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ORIGINAL ARTICLE

Relationship Between Vitamin D and Nutritional Status in Healthy Reproductive Age Women

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Recently a variety of studies reported high prevalence of vitamin D deficiency in adult individuals in different countries and several previously published studies have linked obesity to a poorer vitamin D status, in which serum 25-OHD levels are inversely correlated with body fat. The aim of the present study was to evaluate prevalence of vitamin D deficiency and its relationship with nutritional status among women of reproductive age in the city of Tabriz.

Material and Methods: This was a cross-section study conducted on 252 reproductive, 15-49 year-old women of the city of Tabriz, randomly selected from among the general population. From each subject 5 mL vein blood was obtained and serum levels of calcium, phosphor, alkaline phosphatase, and vitamin D were measured Levels of <5 ng /mL were considered as severe deficiency, 5- 9.90 ng/ mL as moderate, and 10- 20 ng / mL as mild. A demographic questionnaire was completed; weight and height were measured using seca scale and cotton ruler. Body mass index was calculated based on weight and height. Vitamin D was measured by radioimmunoassay.

Results: The results indicated that vitamin D deficiency in women was as follows: severe vitamin D deficiency 15.1%, moderate deficiency 15.5%, and mild deficiency 33.7%. Of these women 3.7% were underweight and 59.8% had different stage of obesity. Only 37.5% had BMI within normal range. There was a significant correlation between serum levels of vitamin D and weight and age (r = 0.16, p= 0.01 and r = 0.19, p= 0.003). There was no significant association between BMI and serum vitamin D level.

Conclusion: Based on this study, it is speculated that vitamin D deficiency is prevalent in the women of Tabriz. No relationship was found between vitamin D and nutritional status. Therefore, interventions such as education and sun exposure are recommended for the health promotion of these women.

Key Words: Vitamin D deficiency, Reproductive age women, BMI,

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Introduction

Several recent studies have identified a surprisingly high prevalence of vitamin D insufficiency in otherwise healthy adults living in different countries, which could be a major health problem in the future of those with certain life style characteristics.[1,2] People with low levels of vitamin D and its metabolites are at increased risk for bone disorders particularly osteomalacia and osteoprotic fractures. More recent is the awareness of a preclinical phase of vitamin D deficiency, known as vitamin D insufficiency, which increases the risk of bone lesions.[3] Low levels of vitamin D metabolites are associated with malabsorption of calcium, which results in bone loss.[4] Vitamin D can be obtained through the diet or it is synthesized in the skin after exposure to the sun. However, because few foods provide a natural source of vitamin D[5] and because fortification of foods with vitamin D is often unreliable,[6] skin synthesis is thought to constitute the major source. People living in countries at higher latitudes are more prone to seasonal vitamin D insufficiency because wintertime sunlight does not promote conversion of the vitamin D precursor in the skin.[7] Levels of vitamin D and its main circulating metabolites, 25-hydroxy vitamin D [25 (OH) D], are under the predominant influence of solar ultraviolet B radiation (wavelength 290 to 315 nm). In addition to the above mentioned factors, recent concerns have been raised about the high prevalence of low serum 25(OH)D values observed in obese individuals. The first evidence of a relationship between vitamin D and body fat was described by Lumb et al.[8] in 1971. They hypothesized that vitamin D after absorption is sequestered and stored in tissues like fat and muscle and then released slowly into the circulation. Results of studies are controversial. Epstein et al.[13] and Nesby-O'Dell et al.[10] reported no relationship between serum 25(OH)D levels and obesity or body mass index (BMI) in blacks, whereas Parikh et al.[11] found a significant negative correlation between BMI and serum 25(OH)D in African-Americans. Arunabh and colleagues demonstrated that there is a reverse correlation between body fat and serum level of vitamin D and.[12] Recently, Worstman et al.[13] confirmed that obesity-associated vitamin D insufficiency most likely is due to decreased bioavailability of vitamin D3 from cutaneous and dietary sources because of its deposition in body fat compartments. The low levels of 25-OHD in obesity have been attributed to multiple factors like decreased exposure to sunlight because of limited mobility, negative feedback from elevated 1,25-hydroxyvitamin D and PTH levels on hepatic synthesis of 25-OHD,[14] and excessive storage of vitamin D in the adipose tissue.[15] Therefore, it seems that obesity and body fat affect the endocrine system and vitamin D status. Based on this evidence, it is expected that obese individuals need higher than usual doses of vitamin D. Controversial results have been obtained by researchers,.which is why we studied the prevalence of vitamin D deficiency and its relationship with nutritional status among reproductive age women from the city of Tabriz.

Materials and Methods

Subjects

Our study includes 252 healthy reproductive age women living in urban Tabriz, selected from the general population for a large cross-sectional study for evaluation of vitamin deficiency and its related risk factors. The exclusion criteria were: 1) history of any metabolic bone disease; 2) malignancy at any age; 3) history of thyroid, parathyroid, adrenal or gonadal disease; 4) history of drug abuse; 5) any hepatic or renal disorder; 6) usage of drugs which may affect bone and calcium metabolism in the past 3 years, including estrogen, calcium, or vitamin D supplementation and 7) hysterectomy or gastrointestinal resection. Fasting blood collected in the morning on the same day and samples were separated into small portions and stored at –70 ^{o}C until assay. Demographic questionnaires on educational level, age, etc. were completed.

