VITAMIN D STATUS IN LEBANESE UNIVERSITY STUDENTS

Marie-Hélène GANNAGÉ-YARED¹, Rima CHEIDID², Georges HALABY³


ABSTRACT : Vitamin D inadequacy is highly prevalent in Lebanon in young adults, school children and postmenopausal osteoporotic women. However, this prevalence has not been previously studied in university students.

Three hundred and eighty-one students (mean age 23.9 ± 3.9 years), randomly recruited from Saint-Joseph University, were included in this cross-sectional study (201 males and 180 females). Recruitment was performed across all seasons.

The mean 25 hydroxyvitamin D (25(OH)D) was 31 ± 12.4 ng/ml. 25(OH)D was inversely correlated with BMI and waist circumference (r = -0.18 and r = -0.19, p < 0.001 for both variables). 25(OH)D was significantly different between the winter season and the other seasons (p = 0.023, p = 0.001 and p < 0.0001 for spring, summer and fall respectively). 25(OH)D was lower in men compared to women (29.01 ± 11.23 versus 33.2 ± 13.4, p < 0.01). This gender difference disappears after adjustment for both season and BMI.

In addition, the inverse relation between 25(OH)D and BMI was non significant in the female population. In a stepwise multilinear regression analysis using 25(OH)D as a dependent variable, season and BMI were the independent predictors of vitamin D levels (p < 0.0001 and p = 0.001 respectively).

Our results suggest that, in a population of high educational level, vitamin D status is better compared to other subgroups of the Lebanese population. In addition, we found, after adjustment for BMI and season, no gender difference in 25(OH)D levels while the winter season and a high BMI negatively affect vitamin D status.

INTRODUCTION

Satisfactory vitamin D status is of major importance for bone health [1-3]. Both inadequate vitamin D intake and low sun exposure lead to vitamin D deficiency [1, 4-6]. Vitamin D inadequacy is a highly prevalent condition worldwide [1]. It is however less commonly observed in the United States (US) where fewer individuals [9-10] are affected. Vitamin D food supplementation in the US probably accounts for this difference. In Middle Eastern countries, more particularly in Lebanon, several recent studies have shown a surprisingly high incidence of vitamin D deficiency in people aged 30-50 [13], school children [14], elderly people [15] and postmenopausal osteoporotic women [16-17]. Similar results were ob-

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RÉSUMÉ : L’insuffisance en vitamine D est très prévalente au Liban dans la population jeune, chez les enfants scolarisés et chez les femmes postménopausées ostéoporotiques. Cependant, cette prévalence n’a jamais été recherchée chez les sujets universitaires.

Trois cent quatre-vingt-un et des étudiants de l’Université Saint-Joseph (âge moyen 23,9 ± 3,9 ans) ont été sélectionnés de manière randomisée au cours de toutes les saisons.

Le taux moyen de 25(OH)D est de 31 ± 12,4 ng/ml. La 25(OH)D est inversement corrélée à l’IMC et au tour de taille (r = –0,18 et r = –0,19, p < 0,001). Il existe une différence significative entre la saison hivernale et les trois autres saisons (printemps : p = 0,023 ; été : p = 0,001 ; automne : p < 0,0001 ). La 25(OH)D est inférieure chez les hommes comparativement aux femmes (29,01 ± 11,23 versus 33,2 ± 13,4, p < 0,01). Cette différence disparaît après ajustement pour l’IMC et la saison. La relation inverse entre la 25(OH)D et l’IMC est non significative dans la population féminine. Dans une régression linéaire multiple, avec la 25(OH)D comme variable dépendante, les variables saison et IMC sont indépendamment prédictives des taux de vitamine D (p < 0,0001 et p = 0,001 respectivement).

Nos résultats suggèrent que les statuts en vitamine D dans une population de haut niveau éducationnel, sont meilleurs que dans les autres sous-groupes de la population libanaise. De plus, nous avons trouvé que la saison hivernale et un IMC élevé sont les principaux facteurs affectant négativement les taux de vitamine D.
served in Iran [18], Saudi Arabia [19], Kuwait [20] and Jordan [21]. Dress codes, culinary habits, very hot sun unabling sun exposure account for these differences [22-23]. Because of the lack of data on vitamin D status in Lebanese university students, we undertook this study to evaluate the prevalence of hypovitaminosis D as well as its determinants in a selected population of high educational level.

MATERIALS AND METHODS

Participants

Participants were students recruited from the Saint Joseph University Medical Sciences Campus, located in Beirut. This campus, the second largest in Lebanon, admits students from all parts of the country.

Three hundred and eighty-one randomly selected students from both sex accepted to participate in the study. Recruitment was done during the four seasons. Every participant signed a written and informed consent which had been previously approved by our University Ethical Committee.

