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Original Article

Vitamin D Level among Overweight and Obese Adults Attending Outpatient Clinics at Alexandria Main University Hospital

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Abstract

Background: Vitamin D deficiency (VDD) and a high body mass index (BMI) are both regarded as serious public health issues. VDD has been documented at all stages of life and is frequently linked to the development of obesity.

Objective(s): To measure Vitamin D (Vit. D) level in overweight and obese adult patients, and to determine the effect of anthropometric measurements on Vit. D level.

Methods: A cross-sectional study was conducted by random sampling technique, upon 250 overweight and obese adult patients (62% females and 38% males) admitted to the outpatient clinics at Alexandria Main University Hospital in the period from April 2021 to September 2021. Patients were categorized according to WHO BMI classification. Data were collected by a questionnaire through interview which included data about the patients' sociodemographic characteristics. Anthropometric measurements were recorded, and the enzyme linked fluorescence assay (ELFA) method was employed to quantify serum 25(OH) D by using the Endocrine Society cutoffs to determine Vit. D level.

Results: Among 250 overweight and obese patients, 59.2% suffered from VDD. Negative correlations were found between Vit. D levels and age (r=-0.139) , weight (r=-0.844), waist circumference (r=-0.502), and truncal fat (r=-0.395).

Conclusion: More than half of the overweight and obese persons had low serum concentrations of Vit. D. Their anthropometric measurements had a negative correlation with Vit. D levels. They may need a higher dose of Vit. D supplements compared to lean subjects.

Keywords: Obesity, BMI, Vitamin D deficiency, Truncal fat, Egypt

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INTRODUCTION

Obesity constitutes a worldwide epidemiological public health problem; it is defined as an excess amount of body fat and represents a significant health problem worldwide. [(1)] According to a report published by the World Health Organization (WHO) in 2016, there were over 2 billion adults who were overweight, with 650 million of them were obese (BMI $\geq$ 30 Kg/m^2). [(2)] This equates to 39 percent of adults aged 18 and older being overweight (39 percent of males and 40 percent of females), with 13 percent who were obese. Between 1975 and 2016, the global prevalence of obesity nearly tripled.[(2)]

Obesity is one of the major public health problems. The estimated prevalence of overweight and obesity in those aged 20 years and higher with a BMI more than 25 Kg/m^2 is 61-70 percent. This equates to 65% for males and 76% for females aged 15 and above.[(3)] Based on the WHO fact sheet 2016, Egypt ranks 18th with the highest prevalence of obesity worldwide.[(4)]

Nowadays, Vit. D is often considered as a hormone more than vitamin that must be converted to its active form, 1,25 dihydroxyvitamin D, in order to have a biological effect. Vit. D is required for bone tissue growth and maintenance, as well as calcium and phosphorus homeostasis. Cell differentiation, proliferation, and hormone release are all linked to it. [(1)]

Low serum Vit. D levels are one of the metabolic abnormalities frequently associated with obesity. 25-hydroxyvitamin D serum levels are widely used as a biomarker for an individual's long-term VDD. [(1)] VDD is defined by the Institute of Medicine (IOM) as a medical condition characterized by rickets and osteomalacia, with a blood 25(OH)D concentration of less than 20 ng/mL (50 nmol/L). [(5)] Obesity and VDD are now recognized as global epidemiological issues. [6] Some studies have highlighted the link between Vit. D and body weight. VDD was linked to obesity in a meta-analysis conducted in 2015, regardless of age or latitude. In a study conducted by Vimaleswaran *et al* found that a higher BMI result in having a lower 25(OH)D levels. [7] The prevalence of VDD in overweight and obese people was shown to be quite high in another study conducted by Paul et al. [8]

Serum concentrations of 25-hydroxyvitamin D are the greatest predictor of whole-body Vit. D storage. The link between low 25(OH)D levels and obesity is well established, but the causes are not entirely understood. Obese persons have low serum concentrations of 25-hydroxyvitamin D and a high prevalence of VDD, according to many clinical and epidemiological studies, with a negative correlation between Vit. D concentrations and both of waist circumference (WC) and BMI. [9]

Obesity is a significant health problem in Egypt. [10] There is an urgent need to measure Vit. D level in overweight and obese adult patients as underlying factor of obesity. [11]

The aim of present study was to measure Vit. D level in overweight and obese adult patients, and to determine the effect of anthropometric measurements on Vit. D level.

METHODS

Study Design and Subjects

This was a cross-sectional study on 250 overweight/ obese outpatients (155 females and 95 males) aged 18 to 70 years old, categorized according to WHO classification of BMI [12] attending Alexandria Main University Hospital.