Biochemical Measurements

Plasma 25-hydroxyvitamin D was measured in overnight fasting blood samples by using commercial radioimmunoassay kits (Incstar Corp). These kits utilize polyclonal antibody and 125I–labeled antigen to measure bioactive vitamins D after an actonitrile extraction procedure. Three quality control samples of low, medium, and high concentrations were analyzed in each assay. The level of <5 ng /mL was considered as severe deficiency, 5- 9.90 ng/mL as moderate, and 10-20 ng /mL as mild.[16] The CV of the RIA method for vitamin D was less than 10%.

Other measurements

Other measurements included body weight, measured by using calibrate scales while subjects wore only light clothes and no shoes; BMI, height was measured using body weight measures; during interviews questionnaires on Socioeconomic and demographic data were collected. Mid arm circumflex was measured on the left arm in the mid bicep area.

Statistical Analysis

Descriptive statistics were computed for all variables. SPSS and INSTAT statistical programs were used to analyze results. Student's t test and ANOVA were used for the comparison. Correlation analysis with Pearson's coefficient factors was applied to find the correlation between related groups. Risk factors in the groups were evaluated by fisher's chi-square test. P<0.05 was considered statistically significant.

Results

Based on this study, mean age, height, weight and BMI of females were 31±7.8 years, 158.5±5.7 cm, 67.2±13.4 kg and 26.76±5.2 kg/m² respectively. In the correlation study, (shown in table 1) there was a direct significant correlation between serum 25-OHD with age, weight, MAC (mid arm circumflex) and BMI (p= 0.01, r = 0.164 and p= 0.03, r = 0.19, p=0.018 r =0.126, p=0.031 r =0.136 respectively). Base on the cut-off point, 35.8% of individuals had normal levels of vitamin D, whereas 64.2% had mild to severe vitamin D deficiency (Table 2). Nutritional status of subjects was analyzed based on BMI, and results are shown in Table 3. The prevalence of wasting was 3.7%, all in stage I and there were no moderate and severe wasting. Only 35.4% BMI of 35.4% was within normal range. Although there was a direct correlation between body weight, BMI and serum levels of vitamin but was no statistically significant difference between categorized BMI and vitamin D in female subjects (Table 3).

Table 1. Correlation of serum 25-OHD with age, weight, height MAC* and BMI† in 252 subjects

Variable	Mean±SD	r	p
Age	30.99±7.8	0.164	0.01
Weight(kg)	67.2±13.4	0.19	0.03
Height(Cm)	158.5±5.7	-0.028	0.66
MACa(Cm)	28.7±3.978	0.126	0.018
BMIb(kg/m²)	26.8±5.2	0.136	0.031

* Mid arm circumflex, † Body mass index

Table 2. Prevalence and intensity of vitamin D deficiency

Vitamin D status	Number	Percent (%)
Severe deficiency	38	15.1
Moderate deficiency	39	15.5
Mild deficiency	84	33.6
Normal	90	35.8
Total	251	100

Level of <5 ng /mL was considered as severe deficiency, 5- 9.90 ng/mL as moderate, and 10- 20 ng /mL as mild.[16]

Discussion

This was a cross-sectional, population based study that showed the high prevalence of vitamin D deficiency in the reproductive age women of Tabriz city. Based on the results, 15.1% of females had severe, 15.5% moderate, and 33.6% mild vitamin D deficiency respectively. It hass been reported that in Scandinavian countries having fortified nutrition with vitamin D, the prevalence of vitamin D

Table 3. Mean ±SD of serum levels of vitamin D in different body mass indices categories

Body Mass Index(kg/m2)	Number	Percent	Vitamin D (ng/ml)
<18.5 (underweight)	9	3.7	16±13
18.5 – 24.9(normal)	87	35.4	24±30
25 – 29.9(Overweight)	87	35.4	29±29
30 – 34.9(mild obesity)	50	20.3	29±31
35 – 40 (moderate obesity)	10	4.1	36±37
> 40 (severe obesity)	3	1.2	28±27

P<0.24 (between BMI groups)

deficiency is between 1.6-14.8% in different age groups.[17, 18-21] Therefore, lack of availability of vitamin D fortified foods and low consumption of vitamin D enriched sea foods in East Azerbaijan, could explain the vitamin D deficiency. In other European countries where there is no vitamin D supplementation, deficiency of vitamin D is prevalent. Chopy et al estimated the vitamin D status of a general adult urban population selected from 20 French cities grouped in nine geographical regions (between latitude 43 degrees and 51 degrees N). Major differences in 25-hydroxyvitamin D (25(OH) D) concentration were found between regions, the lowest values being seen in the North and the greatest in the South, with a significant 'sun' effect and latitude effect. In this healthy adult population, 14% of subjects exhibited 25(OH) D values of 12 ng/ml, which represents the lower limit (< 2 SD) for a normal adult population measured in winter.[22] In comparison to our study in Tabriz, vitamin D deficiency was prevalent in France, a difference that could be explained by the different climate conditions.

