The Relationship Between Vitamin D3 Blood Level, Socioeconomic Status And Body Mass Index among obese subjects

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Abstract:

Objective: To examine the relationship between socioeconomic status (SES), body mass index (BMI) and vitamin D level in obese non-diabetic, non-hypertensive Egyptian subjects.

Design and Method: Vitamin D3 blood level of 217 Egyptian adults between 19-58 years of age was measured. Anthropometric measurements were taken and socioeconomic information was collected.

Results: 63.5% of participants (n=138) were vitamin D3 deficient (vitamin D3< 20 ng/mL) of which 82.6% were females (n=114), 83.3% were married, 44.9% obtained more than 12 years education. More than half (56.5%) of the participants were either white collars or professionals. Vitamin D3 deficient participants were significantly younger than their counterparts with mean age 34±5.8 and 36±8.5 years and had higher mean BMI 35.5 ± 5.2, 33.5 ± 3.3 (p<0.05) respectively. Low serum vitamin D3, high education and occupation levels were predictors of high BMI.

Conclusion: Vitamin D3 deficiency is common among Egyptian adults and is associated with high BMI which calls for more intervention research to test if vitamin D3 supplementation could reduce the prevalence of obesity.
Introduction

Obesity, a medical disorder of excessive accumulation of body fat have been associated with increased mortality and causes serious health problems (Flynn et al., 2006, Moyer 2012, Bagheri et al., 2018). Increased by 27.5% between 1980 and 2013 from 921 million adults to 2.1 billion (Cassity et al., 2016). Obesity is a rapidly growing health problem in most developed countries (McLaren 2007; Ogden et al., 2007). Globally, 40% of deaths and 38% of the DALYs related to high BMI occurred among non-obese individuals. While some studies have argued that overweight is associated with lower risk of all cause mortality compared to a normal range of 18-25 kg/m² (Flegalet et al., 2013).

In 2013, the World Health Organization (WHO) called for zero increase in the prevalence of obesity among adults and zero increase in the prevalence of overweight among children (McGuire, 2015). Given the rising burden of obesity and extreme obesity, health care professionals need to play a more active role in both the promotion of weight loss and controlling the complications of obesity (Roberto et. al., 2015). The highest level of adult obesity observed in Egypt in 2015 was at 34.9% (32.4-37.3%) (GBD, 2017).

Although vitamin D is obtained from exposure to sunlight and from diet, vitamin D deficiency is not uncommon in many regions and the areas at high risk of vitamin D deficiency include South Asia and the Middle East (Hwalla et al., 2017). Causes of vitamin D deficiency studied included lack of exposure to sunlight either due to cultural dresses styles or excessive use of sunscreen, or due to institutionalization and altitude (Cole et al., 2012). Diet, lifestyle, demographic aspects also play a role. In addition, research showed more obese individuals tend to have lower vitamin D levels (Cole et al., 2012).

The prevalence of vitamin D deficiency and insufficiency was found high among women of childbearing age in Egypt where 72% of the 208 women studied were found to be vitamin D insufficient (serum 25(OH)D <50 nmol/L) (Botros et al., 2015). Also El Sagheer et al. (2016) examined 100 women aged 20-40 years and found them to be vitamin D insufficient and reported that the lack of sun exposure, lack of vitamin D supplementation, and the presence of pseudo-fracture were independent factors associated with vitamin D insufficiency. In addition, El Tayebet
al., (2013) randomly tested 59 men, aged 40-59 years, and found 62.7% had desirable serum $25(\text{OH})\text{D} \geq 75$ nmol/L, with 13.6% and 23.7% having inadequate (50-72.5 nmol/L) and insufficient (<50 nmol/L) status, respectively. Low prevalence of vitamin D deficiency has been reported among elderly at 19.3% (El Rifai et al., 2014) and vitamin D insufficiency was 77.2% (Aly et al., 2014). Vitamin D deficiency have been implicated in the development of several metabolic complications including metabolic syndrome and its components factors such as abdominal adiposity, insulin resistance (and beta cell function), hypertension, and atherogenic dyslipidemia (Bagheri et al., 2018).

We are not aware of any studies in Egypt that investigated the relationship between obesity and vitamin D deficiency. The current study aims to assess the prevalence of vitamin D deficiency among obese Egyptian adults and determine predictors associated with vitamin D deficiency.