Population and Sampling

Patients who attended the outpatient clinics of Alexandria Main University Hospital for various clinical health conditions as dermatological and minor surgical procedures were randomly selected. Those taking Vit. D supplements, individuals with T1DM or T2DM, severe acute or chronic inflammatory disorders, renal or hepatic failure, neoplastic, pregnant, chronic and endocrine diseases and any recent infection were all excluded from participation in the study.

Sample size was calculated using on-line sample size calculator, based on the prevalence of VDD deficiency in previous research study in Egypt which was 83%. [13,14], 5% margin of error and 95% confidence level, the estimated sample was 217. The sample size was increased by 15% accounting for dropout or attrition of the sample, so the sample size was 250.

Data collection:

Data collection was carried out from April 2021 and to the end of September 2021 using an interview questionnaire sheet. It consisted of two parts: Part one assessed sociodemographic characters of the participants (patient's age, gender, place of residence), and Part two included data about their anthropometric measurements, weight, height, waist circumference (WC), body mass index (BMI), and truncal fat (all recorded through direct measurement).

The measurements were performed by the researchers themselves using the WHO standard technique of measuring weight and height.[12] Patients were asked to take off their shoes and wear light clothes. Body composition analysis (Inbody 270 scale) was used to determine weight (within 0.5 kgs) and truncal fat which was measured in kgs.[15]

Height was measured with a non- elastic tape (within 0.5 cm) while subjects taking off their shoes.[12] BMI was calculated by dividing weight (in kgs) by height (in meter squared) .[12] BMI was used to determine general obesity, BMI above 25 Kg/m^2 and 30 Kg/m^2 were used to classify overweight and obesity, respectively. Obesity is frequently subdivided into categories: Grade I: BMI of 30 to < 35, Grade II: BMI of 35 to < 40 and Grade III : BMI of 40 or higher. Grade III obesity is sometimes categorized as "severe" obesity.

Measurement of waist circumference (WC) (within 0.5 cm) at the narrowest point midway between the iliac crest and the last rib using a standard measuring non-elastic `tape over light clothing was used to assess central obesity, which was diagnosed when WC ≥ 88 cms for women and WC ≥ 102 cms for men.[16] For men, a waist circumference below 94 cm (37 in) is 'low risk', 94–102 cm (37-40 in) is 'high risk' and more than 102 cm (40 in) is 'very high'. For women, below 80 cm (31.5 in) is low risk, 80–88 cm (31.5-34.6 in) is high risk and more than 88 cm (34.6 in) is very high. [17]

Biochemical assay: Each subject's venous blood sample was collected. The enzyme linked fluorescent assay (ELFA) method was used to quantify serum 25-hydroxyvitamin D using the auto analyzer VID AS (Marcy, France). The venous blood samples were withdrawn by a qualified nurse at outpatient clinics of Alexandria Main University Hospital according to the standards described by Public Health Ontario, 2015. [18] Blood samples were stored then examined by ELISA Kit Monobind Inc. Lake forest, CA92630, USA, product code: 9425-300. Laboratory investigations were done at the department of Clinical Pathology, Alexandria Main University Hospital. According to the Endocrine Society's Clinical Practice Guidelines, 2011, 25-hydroxyvitamin D levels were classified as normal (≥ 30 ng/mL), insufficient (>20 to 29.9 ng/mL), and deficient (< 20 ng/mL). [8]

Statistical analysis of the data:

The IBM SPSS software programme version 20.0 was

used to analyze the data. (IBM Corporation, Armonk, NY). Number and percentage were used to describe qualitative data. The Kolmogorov-Smirnov test was employed to ensure that the distribution was normal. Range (minimum and maximum), mean, and standard deviation, were used to characterize quantitative data.
For normally distributed data, independent t-tests were used to compare two independent samples, whereas F-tests (ANOVA) were used to compare more than two samples. The Chi square test was performed for categorized parameters. The Pearson correlation coefficient was employed to investigate the relationship between the two variables. The significance threshold was set at 0.05.

Ethical considerations:
Before clinical and laboratory investigations, all study participants signed an informed written consent form which included data about objectives, methods, benefits, expected harms and confidentiality of data. Throughout the research process, the study subjects' privacy was respected. The information was kept anonymous, and each person was assigned merely a number. The Alexandria Faculty of Medicine's ethical committee approved this research with a reference number 0305324.

