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Article *in* Journal of Tropical Pediatrics · September 2008

DOI: 10.1093/tropej/fmn078 · Source: PubMed

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Brief Report

Vitamin D Insufficiency among Children and Adolescents Living in Tehran, Iran

by Ali Rabbani,[a] Seyed-Moayed Alavian,[b] Mohammad Esmaeil Motlagh,[c] Mohammad T. H. Ashtiani,[d] Gelayol Ardalan,[e] Ali Salavati,[a] Bahareh Rabbani,[a] Ahmad Rabbani,[a] Sedigheh Shams,[d] *and* Nima Parvaneh[a]

[a]*Growth and Development Research Center, Tehran University of Medical sciences, Tehran, Iran*

[b]*Liver and Gastrointestinal Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran*

[c]*Bureau of Family Health, Ministry of Health and Medical Education, Tehran, Iran*

[d]*Department of Pathology, Children's Medical Center, Tehran University of Medical sciences, Tehran, Iran*

[e]*Youth & School Health Office, Ministry of Health and Medical Education, Tehran, Iran*

Summary

Vitamin D is important for calcium absorption and skeletal growth. Vitamin D insufficiency (VDI) is a prevalent health problem in children. A study was performed to determine the prevalence of VDI in healthy children living in Tehran, Iran. In a cross-sectional study, 963 students (424 boys and 539 girls) aged 7–18 years were selected by random sampling. Serum 25-hydroxyvitamin D (25-OHD), calcium, alkaline phosphatase and phosphorus were measured. VDI was defined as serum 25-OHD <20 ng/ml. Prevalence of VDI was 53.6% in girls and 11.3% in boys. VDI in female students was about five times more common than males ($p < 0.000001$). VDI in children and adolescent girls is a health problem not only for these age-groups but also for the next generation to come. Encouraging girls to have more sun exposure, fortification of foods and prescription of supplemental vitamin D are recommended.

Key words: vitamin D, insufficiency, children.

Introduction

During childhood and adolescence, vitamin D is important for calcium absorption and skeletal growth. In addition to its effects on normal bone turnover, prevention of rickets in children, and mineralization during adulthood, vitamin D may confer protection against insulin-dependent diabetes mellitus, hypertension and cancer [1].

Vitamin D plays an integral role in bone mineralization by promoting calcium absorption in the small intestine and stimulating osteoblastic activity to maintain serum calcium and phosphorus levels in the normal range [2].

Vitamin D insufficiency (VDI) is an unrecognized and prevalent health problem in children and adolescents [3–5]. Serum 25-hydroxyvitamin D (25-OHD) level is the best measure of Vitamin D status. 25-OHD levels should be maintained at >15 ng/ml to maintain normal skeletal dynamics [6]. Few data are available regarding the prevalence of this nutritional deficiency among healthy Iranian children and adolescents [7, 8].

The aim of this study is to determine the prevalence of VDI among Iranian healthy students aged 7–18 years, living in Tehran.

Subjects and Methods

We selected 963 healthy children, aged 7–18 years, based on a randomized clustered sampling from the public and private schools located in urban Tehran during winter months. All of the students belonged to mid-socioeconomic class and had regular diet popular in Iran. All of the participated girls were veiled outdoors based on Islamic rules.

We used the following exclusion criteria: chronic illness, current vitamin D supplement intake and use of medications known to affect bone metabolism. A written consent was provided for all parents.

Acknowledgements

We would like to thanks laboratory staffs Mrs Heshmat Irani, Ameneh Mohseni and Fahimeh Jafari.

Correspondence: Ali Rabbani, Growth and Development Research Center, Children's Medical Center, 62 Gharib St, 14155-6386 Tehran, Iran. Tel.: +98 21 66428998; Fax: +98 21 66923054; E-mail <rabania@sina.tums.ac.ir>.

doi:10.1093/tropej/fmn078 Advance Access Published on 5 September 2008

A venous blood sample (10 ml) was taken from all participants at Children's Medical Center.

Serum 25-OHD levels were determined by radio-immunoassay (BioSource Europe S.A., Belgium). Inter- and intra-assay coefficients of variation (CV) were 3.3 and 5.2%, respectively.

VDI was defined as serum 25-OHD <20 ng/ml. A serum level of 25-OHD <8 ng/ml was defined as severe, 8 ≤ 25-OHD <15 ng/ml as moderate and 15 ≤ 25-OHD <20 ng/ml as mild VDI [6, 9].

Also a cut-off point of 25-OHD <32 ng/ml, previously estimated for Iranian children, was used for comparison [8].

Serum calcium, phosphorus and alkaline phosphatase (ALP) levels were measured by a colorimetric method (Maan, Iran). The inter- and intra-assay CVs of serum calcium were 3.1 and 2.2%; for phosphate, 3 and 2.5%; and for ALP, 8.3 and 4.7%, respectively.

SPSS software (version 16; USA) was used for data analysis. Values for results were expressed as means ± SD. Comparison between groups was done using independent Student's *t*-test. *p*-values <0.05 were considered statistically significant.

Results

The mean (SD) serum level of 25-OHD was 46.53 (21.63) ng/ml in males and 24.174 (18.46) ng/ml in females ($p < 0.00001$). The mean levels of 25-OHD of different ages are shown in Fig. 1. The mean serum level of 25-OHD diminishes with advancing age in Iranian girls ($r = -0.389$, $p < 0.001$).

