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Study of the Possible Effect of Obesity on Vitamin D Level among a Sample of Adult Men in the Western Region of Kingdom of Saudi Arabia

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Authors' contributions

This work was carried out in collaboration between all authors. Authors M-SMA and AZE designed the study, wrote the protocol, managed the literature searches, edited the manuscript and supervised the work. Author MMK collected data and wrote the first draft of the manuscript. Author MH revised the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aim of the Study: This cross sectional study was aimed to investigate the effect of obesity on vitamin D levels in adult male in the western region of Saudi Arabia.
Study Design and Methods: One hundred twenty two Healthy men, aged 20–45 years are included in this study. They were divided into normal (n=48), overweight (n=26) and obese (n=48), according to their body mass index (BMI). Serum 25[OH]D, parathyroid hormone (PTH) and calcium

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were measured in different BMI groups. We also measured total body fat percentage (TBF%) and bone mineral density (BMD) in Spine (L1–L4), Femur Neck and Total Body, by DXA technique.
Results: Of the total participants, 94.9% had vitamin D deficiency with a mean 27.6±10.78 nmol/L (normal level; 75-250 nmol/L). The mean serum levels for 25(OH)D for the normal, overweight and obese groups were 28.7±12.16 nmol/L, 27.0±8.71 nmol/L and 27.0±10.43 nmol/L, respectively. Of the total participants, 89.4% had an above-average TBF%, and it was negatively correlated with serum 25(OH)D. Serum calcium was significantly lower in the obese group compared with the normal BMI group (P<0.001). Serum PTH was significantly higher in the obese group compared with the normal BMI group (P<0.023). The BMI was significantly positively correlated with the different BMD measurements. Of our participants, 62% were physically inactive and only 14% were exposed to sunlight.
Conclusion: The prevalence of vitamin D deficiency in Saudi Arabian men is high, regardless of differences in BMI. Elevations in TBF% in different BMI categories play an important role in elevated vitamin D deficiency rates. A sedentary lifestyle and elevated adiposity contribute to an elevation in the vitamin D deficiency rate.

Keywords: vitamin D; Body mass index; bone mineral density; obesity.

1. INTRODUCTION

Vitamin D is one of the fat-soluble vitamins [1,2]. It is also considered a steroid hormone depending on its action [3,4], and is present in two forms, vitamin D2 and D3, according to its origin. D2 is only derived from dietary sources, whereas D3 comes from dietary sources and can be synthesized in the body. Both D2 and D3 are inactive in the body, and they are activated through two hydroxylation reactions. The first hydroxylation reaction occurs in the liver and the second hydroxylation reaction occurs in the renal and extrarenal tissues [4].

Vitamin D is vital for many functions in the human body. The most important function of vitamin D is promoting absorption of calcium and phosphorus from the gut [5,6]. Also, it has an important role in maintaining the homeostasis of calcium and phosphorus in the body. Furthermore, it is important for skeletal growth, bone mineralization and bone metabolism [5,6].

Nearly one billion people of all ages around the world suffer from vitamin D deficiency [6-8] that could lead to many disorders, such as hyperparathyroidism, increased bone loss, increased possibility of fractures, tooth loss, rickets, osteomalacia, osteoporosis, dermopathy, asthma, cardiovascular diseases, depression, retinopathies, hypertension, hyperlipidemia and some types of cancer, such as breast, colon, prostate and esophageal cancer [5,8-13].

Obesity is a major health problem today [14]. Globally, it is considered the fifth leading cause of death [15]. According to the World Health Organization (WHO), in 2014, more than 1.9 billion adults around the world were suffering from overweight and obesity [16]. About 13% of adults around the world (11% of men and 15% of women) were obese, and 39% of them (38% of men and 40% of women) were overweight. Recently, in 2015, about 2.3 billion adults worldwide were suffering from overweight and 700 million were suffering from obesity according to WHO [17]. Overweight and obesity are defined as abnormal or excessive fat accumulation in the adipose tissues that may impair health [15,16].