**Subjects and method**

**Subjects:**

Participants were recruited from outpatient clinics at the National Nutrition Institute (NNI) in Cairo, Egypt. Out of 400 subjects recruited, 246 obese adults between 19-58 years of age agreed to participate in the clinical trial investigating the effect of vitamin D supplementation on weight reduction. Trial was approved by the Ethics Committee at the General Organization of Teaching Hospital and Institutes and consent forms were obtained from participants. Exclusion criteria included obese subject with diabetes, hypertension, kidney or liver diseases. Participants were screen for vitamin D3 (25-hydroxyvitamin D) deficiency, diabetes, liver and kidney functions. 29 participants were excluded for not meeting inclusion criteria and 217 participants were included in the current study where 138 participants were vitamin D3 deficient and 79 were vitamin D3 sufficient.

**Data Collected:**

Socioeconomic data including age, gender, education, occupation, marital status, family size were collected using the validated socioeconomic questionnaire developed by El Gilany et al. (2012). Body height and weight were measured to the nearest 0.1cm and 0.1kg, respectively, while wearing light clothes and barefooted. WHO
anthropometric measurement protocol was used. BMI was calculated as weight (kg) divided by the height square in meters (WHO, 1995).

Laboratory Analysis:

25-Hydroxy Vitamin D (25(OH) D) serum level was estimated using the EUROIMMUN Enzyme-linked Immune-sorbent Assays (ELISA) test kits for determination of 25 vitamin D. A 25(OH) D level of less than 20 ng per milliliter (ng/mL) or 50 nmol per liter (nmol/L) indicates vitamin D deficiency. Insufficiency of vitamin D is defined as a 25(OH)D level of 21 to 29 ng/mL or 52 to 72 nmol/L (Holick, 2007). A 25(OH)D optimal level begins at 30 ng/mL or 75 nmol/L (Bischoff-Ferrari et al., 2006; Holick, 2007). For the current study, vitamin D3 deficiency was determined as 25 hydroxy Vitamin D < 20 ng/mL.

Statistical Analyses

Statistical Package for Social Sciences (SPSS version 21, 2012) was used. Descriptive statistics included mean, standard deviation and frequencies were performed to compare differences in socio-demographic characteristics between vitamin D deficient and sufficient participants. Linear regression was performed to determine predictors of high BMI (dependent variable). Independent variables included age, gender, marital status, education, occupation and vitamin D serum level.

Results and Discussion:

In this study, 79 out of the 217 participants were vitamin D sufficient (36.4%) while 138 were Vitamin D deficient (63.6%). Vitamin D deficiency was found to be prevalent across the Middle East and North Africa (Green et al., 2015; El Garf et al., 2015; Hwalla et al., 2017). Characteristics of the population studied are described in Table 1. 82.6% of vitamin D deficient subjects were females although the difference in vitamin D deficiency and/or sufficiency between males and females did not reach statistical significant level. It could be explained by the unequal number of males and females participants.

The current study revealed that educational attainment and marital status were significantly different between vitamin D sufficient and their deficient counterparts. Among vitamin D3 deficient participants, 44.9% had compared to 39.2% among vitamin D3 sufficient. Moreover, vitamin D3 deficiency increased with increase educational attainment where 44.9% of vitamin D3 deficient had more than 12 years education.
compared with subjects with no education (8%), less than 12 years (13.0%) and 12 years education (34.1%). 83% of vitamin D deficient participants were married compared with 70.9% among vitamin D sufficient

No statistical significant relationship between gender and vitamin D deficiency was detected. This finding was confirmed by many studies (Baradaran et al., 2012, Kafeshaniet al., 2016 and Khazaei et al., 2017). Unlike the current study, Lagunova et al. (2009) found a significant decrease in serum 25(OH) D3 among females compared to males. Men had higher rates of vitamin D deficiency than women and about 40% of severely obese women and 75% of men had vitamin D deficiency during the winter and spring and only about 25% of them stayed deficient during the summer. Also AlJohara et al. (2018) showed not only a high prevalence of vitamin D deficiency (85%, n = 2414) among the adult Saudi population but also that younger adult (78% were in the age group of 30 to 50 years) and males (72.0% vs. 64.0%) had a higher prevalence when compared to older and female participants. Moreover, Johnson et al. (2012) demonstrated that men had higher odds of vitamin D deficiency even after adjustment for the confounders such as season, age, current smoking and vitamin D supplements.

