D and PTH) were performed on fully-automated Elecsys instrument (Hitachi-Roche-Elecsys, 2010, USA). Each parameter was completed according to specific kit.

Statistical analysis: Statistical analysis was performed with SPSS software version 17. P-value less than 0.05 consider statistically significant. T-tests were used for comparison of differences and relation between the number of two parameters and more. Pearson correlation test was attained to determine the possible relation between vitamin D and other indicators.

RESULTS

As seen in Table 1, the mean age of male participants was 10.4 years and 9.6 years for females. The sample study was 148 subjects, 59% were males (n = 87) and 41% were females (n = 61). There was no significant difference between male and female groups with regard to their age and weight. The study group can be classified as vitamin D deficient category, with mean vitamin D equals 10.5 ng/ml. Mean vitamin D for female group was 7.7 ng/ml, which is under sever deficiency of vitamin D. There was a statistical difference ($p<0.05$) on vitamin D status between male and female group. Overall serum PTH, calcium and phosphorus were within the normal ranges, but ALP was higher than the normal range.

Figure 1 demonstrates the percentage of males and females with respect to their vitamin D status (deficient, insufficient and normal). The unexpected result was no normal serum vitamin D in female subjects, with only 11.5% (n = 10) normal male children. The majority of the sample was classified under deficient group with percentage of 96.7% (n = 59) and 78.2% (n = 68) for females and males, respectively.

Table 2 and 3 classify male and female groups with respect to their vitamin D status, respectively. There was a significant difference ($p<0.05$) on serum vitamin D levels between each subgroup. The deficient groups for both males and females were considered as sever vitamin D deficiency. As mentioned before, no normal subjects were detected in the female group, which means that vitamin D deficiency is a serious health problem for children females, as well as for males with lower extent.

Table 1: Characteristics of the sample study

Character	Group		
	Males (n = 87)	Females (n = 61)	Total (n = 148)
Age (years)	10.4±01.6	9.6±01.6	10.1±01.66
Weight (kg)	31.7±10.6	29.8±09.9	30.9±10.3
VD (ng\ml) (normal; $\geq$30)	12.4^{a}±11.4	7.7^{b}±05.7	10.5±09.7
Ca (mg\dl) (normal; 8.8-10.8)	10.1±00.5	9.7±00.5	9.9±00.5
P (mg\dl) (normal; 4.5-5.5)	4.9±00.6	4.9±00.7	4.9±00.7
PTH (pg\ml) (normal; 14-65)	43.1±18.0	48.7±21.7	45.4±19.7
ALP (u\L) (normal; 60-170)	243.4±89.6	237.2±55.7	240.9±77.3

- Results are considered as Mean±SD.
- Means with different superscripts are significantly different at $p<0.05$.
- Abbreviations; VD: Vitamin D as 25 (OH)-D, Ca: Calcium, P: Phosphorus, PTH: Parathyroid Hormone, ALP: Alkaline Phosphatase

Table 2: Descriptive data for the male group (n = 87) according to their vitamin D status

Character	Vitamin D status: Normal (n = 10)	Insufficient (n = 9)	Deficient (n = 68)
Age (years)	9.2±00.9	9.6±00.9	10.7±01.7
Weight (kg)	26.9^{b}±06.0	25.9^{b}±03.7	33.1^{a}±11.3
VD (ng\ml) (normal; ≥30)	37.6^{a}±08.1	23.2^{b}±01.6	7.3^{c}±04.6
Ca (mg\dl) (normal; 8.8-10.8)	10.3±00.5	10.0±00.3	10.0±00.5
P (mg\dl) (normal; 4.5-5.5)	5.1±00.6	4.8±00.7	4.9±00.6
PTH (pg\ml) (normal; 14-65)	41.4±18.4	41.3±11.5	43.6±18.8
ALP (u\L) (normal; 60-170)	265.5±45.4	212.6±68.2	244.3±96.3

- Results are considered as Mean±SD.
- Means with different superscripts are significantly different at $p<0.05$
- Abbreviations; VD: Vitamin D as 25 (OH)-D, Ca: Calcium, P: Phosphorus, PTH: Parathyroid Hormone, ALP: Alkaline Phosphatase

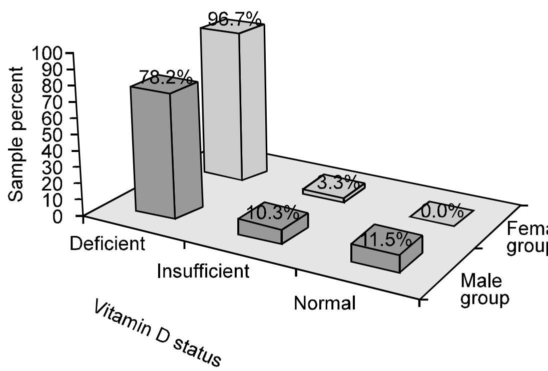

Fig. 1: Percentage of vitamin D status for each group

Table 3: Descriptive data for the female group (n = 61) according to their vitamin D status

Character	Vitamin D status: Insufficient (n = 2)	Deficient (n = 59)
Age (years)	12.0±00.0	9.5±01.6
Weight (kg)	28.0±00.1	29.9±10.0
VD (ng\ml) (normal; ≥30)	27.1^{a}±00.8	7.0^{b}±04.5
Ca (mg\dl) (normal; 8.8-10.8)	9.4±00.1	9.6±00.5
P (mg\dl) (normal; 4.5-5.5)	6.6^{a}±00.8	4.9^{b}±00.6
PTH (pg\ml) (normal; 14-65)	69.4±51.0	47.4±19.4
ALP (u\L) (normal; 60-170)	204.0±63.6	238.3±55.7

- Results are considered as Mean±SD.
- Means with different superscripts are significantly different at $p<0.05$
- Abbreviations; VD: Vitamin D as 25 (OH)-D, Ca: Calcium, P: Phosphorus, PTH: Parathyroid Hormone, ALP: Alkaline Phosphatase

Correlation test showed that there was a negative correlation but not significant between vitamin D and PTH. Subject weights showed a significant negative correlation ($p<0.05$) with vitamin D.