The prevalence of VDI in all students was 34.9% (25-OHD <20 ng/ml). Prevalence of VDI was 53.6% ($n = 289$) in girls and 11.3% ($n = 48$) in boys. VDI in female students was about five times more common than in males (OR = 9.05, 95% CI = 6.41–12.78, $p < 0.000001$). The prevalence of severe VDI (25-OHD <8 ng/ml) was 11.3% ($n = 61$) in girls and 0.9% ($n = 4$) in boys. The prevalence and severity of VDI in Iranian children are shown in Table 1. When assuming 25-OHD levels below 32 ng/ml as reported previously for Iranian children, the prevalence of VDI was 76.8% ($n = 414$) in girls and 25.7% ($n = 109$) in boys.

The mean calcium levels were 9.37 ± 0.4 mg/dl and 9.38 ± 0.4 mg/dl in males and females, respectively.

The mean phosphorus levels were 4.18 ± 0.6 mg/dl in males and 4.04 ± 0.4 mg/dl in females. None of the studied student presented the clinical features of rickets.

Discussion

There was a high prevalence of VDI (34.9%) among otherwise healthy children and adolescents in a convenient sample from urban Tehran. The deficiency was significantly more frequent in girls (53.6%) than boys (11.3%). These findings add to growing body of data, including previous reports from Iran suggesting that this nutritional deficiency is a prevalent problem among the pediatric age-group [7, 8].

In another study performed in Isfahan in 2004, the vitamin D status of adolescents aged 14–18 years was investigated [8]. In that study, also VDI was more

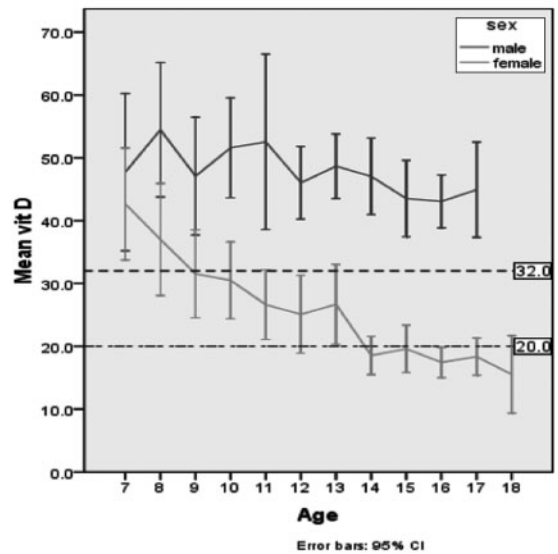

FIG. 1. The mean levels and 95% CIs of 25-OHD (ng/ml) in boys and girls in different ages (year).

TABLE 1
Prevalence of vitamin D deficiency in Iranian children and adolescents living in Tehran

25-OHD	All students % (n)	Girls % (n)	Boys % (n)	*p*-value[a]
General (*25-OHD* <20 ng/ml)	34.9 (337)	53.6 (289)	11.3 (48)	<0.00001
Mild (15 <*25-OHD* ≤ 20 ng/ml)	10.9 (105)	15.8 (85)	4.7 (20)	<0.00001
Moderate (8< *25-OHD* ≤15 ng/ml)	17.3 (167)	26.5 (143)	5.7 (24)	<0.00001
Severe (*25-OHD* <8 ng/ml)	6.7 (65)	11.3 (61)	0.9 (4)	<0.00001
*Local cut-off (*25-OHD <*32 ng/ml)*	54.3 (523)	76.8 (414)	25.7 (109)	<0.00001

[a]Comparison of vitamin D deficiency prevalence between boys and girls.

common in girls (72.1%) than boys (18.3%). Another study performed in 1999–2000 in Tehran showed that the maximum values of serum 25-OHD for women were either equal or less than the minimum values for men [10]. All these data show that the gender difference in levels of 25-OHD and prevalence of VDI continues during the adulthood in Iran.

The severity of VDI increases with age in Iranian girls but not boys. This is in contrast to the findings from western countries [6]. There is no difference in intake of vitamin D between girls and boys in Iran. The found gender difference seems to be due to the extent of sunlight exposure. Iranian Muslim girls of 9-years old and higher ought to stringently cover their body and hair. During winter, this coverage could more profoundly affect the extent of vitamin D production in the skin.

For adolescents, especially girls, suboptimal vitamin D status appears to be noteworthy. Maximal bone accretion is crucial during adolescence for achievement of peak bone mass and prevention of osteoporosis [11, 12]. Indeed, vitamin D replacement has a positive impact on musculoskeletal parameters in girls, especially during the premenarcheal period [13].

The subclinical VDI continues to the adulthood; not only the threat of osteoporosis for mothers but also the bearings of infants at risk of rickets are major concerns. In a study conducted in Tehran in 2001, it has been shown that 80% of nursing mothers had VDI [14]. The vitamin D status of the newborns is dramatically altering related to the vitamin D status of the mother. Maternal VDI has been identified as a major cause of rickets in infants [10, 14–16].

Here, we conclude that VDI in children and adolescents is a major health problem not only for these age-groups but also for the next generation to come.

Preventive measures, such as encouragement of girls and women to have more sun exposure, fortification of foods and prescription of supplemental vitamin D are strictly recommended.

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