No statistical difference in vitamin D level was detected by occupation in the current study. On the contrary, Sowah et al. (2017) found that shift-workers, healthcare workers and indoor workers are at high risk to develop vitamin D deficiency which was explained by a lifestyle that limits sunlight exposure. Similar findings were reported by Gonzalez et al. (2007) and van der Meer et al. (2011). Multiple studies showed that the occupations with minimal or no exposure to sunshine even those in sunny countries, put subjects at a greater risk of developing vitamin D inadequacy (Romano et al., 2015; Kwon et al., 2015; Roomi et al., 2015; Xiang et al., 2013).

Table 2 results showed that height and family size were not statistically different between vitamin D sufficient and vitamin D deficient counterparts. However mean BMI was statistically significantly greater for vitamin D deficient subjects compared to vitamin D sufficient counterpart (35.5 ± 5.2 and 33.5 ± 3.3 kg/m², respectively). Also vitamin D sufficient were 1 cm taller than vitamin
D deficient participants with a mean +SD of 165.9 ± 8.9 and 64.9 ± 7.7 cm respectively. Age was significantly different among vitamin D sufficient and vitamin D deficient counterparts (36.0 ± 8.5 and 34.0 ± 5.8 respectively). Some studies showed a positive correlation between serum vitamin D and age (Bischoff et al., 2004; Steingrimsdottir, et al., 2005; Baradaran et al., 2012; Khazaei et al., 2017). Unlike Adamiet et al., (2008) who reported no difference between vitamin D deficiency and age.

The current study found that BMI was higher among vitamin D deficient compared with vitamin D sufficient participants. Also McGill et al., (2008) revealed a significant inverse relationships of vitamin D3 with BMI (p = 0.005).

Linear regression models showed that predictors of high BMI included serum vitamin D, education level and occupation (Table 3). The β coefficient for serum vitamin D was -0.05 (CI -0.087, -0.006; p=0.03) indicating decreased serum vitamin D with increased BMI. Similarly subject with professional occupation predicted high BMI (β=-0.42, CI -0.727—0.121; p<0.006). On the contrary educational attainment BMI increased with increased education level (β =1.00, CI 0.005-2.008; p<0.05). Similar to the current study, Chakhtoura et al., (2018) studied vitamin D deficiency in the Middle East and North Africa countries and the risk factors of vitamin D deficiency and found that the significant predictors of low 25(OH)D levels were female gender, increasing age and body mass index, veiling, winter season, use of sun screens, lower socioeconomic status, and higher latitude. Also Liu et al., (2018) reported that obese adults showed 3.09 times higher prevalence of vitamin D deficiency and 1.80 times higher prevalence of vitamin D insufficiency than non-obese adults among US population. Likewise 25(OH)D concentrations <40 nmol/L were twice likely to be found in the obese compared to non-obese and in Scottish participants than in those from other parts of Great Britain (ie, England and Wales) (P < 0.0001 for both) (Hyppönen and Power, 2017).

In conclusion, vitamin D deficiency is prevalent in Egypt among obese adults and it may be necessary to reach a desirable 25(OH)D level of 20 ng/ml to combat obesity. Studies are needed to investigate the effect of vitamin D supplementation on weight change and confirm the long term safety.
Table 1: Characteristics of participants (N=217)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Vitamin D sufficient (≥20 ng/ml)</th>
<th>Vitamin D deficient (&lt;20 ng/ml)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N=79)</td>
<td>(N=138)</td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>22 (27.8)</td>
<td>24 (17.4)</td>
<td>0.07</td>
</tr>
<tr>
<td>Females</td>
<td>57 (72.2)</td>
<td>114 (82.6)</td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td>0.23*</td>
</tr>
<tr>
<td>No education</td>
<td>11 (13.924)</td>
<td>11 (8.0)</td>
<td></td>
</tr>
<tr>
<td>&lt;12 years</td>
<td>2 (2.532)</td>
<td>18 (13.0)</td>
<td></td>
</tr>
<tr>
<td>12 years</td>
<td>35 (44.304)</td>
<td>47 (34.1)</td>
<td></td>
</tr>
<tr>
<td>&gt;12 years</td>
<td>31 (39.340)</td>
<td>62 (44.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>Housewives, unemployed</td>
<td>17 (21.5)</td>
<td>40 (29.0)</td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>6 (7.5)</td>
<td>20 (14.5)</td>
<td></td>
</tr>
<tr>
<td>White collar</td>
<td>26 (32.9)</td>
<td>29 (21.0)</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>30 (38.0)</td>
<td>49 (35.5)</td>
<td></td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
<td>0.03*</td>
</tr>
<tr>
<td>Single</td>
<td>23 (29.1)</td>
<td>23 (16.7)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>56 (70.9)</td>
<td>115 (83.3)</td>
<td></td>
</tr>
</tbody>
</table>

p-values are significantly different at p< 0.05

Table 2: Mean age, Weight, Height, BMI and family size among vitamin D deficient and vitamin D sufficient participants