Questionnaire results demonstrated that children intake of food sources rich in vitamin D was high for both genders. The percentage of boys of their adequate daily intake according to food guide pyramid from milk, yoghurt, egg and fortified cereals was 95.4%, 96.2%, 94.2% and 35.4%, respectively. On the other hand, the corresponding intake of previous foods for female group was respectively shown as 95.0%, 96.6%, 96.6% and 95.8%. The exposure to sunlight was almost nil within female children and few percentage males were exposed to sun enough irradiation.

DISCUSSION

Vitamin D deficiency is the most common metabolic bone disease in the world, it is thought to be a multi factorial (Kelly *et al*., 2009). The most common symptoms of vitamin D deficiency are rickets in young children and osteomalacia in adult (Leanne *et al*., 2007; Whitney and Rolfes, 2008). As reported by many authors, sub-optimal vitamin D levels have been linked with many diseases, such as fibromyalgia, rheumatoid arthritis, systemic lupus erythematosus, multiple sclerosis, upper respiratory tract infections, premenstrual syndrome, polycystic ovary disease, psoriasis, muscle weakness, lower back pain, diabetes, high blood pressure and some types of cancer (DeLuca, 2004; Holick, 2007; Schwalfenberg, 2007; Damanhouri, 2009). Also, vitamin D deficient diets are associated with milk allergy, lactose intolerance and strict vegetarianism (NIH, 2008). Holick (2006) reported that vitamin D deficiency during childhood may imprint an increased risk of many chronic diseases for the rest of one's life. Therefore, the current study was focused on determination of vitamin D status for children school, because early detection of vitamin D deficiency can be easily managed before facing serious health consequences with age.

Researches on vitamin D status in Saudi Arabs were recognized from years. One research in Riyadh (capital of Saudi Arabia) by Faraj and Mutairi (2003) concluded that 83% of the study patients (n = 299) had an abnormally low level of vitamin D. Similar study which did by Al-Turki *et al*. (2008) on Saudi women between 25-35 years was concluded that vitamin D deficiency among them was 30% and 50% in older women. Previous researchers have been found that ALP and parathormone levels were significant higher in women with low vitamin D levels. Sadat-Ali and his colleague (2009) studied the level of vitamin D in Eastern region of

Saudi Arabia, which concluded that the prevalence of vitamin D deficiency among healthy Saudi men is between 28%-37%. Older study performed by Sedrani *et al.* (1983) observed that 73% of the male values of vitamin D and 30% of the female values below 10 ng/ml; sever vitamin D deficiency. Also, Fonseca *et al.* (1984) reported that from thirty-one adult Saudi Arabian females only 3 subjects had a vitamin D concentration within the normal range. Therefore, hypovitaminosis D in Saudi Arabia is an old new problem.

In the current study, normal level of vitamin D was only obtained in 6.8% from the total sample (10 normal /148 subjects) and normal ones were only from male group. The majority of sample had an abnormal level of vitamin D; insufficient and deficient were 93.2%. Abnormal percentages in male and female groups were 88.5% and 100%, respectively. These abnormal finding are the highest values as compared with the prevoius results. Athough the intake of children from food scources rich in vitamin D was high, foods are not the principale source for their adequacy for vitamin D. Sunlight exposure of the skin is known to be the most important source of vitamin D, which is able to supply the body with 80-100% of vitamin D daily requirements (Glerup *et al.*, 2000). Children exposure to sunlight was not enough to ensure their vitamin D requirements, mainly for females. Some of male children played outdoors but usually under shade places to prevent direct contact with the sun. Female children schools are completely covered from the sun, most transporting cars are sun-covered, as well as walking with their parents out of houses only after sunset and inside malls and buildings. All these conditions increase the occurrence of vitamin D deficiency between children. Some researchers have been shown that veiled women are at high risk of vitamin D deficiency (Glerup *et al.*, 2000). On the other hand, Sedrani *et al.* (1983) concluded that vitamin D of veiled Saudi female students was sufficient. So, Arabic veiled may reduce the exposure to sun irradiation, but it's not the real problem for hypovitaminosis D, which could be contributed in limitations to sun exposure.

With regard to other biochemical tests, most of them were within the normal ranges. This result was in agreement with Mahdy *et al.* (2010) findings to the effect that serum levels of calcium, phosphorus and alkaline phosphatase were not sufficiently reliable in predicting hypovitaminosis D. There was a negative considerable correlation between weight and vitamin D and this correlation was clearly seen in male results than females. Weiler *et al.* (2005) concluded that vitamin D deficiency among infants was associated with greater weight and height, which is in line with the study result.

Conclusion: Vitamin D deficiency is a critical health problem in Saudi Arabia and especially in Makkah area. The main result for hypovitaminosis D is short exposure to sunlight rather than inadequate consumption of foods high in vitamin D content. We encourage having national effective procedures to increase public nutritional awareness to vitamin D deficiency and how to reduce the incidence of hypovitaminosis D in the future.

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