The following anthropometric measures, performed using the same devices throughout the study, were taken by a registered nurse: height in meters, weight in kilograms using a manual scale, and waist circumference (WC) taken at the umbilicus in centimeters. Body mass index (BMI) was calculated as weight (kg)/height (m)².

Biological parameters

Fasting peripheral blood was collected on plain tubes, centrifuged and then stored at -80°C for later 25(OH)D measurements. Only one sampling was performed for each subject. 25(OH)D was measured using the DiaSorin radioimmunoassay (Minnesota, USA). The assay sensitivity is 2 mIU/ml and coefficient of variation is below 9%.

Statistical analysis

Statistical analysis was performed using the SPSS version 13.0. Data are expressed as mean ± standard deviation (SD) value or as percentage. Univariate analysis was performed using the Pearson coefficient of correlation. Student’s t-test was used to compare mean values between men and women. Differences in proportion were evaluated using a χ² test. A stepwise multilinear regression analysis was performed in the overall population in order to look at the determinants of 25(OH)D. Data were considered statistically significant if p values were < 0.05.

RESULTS

Three hundred and eighty-one subjects were included in this cross-sectional study (201 males and 180 females). Population age ranged between 18 and 30 years, with a mean of 23.9 ± 3.9 years. Baseline clinical characteristics of the population are shown in Table I. One hundred and fifty-eight subjects were recruited during winter, 126 during spring, 76 during fall and 21 during summer. The few number of subjects recruited during the summer season was related to the summer vacations of the students. The mean 25(OH)D level was 31 ± 12.4 ng/ml. Just one participant had 25(OH)D levels < 10 ng/ml, 18.6% had 25(OH)D levels ≥ 10 and < 20 ng/ml, 32.8% had 25(OH)D levels ≥ 20 and < 30 ng/ml and 48.3% had 25(OH)D ≥ 30 ng/ml.

25(OH)D was inversely correlated with BMI and WC (r = –0.18 and r = –0.19, p < 0.001 for both variables). This inverse correlation was non significant in women (r = –0.09, p = 0.22 for WC and r = –0.08 and p = 0.31 for BMI). 25(OH)D was the lowest during the winter season (26.12 ± 8.7 versus 29.9 ± 11.97 in spring, 35.9 ± 10.1 in summer and 41.6 ± 13.8 in fall). There was a statistically significant difference in 25(OH)D levels according to season using a one way ANOVA test (p < 0.0001). The post hoc test showed a statistically significant difference between winter and the three other seasons, spring, sum-

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>BASELINE CLINICAL AND BIOLOGICAL DATA OF THE OVERALL POPULATION, MEN AND WOMEN</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>DATA ARE EXPRESSED AS MEAN ± SD OR IN PERCENTAGE</td>
</tr>
<tr>
<td></td>
<td>Total (n = 381)</td>
</tr>
<tr>
<td>AGE (years)</td>
<td>23.9 ± 3.9</td>
</tr>
<tr>
<td>BODY MASS INDEX (kg/m²)</td>
<td>23.9 ± 4.1</td>
</tr>
<tr>
<td>WAIST CIRCUMFERENCE (cm)</td>
<td>82.7 ± 12.2</td>
</tr>
<tr>
<td>25(OH)VITAMIN D (ng/ml)</td>
<td>31 ± 12.48</td>
</tr>
<tr>
<td>&lt; 10 ng/ml</td>
<td>0.003%</td>
</tr>
<tr>
<td>≥ 10 and &lt; 20 ng/ml</td>
<td>18.6%</td>
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</table>
mer and fall ($p = 0.023$, $p = 0.001$ and $p < 0.0001$ respectively). There was no difference between the summer and the fall season ($p = 0.08$). Finally, $25(OH)D$ was found to be lower in men compared to women ($29.01 \pm 11.23$ versus $33.2 \pm 13.4$, $p < 0.01$). This gender difference in $25(OH)D$ levels disappeared after adjustment for both season and BMI.

Only seven subjects were taking multivitamins, the mean $25(OH)D$ level was not different in these subjects compared to those who were not taking vitamin D.

In a stepwise multilinear regression analysis, using $25(OH)D$ as a dependent variable, and BMI, WC, season and sex as independent variables, we found in the overall population that the two independent predictors of hypovitaminosis are season and BMI ($p < 0.0001$ and $p = 0.001$ respectively) (Table II). Similar results were observed when the analysis was performed separately in men ($p < 0.0001$ and $p = 0.015$ respectively), while in women only season was significant ($p < 0.0001$).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>$\beta$ Coefficient</th>
<th>Standard Error</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>31.64</td>
<td>3.45</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Season</td>
<td>5.115</td>
<td>0.497</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td>-0.464</td>
<td>0.135</td>
<td>0.001</td>
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</table>

**DISCUSSION**

In this study we find that vitamin D inadequacy (defined as $25(OH)D < 30$ ng/ml) affects 51.7% of our young population. This prevalence is much lower than what was previously reported in several subgroups of the Lebanese population. In fact, using a cutoff of 20 ng/ml, vitamin D deficiency affects 52% of Lebanese schoolchildren [14]. In addition, using a lower cutoff of 15 ng/ml, 74% of the young Lebanese population aged 30-50 are affected [13].