<table>
<thead>
<tr>
<th></th>
<th>Vitamin D sufficient (≥20 ng/ml)</th>
<th>Vitamin D deficient (&lt;20 ng/ml)</th>
<th>T-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>36.0±  8.5</td>
<td>34.0±  5.8</td>
<td>-2.075</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>92.3±11.9</td>
<td>96.5±15.7</td>
<td>2.207</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.9±8.9</td>
<td>164.9±7.7</td>
<td>0.801</td>
</tr>
<tr>
<td>BMI</td>
<td>33.5±3.3</td>
<td>35.5±5.2</td>
<td>3.296</td>
</tr>
<tr>
<td>Family size</td>
<td>5.0±1.4</td>
<td>4.0±1.2</td>
<td>1.001</td>
</tr>
</tbody>
</table>

Values in the same row and suitable not sharing the same subscript are significantly different at p< .05

Table 3: Predictors of body mass index among adult obese participants

<table>
<thead>
<tr>
<th>Predictors</th>
<th>B-coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.1</td>
<td>0.08</td>
</tr>
<tr>
<td>Serum Vitamin D</td>
<td>-0.05</td>
<td>0.03*</td>
</tr>
<tr>
<td>Education level</td>
<td>1.00</td>
<td>0.05*</td>
</tr>
<tr>
<td>Occupation</td>
<td>-0.42</td>
<td>0.006**</td>
</tr>
<tr>
<td>Marital Status</td>
<td>1.72</td>
<td>0.08</td>
</tr>
</tbody>
</table>
References


22. Green, R. J.; Samy, G. and Miqdady, M. S. (2015); Vitamin D deficiency and insufficiency in Africa and the Middle East, despite year-round sunny days: July 2015, Vol. 105, No. 7.


40. (SPSS version 21, 2012)


دراسة العلاقة بين مستوى فيتامين د في الدم والكالة الاجتماعية والاقتصادية و معدل كتلة الجسم لأشخاص بناء

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المؤلفون العرب:

الهدف: فحص و تقييم العلاقة بين الكالة الاجتماعية والاقتصادية و معدل كتلة الجسم و مستوي فيتامين د في الدم في اشخاص مصابين بال됸 بالفيتامين D ل 3 من التحليل تصل إلى متوسط تحليل كما تتجاوز احتياجات usuario في فحص الكالة الاجتماعية والاقتصادية و الوزن و رفع الجسم و تجربة نسبة معدل كتلة الجسم لكل شخص.

النتائج: وجد أن 63.5% من الأشخاص المشاركين في البحث (عددهم 138) يعانون من نقص في معدل فيتامين D_seq. وتوزع النسبة الأكبر من من يعانون من نقص معدل فيتامين D من النساء (82.3%) ووجد أن (83.6%) من من يعانون من نقص معدل فيتامين D من الرجال. وجد أن (44.9%) منهم قد تلقي تغذياً لمدة أكثر من 12 سنة. وأيضاً وجد أن أكثر من نصف المشاركون (56.5%) كانوا من ذوي الوظائف الفنية والمهنية والإدارية أو الوظائف الفاعلة والفنية أو المهنية العليا. كما وجد أن الأشخاص الذين يعانون من نقص معدل فيتامين D في الدم كانوا أصغر في العمر من نظرائهم ذوي معدل فيتامين D الطبيعي. وجد أيضاً وجد أن الأشخاص الذين يعانون من نقص معدل فيتامين D في الدم هم الأعلى في متوسط معدل كتلة الجسم.

ووجد أن نقص معدل فيتامين D في الدم و التعليم العالي والمستوي المهني من مؤشرات ارتفاع مؤشر كتلة الجسم.

الخاتمة: يعتبر نقص فيتامين D منتشر بين المصابين بالبلاكين والذي يرتبط مع ارتفاع مؤشر كتلة الجسم والذي يتطلب أبحاث داخلية أكثر لاختبار هل يمكن لكمالات فيتامين D أن تقلل من انتشار السمنة أم لا.

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