Obesity is related to many health problems, such as type II diabetes mellitus, coronary artery disease, hypertension, stroke, metabolic syndrome, dyslipidemia, liver and gallbladder diseases, abnormal menses and infertility [15, 18-20]. Moreover, it is a predisposing factor for some types of cancer (endometrial, breast, and colon), psychological disorders, osteoarthritis, degenerative joint disease, dyspnea and sleep disturbances, such as obstructive sleep apnea [14,16,21,22]. In addition, there is a positive correlation between an increased BMI and an increased incidence of fractures, especially of the hip [23]. Moreover, overweight and obese individuals are more prone to vitamin D deficiency, and a negative correlation exists between vitamin D levels and BMI due to many factors, such as trapping vitamin D in adipose tissues and the obese individuals' lower exposure to sunlight due to less mobility, cosmetic reasons, and clothing habits of wearing wide clothes that cover their whole body [5,24-31]. So,the aim of the current study is to investigate the effect of obesity on the vitamin D level in men of the Western Region of Saudi

Arabia and to correlate this with body mass indices and some biochemical parameters.

2. SUBJECTS AND METHODS

This cross – sectional study was approved by the Department of Clinical Biochemistry at the Faculty of Medicine at King Abdulaziz University, Jeddah. It was then submitted to the Deanship of Graduate Studies and approved. This study was carried out at the Center of Excellence for Osteoporosis Research (CEOR) at King Fahd Center for Medical Researches, Jeddah.

The participants were recruited through advertisements on social media, such as Whats-App, and from outpatient clinics of the CEOR. We accepted only apparently healthy males, aged between 20 and 45 years old. The exclusion criteria from the current study include any one with chronic diseases such as renal failure, hepatic disorders, hypertension, diabetes mellitus, osteoarthritis and established osteoporosis, or have hormonal disorders (hyperthyroidism, hyperparathyroidism, etc.), blood disorders, or have a recent fracture (within the last two years), or those on medication that influences bone metabolism (e.g., glucocorticoids, calcitonin, anticonvulsants or thyroid hormones).

All eligible men for inclusion in this study were given an appointment to attend the clinic in the CEOR for examination. On average, two people were examined each day from Sunday to Thursday between January 2014 and April 2015. At the end of the study, we had a total of 122 participants.

Before starting to collect data from the participants, we explained the objectives of this study and its procedure to them. The examination began by taking written and signed consent from each man to participate in the study. Then, we filled out the questionnaire prepared by the CEOR [32].The questionnaire contains five sections; the first section includes basic information, the second section concerns the health status of the participant, the third section in about the participant life style, the fourth section as about the regular usage of any medication and the fifth section is about the consumption frequency of some food.After filling out the questionnaire, we calculated the BMI via the ordinary scales used in the measurements of height and weight [10].

2.1 Biochemical Investigation

12 Hours overnight fasting venous blood sample was collected by venipuncture under standardized conditions. The blood sample was collected in plain tubes, allowed to clot for 30 minutes, then centrifuged at 7,000 rpm for 15 minutes to collect serum. Serum samples were divided into aliquots and stored at -80◦C in special cups to avoid light exposure. The serum samples remained frozen until the time of analysis of the following parameters were done:

Quantitative estimation of serum 25(OH)D levels were carried out using a DiaSorin LIAISON system autoanalyzer through a LIAISON 25 OH Vitamin D total assay that uses direct competitive chemiluminescence immunoassay (CLIA) technology (DiaSorin Inc, Stillwater, MN, USA). Serum PTH levels measured by the Cobas e411 immunoassay auto-analyzer through the PTH assay that uses electrochemiluminescence immunoassay (ECLIA) technology (Roche Diagnostics GmbH, D-68298 Mannheim, Germany). The sensitivity of the assay is 0.64 pmol/L (6 pg/ml), and intra- and interassay CV percentage were 4.9% and 5.3%, respectively. Serum calcium level estimation, we used VITROS 250 Chemistry System auto-analyzer (Ortho-Clinical Diagnostics, Johnson & Johnson Co, USA) through a calcium slide method that uses Colorimetric analysis technology. All samples were analyzed simultaneously to minimize interassay variability as possible.

