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Correlation between Serum Vitamin D Status and Bone Health in Obese Women

[1]AlbaikMM, [2]Jalal JA, [3]Ardawi MS, [4]Said S. Moselhy

[1,2,4]Department of Biochemistry, Faculty of Science, King Abdulaziz University (POBox.80203), Jeddah , Saudi Arabia
[3]Clinical Biochemistry Department, Faculty of Medicine, King Abdulaziz University.
[123]Excellence for Osteoporosis Research Center, King Abdulaziz University.
[4]Biochemistry Department, Faculty of Science, Ain Shams University, Cairo, Egypt.

Abstract: **Obesity and Vitamin D deficiency are now considered a morbidity phenomenon prevalent in the whole world. Moreover, obese subjects are known to have lower vitamin D levels compared to non-obese subjects. The objective of the current study is evaluate vitamin D status in obese women in Saudi Arabia through serum [25(OH)D] and to predict the factors that contribute to vitamin D influence. Moreover, predictive model for body mass index (BMI) was built for Saudi women.Two hundred seventy one Saudi women, aged between 20-40 years, living in Jeddah, Saudi Arabia were conducted with this study. Women were stratified according to their body mass index (BMI) into overweight with 25-<30 kg/m2 and obese with BMI ≥30 kg/m2.The results of the present study showed that prevalence of obesity was estimated by 52.1% (29.2% overweight and 22.9% obese) while the prevalence of vitamin D deficiency and insufficiency in control group (43.8% and 46.9%, respectively), overweight group (44.3% and 49.4%, respectively) and obese group (59.7% and 32.3%, respectively) giving overall deficiency and insufficiency in all women (47.6% and 44.3%, respectively) regardless of BMI. Furthermore, our result showed that serum [25(OH)D] has no significant difference between the studied women in relation to their BMI unless classifying our data to three vitamin D levels into (deficiency serum [25(OH)D] <24.9, insufficiency 25-74.9 and sufficiency ≥75 nmol/L). After this classification, a negative association was shown between serum [25(OH)D] and BMI for only the sufficient group in obese women. However, our results showed that serum [25(OH)D] was presented as a predictive factor of obesity at (P< 0.018, importance 8%) with accuracy (91.7%). The significant variables arranged in descending order of importance were as follows: Tissue fat (22%), HC (19%), BMC (17%), fat free (11%), A/G ratio (10%), serum [25(OH)D] (8%), WHR (5%),**

Tissue (4%) and LDL (4%).In conclusion, the present study has demonstrated that vitamin D deficiency and insufficiency are rather highly prevalent among Saudi women regardless obesity. Obese women are advised to control their weights and to do routine vitamin D assessment.

Keywords: **Obese- bone health- vitamin D**

I. INTRODUCTION

The hypothesis is that vitamin D deficiency is the cause of obesity and that obesity can be reversed by improving vitamin D status [1]. Low serum [25(OH)D] is involved in obesity whether obesity is assessed by BMI or waist circumference [2].Obesity is a risk factor for hypovitaminosis D because obese people often have less exposure to sun exposure due to limited mobility and making less physical activity [3], the possible trapping of vitamin D by the adipocytes [4], fat soluble vitamin D is stored in the body fat compartments reducing its bioavailability [5], the need for vitamin D for stronger bones to support their greater weight in addition to clothing habits [6],The metabolic changes initiated from augmented adipocytes mass. Most effects of obesity comprise dyslipidemias, glucose intolerance, insulin resistance triglyceride [7], increased arterial blood pressure; elevated circulating concentrations of triaclyglycerols, lowered of high density lipoprotein cholesterol [8].Some physical and mental illnesses can increase risk of obesity as hypothyroidism, Cushing's syndrome, growth hormone deficiency and the eating disorders [9]. Certain medications like steroids, atypical antipsychotics and some fertility drugs may lead to gain the weight [10].