Finally, in a recent study, using a cutoff of 30 ng/ml, 84% of postmenopausal Lebanese osteoporotic women [16-17] have vitamin D inadequacy. The prevalence of vitamin D inadequacy in this last international study was the highest in Lebanon versus 64% worldwide [17] and 54% in the US population [24].

The reason for this high prevalence of vitamin deficiency in the Lebanese population is multifactorial. In the study we performed on young people [13], the main predictors of hypovitaminosis D were female gender, inadequate dietary vitamin D intake, urban dwelling, and in addition, in women, veiling and parity. On the other hand, in postmenopausal women [16], inadequate use of vitamin D supplements, high BMI, low educational levels and dress code covering arms were associated with vitamin D inadequacy while season, sun exposure index and dietary vitamin D were not. It is possible that, in this last study, vitamin D supplements, taken by a high percentage of women, mask the vitamin D contribution brought by food to vitamin D status.

The lower prevalence of vitamin D inadequacy observed in the present study is probably related to the higher educational level of our population (university students from a medical campus) and to their lower BMI compared to the other studied subgroups of the Lebanese population. In fact, in the study performed on young subjects [13], the recruitment was done through community centers, thus involving people of lower socioeconomic status (SES). The importance of SES in the determination of vitamin D status was also observed in the Lebanese schoolchildren study [14] in which subjects from schools of high SES had better vitamin D status compared to those with low SES. Similarly, in the Lebanese osteoporotic study, educational level was found to be an independent predictor of vitamin D inadequacy [16]. The relation between educational level and vitamin D status has not been largely studied in worldwide populations. In the US population, vitamin D insufficiency was high in low-income elderly population, particularly in African-Americans, a finding that was only partially explained by the racial difference [25]. Similar results were observed in Italy in elderly osteoporotic women with lower educational level [26]. However, in the international study [27], low educational level was not retained as an independent risk factor for vitamin D inadequacy, suggesting that this risk factor is not a common factor worldwide.

It is surprising to note that vitamin D insufficiency affects more males compared to females. This is probably related to the higher BMI of our male population since, after adjustment for BMI, this difference disappears. This indicates that, in a population of high educational level, women are not more affected by vitamin D inadequacy than are men as opposed to other Lebanese studies [13-14].

Similarly to the international study, in our population, high BMI was found as an independent risk factor for vitamin D inadequacy. Previous studies have shown an inverse relation between $25(OH)D$ and BMI [28-29] that could be explained by a larger body pool size and a slower saturation of $25(OH)D$ stores in obese individuals [30]. However, the reason for the lack of correlation between $25(OH)D$ and both BMI and WC in women is unclear. This could be due to the low BMI of our female population or to a difference between men and women in the sex steroid environment.

One can argue that the difference in the prevalence between all the subgroups of the Lebanese population could be explained by differences in $25(OH)D$ measurements. However, in all the Lebanese studies, the Dia Sorin assay was used except in the study performed on postmenopausal osteoporotic women where the Nichols competitive binding assay was used. This last assay overestimates $25(OH)D_3$, and subsequently gives slightly higher results than the Dia Sorin assay or the

**TABLE II**

<table>
<thead>
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<tbody>
<tr>
<td><strong>BMI (kg/m$^2$)</strong></td>
<td>-0.464</td>
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high performance liquid chromatography (HPLC) assay [31-32]. Finally, at the present time, and because of the use of different vitamin D assays, the optimum serum concentration of 25(OH)D remains the subject of debate. While many laboratories still report normal values of 10 to 50 ng/ml in crosssectional studies, the 25(OH)D threshold below which vitamin D supplementation resulted in a fall in serum parathyroid hormone is approximately 30 ng/ml based on the findings of the Chapuy study [28]. This is why a threshold of serum 25(OH)D below 30 ng/ml was recently considered as an evidence for vitamin D insufficiency [30], a threshold that was retained in our study.

In conclusion, our study shows that half of the Lebanese university students are affected by vitamin D inadequacy. This percentage is lower than what was observed in other subgroups of the Lebanese population, highlighting the importance of educational level as a determinant of vitamin D status. In addition, our results show that vitamin D status is negatively affected by the winter season and by a high BMI. This last finding is only observed in our male population.

REFERENCES