2.2 Bone Mineral Densitometry (BMD) and Whole Body Fat Percentage Measurements

Measurement of BMD for the spine (L1–L4), mean of proximal right and left femurs (total and subregions) and for whole body by DXA, was performed using GE Medical Systems Lunar, iDXA model (LUNAR Prodigy Model, Lunar Corp., Madison, WI) according to standard protocol as described previously [33]. This instrument was also, used for assessing the whole body fat percentage.

2.3 Statistical Analysis

The collected data were entered and analyzed using IBM SPSS statistical software (version 20). The results are presented as means (±SD) or as frequencies according to variable types. We compared the different variables according to

BMI classes, through one way ANOVA test and independent t-test. We also used the post hoc test (Fisher's least significant difference [LSD]) for multiple comparison and Pearson correlation coefficient to make correlations between different variables.

3. RESULTS

One hundred twenty two healthy adult men from 134 are included in the current study. They are age matched(mean age for all participants is 31.6.81±6.81)and there is no significant difference between them in the different BMI categories (normal, overweight and obese) (P=0.215).BMI and fat tissue percentage are significantly higher in obese group when compared with the other two groups(P< 0.000).While, there is no statistically significant differences between them regarding physical activity(P=0.450),smoking habit(P=0.148),sun exposure (P=0.525) and dairy products intake (P = 0.250) Table 1.

In Table 2; the results of the biochemical parameters and bone mineral density are listed. Serum 25 (OH) vitamin D levels show non significant differences between all the studied groups but all of them are below normal level .This indicates that all of them suffer from vitamin D deficiency (mean level for all participants 29.0± 14.23 nmol/L). Moreover, serum Ca levels shows statistically significant lower values as the body weight and BMI increase (obese > overweight > normal) (P=0.001), while the other parameters show non significant changes between the studied groups. Bone mineral density parameters (BMD-total body, BMD-spine and BMD femur neck) show statistically significant lower values in obese individuals when compared with the individuals of the other groups (P=0.041,0.048 and 0.0001 respectively).

Table 3 represents the distribution of all participants based on their serum 25 (OH) vitamin D level on the different BMI groups. Moreover, Table 4 represents a similar distribution regarding fat tissue percentage.

Pearson correlation coefficient between the investigated parameters in all the studied groups (n=122) is presented in Table 5. The following important findings are observed: there are statistically significant positive correlation between serum 25(OH)vitamin D and BMD-total body, BMD-spine and BMD-femur neck. While it shows statistically significant negative correlation with total fat percentage and BMI. Moreover, Body mass index (BMI) shows statistically positive correlation with the different bone mineral density parameters (BMD total body, BMD femur neck and BMD spine respectively).

Table 1. Main characteristics of the participants according to BMI categories

Variables	All participants (n=122)	Body Mass Index (BMI) categories			ANOVA (P Value)
		Normal (n=48)	Overweight (n=26)	Obese (n=48)	
AGE(Years)	31.5±6.81	31.0±7.13	32.0±6.98	33.6±5.61	0.215
BMI(Kg/m^2)	28.2±6.53	22.54±1.77	27.8±1.33	34.6±4.24	0.000*
Fat Tissue (%)	35.3±7.62	28.0±5.81	34.7±4.28	40.6±5.78	0.000*
Physical Activity					
High	28(23%)	12(25%)	8(30%)	8(17%)	0.450
Moderate	18(15%)	7(15%)	3(12%)	8(17%)	
Sedentary	76(62%)	29(60%)	15(58%)	32(66%)	
Smoking					
Yes	33(27%)	12(25%)	4(15%)	17(35%)	0.184
No	89(73%)	36(75%)	22(85%)	31(65%)	
Sun Exposure					
Yes	17(14%)	5(10%)	4(15%)	8(17%)	0.525
No	105(86%)	43(90%)	22(85%)	40(83%)	
Dairy products intake					
Yes	82(67 %)	36(75%)	14(54%)	32(67%)	0.250
No	40(33 %)	12(25%)	12(46%)	16(33%)	