Hormonal signals secreted according to amount of fat 2. Adipocytokines released response to inflammatory condition 3. Acute-phase released response to metabolic syndrome. Appetite (Leptin and resistin decrees appetite while adiponectin and adipocytokines increase appetite).Gut peptide, Glucostatic and thermostatic hypothesizes responsible for appetite and body weight regulation It was suggested an interaction between

vitamin D status and fat distribution through the association between lower amount of visceral and subcutaneous adipose tissue and reducing of omental adipocyte size.Moreover, secondary hyperparathyroidism is assumed to detect mostly in overweight and obese subjects which is may due to low serum [25(OH)D] [11]. The objective of the present study is to assess vitamin D status in obese Saudi women. Therefore, this study aimed to:evaluate serum [25(OH)D] for the total women and for the stratified women according to the obesity category. predict the factors that contribute to vitamin D influence. build a predictive model that can be used to estimate the BMI for the Saudi women based on the significant factors.

II. SUBJECTS AND METHODS

Two hundred seventy one Saudi women, aged between 20-40 years, living in Jeddah, Saudi Arabia (Latitude 21.4500 degrees North and Longitude 39.8167 degrees East) were contacted by phone to explain the study importance and to arrange an appointment in CEOR clinic. Women who agreed to participate in the study were signed a written informed consent and answered a questionnaire concerning to demographic information, medical history, lifestyle and drug intake. The subjects should be free of all diseases that interfere with obesity such as polycystic ovary syndrome, diabetes mellitus, hyperthyroidism, hyperprolactinaemia, menstrual disturbance, hypertension, psychiatric disorder. he study was conducted from November 2013 to September 2014. The study was approved by the Human Research Ethics Committee of CEOR, KAU and was in agreement with ethical standards of the Helsinki Declaration of 1975. Studied subjects were medically examined at the CEOR clinic, provided blood samples and measured their fat distribution by dual energy X-ray absorptiometry (DXA).Venous blood was collected in the morning after fasting for 8 hrs. Serum samples were centrifuged at 3,000 g/ 15 min by (Clay – Adams, USA) centrifuge then stored at -80°C until examined the following parameters, [25 (OH)D], calcium, phosphorus, intact PTH . Biochemical kit for the determination of [25(OH)D] was obtained from DiaSorin Inc, Stillwater, MN, USA and measured by using LIASON autoanalyzer .

III. STATISTICAL ANALYSIS

Statistical analysis of the data was carried out using computer program package(SPSS, version 22).One-Way ANOVA test was used to examine differences among the groups for different variables. A relationship between vitamin D status and BMI was assessed by Bivariate Pearson correlation analysis. Automatic Linear Regression was used to predict the factor of obesity. Differences were considered significant at $P < 0.05$.

IV. RESULTS

The present study was performed to assess the vitamin D status in Saudi obese women. Therefore, serum [25(OH)D] was evaluated for the total women and for the stratified women according to the obesity category. Furthermore, the current study aimed to predict the factors that contribute to vitamin D influence through building a predictive model. Moreover, this study aimed to build a predictive model that can be used to estimate the BMI for the Saudi women based on the significant factors. An example will be shown to evaluate the predicted models obtained.The prevalence of obesity was classified in the present study by the popular methods. By using body mass index (BMI, kg/cm2) method; it was estimated by 52.1% (29.2% overweight and 22.9% obese) while it is displayed as 96.7% of the enrolled women by using total body fat (TBF, >30%) whereas it is exhibited by waist to hip ratio (WHR) scale as 100% of studied women. However, BMI category was chosen to classify the obesity in this study.In the current study, abdominal obesity was evaluated 28.8% by using waist circumference (WC, >88 cm)

scale.Table 2 showed a highly prevalence of vitamin D deficiency and insufficiency as expressed by (serum [25(OH)D] <24.9 and 25-74.9 nmol/L, respectively), in all studied women (47.6% and 44.3%, respectively), regardless of BMI. The same finding of vitamin D deficiency and insufficiency were found when the women stratified to their BMI, in control group (43.8% and 46.9%, respectively), overweight group (44.3% and 49.4%, respectively) and obese group (59.7% and 32.3%, respectively)..Fat Distribution and Body Composition (table 3)The fat distribution and body composition were

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evaluated in table 4.3. This table showed highly significant increasing in all studied parameters between control, overweight and obese groups; total Mass (kg), tissue (%fat), tissue (g), fat (g), fat free (g), lean (g), bone mineral content (BMC, g), Android, Gynoid, Android to Gynoid (A/G) ratio and total bod fat (TBF, %) at P< 0.0001 while fat region (%) was significant at P< 0.05.