Fonseca et al measured 25-OH vitamin D concentrations in 31 adult Saudi Arabian women who presented with acute minor illness. The median plasma 25-OH vitamin D concentration was 6ng/mL (range: 2-18 ng/ml). Only three subjects had a concentration within the normal range (10-55 ng/ml).[23] Sedani et al reported that the level of 25-(OH) D3 was significantly lower in young students of both sexes, and was significantly higher in females than in males.[24] Hashemipour and colleagues showed the high prevalence of vitamin D deficiency in Tehran's population. In their study the prevalence of severe and moderate vitamin D deficiency was 9.5 % and 57.6%, respectively; mild vitamin D deficiency had a prevalence of 14.2%. Vitamin D serum levels in females aged between 20–29 years and 30–39 years were less than other age groups (P<0.001). Median vitamin D level in females, aged 20–29 years and above 60 years were 17nmol/l and 39 nmol/l respectively, and serum vitamin D level had no significant relation with BMI.[25] The prevalence of vitamin D deficiency was higher in the Tehran study population than in Tabriz. Azizi & colleagues showed vitamin D level less than 18 ng/mL in half of the study population. Vitamin D deficiency prevalence in the 10–19, 20–24, and 30–41 year age groups was 47.4%, 59.5%, 44.8% respectively. In their study 25(OH) D equal to or less than 18 ng/dl was considered as vitamin D deficiency.[2] This difference may be a consider as result of using different cut-off points. The Moussavi et al[26] study of Isfahan's high school students showed 72.1% of females have vitamin D deficiency, higher than that of Tabriz women.

As shown in Table 3, overweight and obesity of different stages are prevalent among female residents of Tabriz city and there was a direct correlation between body weight, BMI and serum levels of vitamin D (Table 1) but there was no statistically significant difference between categorized BMI (Table 3). It was also shown that 1.2% of them had severe obesity, 4.1% stage I obesity and 20.3% stage II obesity. Only 35.4% of females had BMI within the normal range. The mean serum levels of vitamin D in underweight females decreased, in females with stage II obesity increased, and in females with stage III obesity decreased. Therefore, it seems that obesity and body fat induce changes in the endocrine system and vitamin D status, as a risk factor. A number of previously published studies[9-11,15,27-29] reported a correlation between serum 25-OHD levels and body fat. Results of these studies ae conflicting. Epstein et al.[9] and Nesby-O'Dell et al.[10]reported no relationship between serum 25(OH)D levels and obesity or body mass index (BMI) in blacks, whereas Parikh et al.[11] found a significant negative correlation between BMI and serum 25(OH)D in African-Americans. Lumb et al.[8] hypothesized that vitamin D after absorption is sequestered and stored in tissues like fat and muscle and then released slowly into the circulation. Similar evidence was found in animal models confirming that adipose tissue is the major storage site for vitamin D3 and a source available for conversion to other metabolites during deprivation.[30] A subsequent study on morbidly obese subjects also suggested that decline in 25-OHD levels in obesity may be secondary to alteration in tissue distribution resulting from increase in adipose mass.[15] More recently, Worstman et al.[13] confirmed that obesity-associated vitamin D insufficiency most likely is due to decreased bioavailability of vitamin D3 from cutaneous and dietary sources because of its deposition in body fat compartments. Diana et al found that BMI was inversely related to serum vitamin D[31], a relation that has also been observed in post menopausal women,[32] elderly people[33] and young obese subjects.[28] Arunabh and colleagues demonstrated that there is an inverse correlation between body fat and serum level of vitamin D and.[12]

Most of the above mentioned studies compared serum vitamin D level in morbidly obese and nonobese subjects; in our study there was no significant difference between women with different categorized BMI and serum vitamin D level. Although there was a direct correlation between body weight, BMI and serum vitamin D level, these differences are probably due to methods of sampling and other unknown factors, which need further investigations.

The results of our study show that with increasing age, vitamin D status becomes better. These results; agree with the finding of some studies for example the Holvik et al study in five immigrant groups living in Oslo showed that serum level of vitamin D tended to increase with increasing age, but this was only significant for persons born in Turkey.[34] Larijani et al reported that vitamin D deficiency decreased significantly with age in the urban population of Tehran.[35] The Diana et al study showed that increasing age was associated with low level of vitamin D status.[31] Looker reported that vitamin D level increases until the age of 65 years and then declines.[36] Therefore, it seems that the relationship between vitamin D and age is relatively complicated, and is influenced by life style factors.

To summarize, it is speculated that vitamin D deficiency is prevalent in the women of Tabriz and obesity has no negative effect on vitamin D status of studied subjects. Interventions like education and sun exposure are recommended for the health promotion of such women.

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