RESULTS

This research involved 250 patients; their age ranged between 18 to 70 years old with mean value 29.0±10. More than two fifths (44.4 %) of the studied sample were in age group 20-30 years, while more than one fifth of the studied sample (24.4%) were in the age group 30-40 years. The females constituted 62.0% of the studied group, 59.6% of cases were from urban areas. BMI ranged from 26.3-51.0 Kg/m^{2}with mean value 37.41±5.59 Kg/m^2. Regarding category of obesity, 32.0 % of cases were suffering from grade I obesity, 29.6% were grade II obesity and 32.8% were grade III and IV obesity. Vit. D level ranged from 3.0-35.0 (ng/ml) where more than half of the studied group had VDD (59.2%). Mean ±SD of waist circumference and truncal fat are 117.5±8.7 cm and 23.7±9.1 kg respectively **(Table 1).**

Table (2) showed that the mean values of different anthropometric measurements, including weight, BMI, waist circumference, and truncal fat among sufficient Vit. D group was significantly lower than insufficient, among insufficient group was significantly lower than deficient and among sufficient group was significantly lower than deficient.

There was statistically significant between females and males regarding Vit. D categories, 26.9 % and 49.6% of males and females, respectively had insufficient Vit. D level. (P<0.001). However, females with deficient Vit. D level (50.4%) had a lower percentage difference compared to males with deficient Vit. D level (68.9%) (P<0.001). These differences were statistically significant **(Table 3).**

The results revealed a negative correlation between age (r= -0.139, P=0.027), weight (r= -0.844, P=0.0001), BMI (r= - 0.605, P=0.001), waist circumference (r= -0.502 P=0.0001) and truncal fat (r= -0.395, P=0.0001) with Vit. D mean **(Table 4)**

Table (1): Distribution of the studied adult overweight/ obese patients according to their socio–demographic, anthropometric measurements and vitamin D level categories

	Adult overweight/ obese patients (n = 250)	
	No.	**%**
Age group (years)		
< 20 years	39	15.6
20-30	111	44.4
31-40	61	24.4
41-70	39	15.6
Range	18-70	
Mean ± SD.	29.0±10.2	
Sex		
Female	155	62.0
Male	95	38.0
Residence		
Rural	101	40.4
Urban	149	59.6
BMI category		
Overweight	14	5.6
Grade I obesity	80	32.0
Grade II obesity	74	29.6
Grade III and IV obesity	82	32.8
Range (kg/m^2)	26.3-51.0	
Mean ± SD	37.41±5.59	
Vit. D levels categories		
Sufficient (≥ 30 ng/ml)	5	2.0
Insufficient (20 to 29.9 ng/ml)	97	38.8
Deficient (< 20 ng/ml)	148	59.2
Range (ng/mL)	3.0-35.0	
Mean ± SD	10.3±5.2	
Waist circumference (cm) Mean ± SD	117.5±8.7	
Truncal Fat (kg) Mean ± SD	23.7±9.1	

Table (2): Relation between vitamin D level categories and anthropometric measurements among adult overweight/ obese patients

	Sufficient (n=5)	Insufficient (n=97)	Deficient (n=148)	ANOVA P value	P1	P2	P3
Weight (kg)							
Range	65.8-73.2	73.2-101.9	89.9-173.0	196.9			
Mean	69.60	90.92	117.84	0.001*	0.003*	0.001*	0.017*
SD	2.65	7.56	13.20				
BMI							
Range	26.3-29.0	27.3-45.9	28.9-51.0	61.35			
Mean	27.26	34.03	39.97	0.001*	0.004*	0.001*	0.013*
SD	1.11	3.51	5.23				
Waist circumference (cm)							
Range	95.0-110.0	95.0-134.0	98.0-139.0				
Mean	105.00	113.64	121.74	35.31			
SD	6.44	6.69	9.08	0.001*	0.001*	0.001*	0.01*
Truncal Fat (kgs)							
Range	14.8-16.1	15.0-31.0	15.0-115.0	24.4			
Mean	15.18	20.34	27.02	0.001*	0.005*	0.001*	0.01*
SD	0.52	3.18	9.89				

Post hoc bonferroni test
P1 comparison between sufficient and insufficient
P2 comparison between sufficient and deficient
P3 comparison between insufficient and deficient

Table (3): Relation between vitamin D level categories and sex among adult overweight/ obese patients

Vit. D level (ng/ml)	Sex				Total (n=250)	
	Female (n=131)		Male (n=119)			
	No.	%	No.	%	No.	%
Sufficient (≥ 30 ng/ml)	0	0.0	5	4.2	5	2.0
Insufficient (29.9-20 ng/ml)	65	49.6	32	26.9	97	38.8
Deficient (< 20 ng/ml)	66	50.4	82	68.9	148	59.2
X^2	17.42					
P	0.001*					