Table 1. Anthropometric data of the studied women

Variables	Control (n= 160)	Overweight (n= 91)	Obese (n= 74)	*P*-value
Weight (kg)	53.1 ± 6.8	67.7 ± 5.5	85.7 ± 11.8	0.0001***
Height (m)	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	0.913
BMI (kg/m^2)	21.3 ± 2.5	27.3 ± 1.5	34.3 ± 3.7	0.0001***
HC (cm)	94.4 ± 6.5	105.3 ± 5.1	116.8 ± 7.7	0.0001***
WC (cm)	73.25 ± 7.5	86.0 ± 6.3	98.4 ± 9	0.0001***
WHR	0.8 ± 0.1	0.8 ± 0.1	0.8 ± 0.1	0.0001***

Values are presented as means±SD; BMI: body mass index; HC: hip circumference; WC: waist circumference; WHR: waist to hip ratio; *** Highly significant *P*< 0.0001.

Table 2. Body composition and fat distribution of women distribution of women

Variables	Control (n= 130)	Overweight (n= 79)	Obese (n= 62)	*P*-value
Total Mass (kg)	52.2 ± 6.7	67.276 ± 5.9	83.941 ± 11.64	0.000***
Tissue (%Fat)	38.7 ± 5.1	46.046 ± 4	50.330 ± 4.31	0.000***
Tissue (g)	50224.61 ± 6534.12	65158.98 ± 5865.24	81759.85 ± 11351.1	0.000***
Fat (g)	19662.21 ± 4536.45	30145.43 ± 4128.56	41403.79 ± 8152	0.000***
Fat Free (g)	32521.60 ± 3291.64	37189.65 ± 3523.74	42542.66 ± 5222.88	0.000***
Lean (g)	30559.81 ± 3137.24	35004.02 ± 3337.84	40232.73 ± 5017.98	0.000***
BMC (g)	1960.86 ± 217.17	2340.97 ± 2011.76	2309.92 ± 281.43	0.025*
Region (%Fat)	37.29 ± 5.02	44.640 ± 3.7	49.081 ± 4.18	0.000***
Android	34.4 ± 8.5	47.1 ± 5.6	54.3 ± 5.5	0.000***
Gynoid	45.7 ± 5.1	51.9 ± 4	53.9 ± 4.6	0.000***
A/G ratio	0.7 ± 0.1	0.9 ± 0.1	1.0 ± 0.1	0.000***
TBF (%Fat)	38.7 ± 5.1	46.0 ± 4	50.3 ± 4.3	0.000***

Values are presented as means±SD; BMC: bone mineral content; A/G ratio: android to gynoid ratio; TBF: total body fat; * Significant *P*< 0.05; *** Highly significant *P*< 0.0001.

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Table 3. Importance and significant of variables affecting BMI

Predictor	**Importance**	***Coefficient Estimation***	***P*-value**
Tissue Fat (%)	22%	Positive	0.001***
HC (cm)	19%	Positive	0.001***
BMC (g)	17%	Negative	0.001***
Fat Free (g)	11%	Positive	0.005***
A/G ratio	10%	Positive	0.006***
Serum [25(OH)D] (nmol/L)	8%	Negative	0.018**
WHR	5%	Positive	0.045**
Tissue (g)	4%	Positive	0.09**
LDL (mmol/L)	4%	Positive	0.115

Values given in parenthesis are percentages out of total within the group; HC: hip circumference; BMC: bone mineral density; A/G: android to gynoid ratio; WHR: waist to hip ratio; LDL: low density lipoprotein; ***Highly significant $P<0.0001$; **significant $P< 0.01$.