Table (4): Correlation between vitamin D mean (ng/ml) and some variables

Vitamin D mean level (ng/ml)	Pearson correlation coefficient	P value
Age (years)	-0.139	0.027*
Weight (kg)	-0.844	0.0001*
BMI	-0.605	0.001*
Waist circumference (cm)	-0.502	0.0001*
Truncal Fat (kgs)	-0.395	0.0001*

DISCUSSION

The link between low Vit. D serum levels and obesity is well established in many studies.[1,6] This work has the advantages of investigating this association, upon 250 outpatients (155 females and 95 males) aged 18 to 70 years old, categorized according to WHO classification of BMI. From April 2021 to September 2021. The majority of the sample (98%) were either insufficient or deficient where the Vit. D levels ranged from 3.0-35.0(ng/ml). More than half of the studied group was deficient (59.2%). These findings are similar to study conducted in Central Laboratory, Duhok/Kurdistan Region of Iraq upon of 391 apparently healthy volunteer by Abdulrahman et al. (2022), [19] they stated that more than 50% of the participant had deficient Vit. D levels less than 20 ng/ml.

Vitamin D status was significantly related to the categories of BMI, which was consistent with the results of Miñambres et al. (2012), [20] as they found that patients with Vit. D deficiency had higher BMI and WC.

Central obesity and wide waist circumference are important public health problems. High waist circumference is linked to potential development of non-communicable diseases.[20] The current study reported an inverse relationship between low serum Vit. D levels and increasing WC and truncal fat mass and this was in accordance with the meta-analysis and systematic review conducted by Hajhashemy et al. (2021), [21] which revealed that in a dose–response manner, blood Vit. D level was found to be negatively linked with the incidence of visceral obesity in adults. Supplementation with Vit. D, on the other hand, had no effect on the BMI, WC, or WHR of healthy people in another recent research conducted by Duan et al. (2020). [22]

In terms of sex and Vit. D levels, the current study found that Vit. D deficiency was significantly higher among males than females (below 20 ng/ml) . This was in line with the findings of AlQuaiz et al. (2018) [23] who discovered that males had a higher frequency of Vit. D deficiency than females, however in studies conducted by Muscogiur et al. (2019), [24] and Sanghera et al. (2017) [25] they stated that decreasing 25 (OH) Vit. D concentrations in females than males may be interpreted by sex different meal habits. Females eat less fish, which is presently considered the main dietary source of Vit. D, and female sex was attributed to more frequent and excessive sunscreen use than male sex. An estrogen-related increase in hepatic hydroxylation of Vit. D and its binding to protein levels in circulation could explain the distinct action of sex hormones on Vit. D metabolism. In healthy Korean men, total and free testosterone concentrations had also been found to be associated with 25(OH) Vit. D concentrations. [24, 25]

In this study there were negative significant correlation between age, weight, BMI, WC and truncal fat with Vit. D level. Regarding age, this study found a significant negative correlation between increasing age and the occurrence of VDD, which is consistent with Gallagher et al. (2013) [26] who found that age-related deficiency affected Vit. D metabolism and reduced the nutritional status of the old age, therefore Vit. D supplementation should be recommended in this age group.

Negative association between increasing weight and BMI and serum Vit. D levels in adults, adolescents, and children was reported by Zhao et al. 2021.[27] Another study concluded that low Vit. D levels was due to decrease in the rate of metabolism and increase in depression that led to overeating and decreasing outdoor activities and exposure to sun (Imaware, 2020). [28] Vit. D insufficiency can promote increased adiposity by increasing parathyroid hormone levels and calcium input into adipocytes, resulting in increased lipogenesis. [7] Vit. D deficiency can cause pre-adipocytes to differentiate too quickly into adipocytes. [29] All previous findings come in agreement with current results.

The study main limitations were lack of availability of seasonal data for serum 25-hydroxyVit. D3 sampling and information regarding daily duration exposure to sun, dress style covering their body especially among women and their food style.

CONCLUSION AND RECOMMENDATIONS

According to the results of this study, Vit. D insufficiency and deficiency were high among patients with higher weight, BMI, waist circumference and truncal fat among adults.

It was suggested that a large-scale community-based study be done to investigate the vitamin D status in the population, including normal weight subjects, compared to overweight and obese and studying other factors, as daily duration exposure to sun, dress style covering their body especially among women and their food style.

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