V. DISCUSSION

Common obesity has become prevalent in recent decades; overweight and obesity are considered as major public health problems [15].Our results showed prevalence of obesity as defined by BMI (29.2% overweight and 22.9% obese), by TBF (96.7%) and by WHR (100%) of studied women. This growth of overweight and obesity may be due to increasing in population size and total calorie intake, in addition to physical activity reduction in Saudi Arabia. The prevalence of overweight and obesity were demonstrated in previous studies. It was reported that 39% of adults were overweight and 13% were obese in 2014. A prevalence overweight was 23.2% (women 22.4%) and obesity was 9.8% (women 11.9%) in the world and in various regions. In the Mediterranean regions, there has been an important increase in the prevalence of excess weight (overweight and obesity) in recent years, more so in women [16]. In Saudi Arabia, were reported the prevalence of overweight was 36.9% (females 31.8%) and prevalence of obesity was 35.5% (females 44%). By 2030, the estimated absolute numbers were projected to total 2.16 billion overweight and 1.12 billion obese individuals [17].

The results of the present study revealed a logically significant increasing in all anthropometric characteristic (height is excluded), fat distribution and body composition caused by weight gain resulted from fat mass accumulation that increases in body size [18]. A highly prevalence of vitamin D deficiency and insufficiency were shown in present study in all studied women (47.6% and 44.3%, respectively), in control women (43.8% and 46.9%, respectively), in overweight women (44.3% and 49.4%, respectively) and in obese women (59.7% and 32.3%, respectively). This prevalence may be explained by traditional lifestyles and Islamic clothing that covered skin from sun exposure since vitamin D is considered as a photoreceptor retained the UVB radiation [19],or may be due to race and ethnicity ,moreover, foods are too low in vitamin D amount to achieve a [25(OH)D] level of 75 nmol/L [20].

This finding was consistent in several studies around the world; Van Schoor and Lips reported that vitamin D deficiency has a high prevalence over the world; they determined risk factors for vitamin D deficiency as low sun exposure, skin

pigmentation, sunscreen use, skin covering clothes and a diet low in fish and dairy products. In other study done by [20], concluded that insufficient vitamin D status is prevalent in Asia, Europe, Middle East and Africa, Latin America, North America, and Oceania–through a survey of published literature. Depending on the region, between 50% and more than 90% of people had [25(OH)D] concentrations below 50 nmol/L. In Europe and Asia, vitamin D status was stated who concluded that vitamin D deficiency is common in Southern Europe, the Middle East, India, China and Japan. It is less common in Northern Europe and Southeast Asia. He demonstrated that important factors are skin type, sex, clothing, nutrition, food fortification, supplement use, BMI and degree of urbanization. In Saudi Arabia,confirmed vitamin D deficiency among healthy Saudi pre- and postmenopausal women that is attributed to obesity, poor exposure to sunlight, poor dietary vitamin-D supplementation and age [21].Although, this inverse association between vitamin D deficiency and obesity was demonstrated in many researches [23], our result didn't show a statistical difference between vitamin D

deficiency and body weight. This discrepancy may be due to race or population, in addition to all studied women, control, overweight and obese women were suffering from vitamin D deficiency and insufficiency.

However, the hypothesis of a negative relationship between serum [25(OH)D] and BMI was achieved after classifying our data to three categories according to their vitamin D level (deficiency, insufficiency and sufficiency) as serum [25(OH)D] (<24.9, 25-74.9 and ≥75 nmol/L, respectively), After this stratification, a negative association was presented for the sufficient group in obese women and this relation was exhibited as mathematical equation which let us unable to predict the woman BMI from the her vitamin D level or predict the vitamin D level from her BMI. Furthermore, many parameters may play as important factors were not measured in this study such as a negative feedback from elevated 1,25(OH)D and parathyroid hormone levels effect on hepatic synthesis of [25(OH)D][22].

In conclusion, the present study has demonstrated that vitamin D deficiency is rather highly prevalent among Saudi women, obese or non-obese. It seems obvious that further studies are needed to address the best preventive practical measures to overcome vitamin D deficiency or insufficiency in Saudi women

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