**Significant Correlation (P < 0.05)*

Table 2. The biochemical parameters and Bone Mineral Density of the participants according to BMI categories

Variables	All participants (n=122)	Body Mass Index (BMI) categories			ANOVA (P Value)
		Normal (n=48)	Overweight (n=26)	Obese (n=48)	
Serum 25(OH)D (nmol/L)	29.0±14.23	30.4±17.11	28.7±12.27	27.9±12.05	0.676
Serum Ca (mmol/L)	2.4±0.16	2.4±0.19	2.4±0.12	2.3±0.13	0.001*
Serum Inorganic Phosphate (mmol/L)	1.5±0.64	1.5±0.63	1.6±0.92	1.4±0.44	0.403
Serum intact PTH (pmol/L)	5.1±2.90	4.9±3.66	4.6±1.76	5.6±2.07	0.532
BMD (g/cm^2)					
Spine (L1-L4)	1.11±0.12	1.17±0.22	1.13±0.09	1.07±0.11*	0.041*
Femur (Neck)	1.03±0.13	1.11±0.13	1.06±0.14	1.01±0.09*	0.048*
Total body	1.17±0.10	1.21±0.11	1.16±0.12	1.11±0.08*	0.000*

**Significant Correlation (P < 0.05)*

Table 3. Distribution of the participants according to BMI categories on different Serum 25(OH)D (nmol/L)

Serum 25(OH)D (nmol/L) cutoff value	Serum 25(OH)D (nmol/L)	All participants (n=122)	Body Mass Index (BMI) categories		
			Normal (n=48)	Overweight (n=26)	Obese (n=48)
<12.5		0			
≥12.5- <25	19.5±3.62	58(47.5%)	23(48.1%)	11(42%)	24(50%)
≥25- <50	32.3±5.85	55(45.1%)	20(41.6%)	14(54%)	21(44%)
≥50- <75	62.6±7.60	8(6.5%)	4(8.3%)	1(4%)	3(6%)
≥75		1(0.9%)	1(2.0%)		

Table 4. Distribution of fat tissue percentage on different BMI categories

Fat tissue percentage	All participants (n=122)	Body Mass Index (BMI) categories			Serum 25(OH)D (nmol/L)
		Normal (n=48)	Overweight (n=26)	Obese (n=48)	
Average (<25%)	n= 18(14.8%) 21.21±2.56%	n= 17(35.4%) 21.3±2.71%	n= 1(3.8%) 20.8±0.0%	n= 0	28.3±22.51
Over the Average (≥25%)	n= 104(85.2%) 36.93±6.19%	n=31(64.6%) 31.5±3.88%	n= 25(96.2%) 35.3±3.16%	n= 48(100%) 40.8±5.31%	29.1±12.41

4. DISCUSSION

Geographic location played a significant role in vitamin D status [7]. Saudi Arabia is one geographic area where vitamin D deficiency is highly prevalent [25] in spite of Saudi Arabia is one of the sunny countries which is supposed to be less liable to develop vitamin D deficiency among its population [33]. For example, Ardawi et al. [10] and Elshafie et al. [8] investigated vitamin D status in men in Saudi Arabia, and found that 87.8% and 92%, respectively, of their participants had vitamin D deficiency. In the present study, we found 94.9% of our participants had vitamin D deficiency (serum 25(OH)D < 50 nmol/L). The high percentage of vitamin D deficiency may be attributed to elevations in total body fat percentage in different BMI categories of our participants. This result may be explained by the hypothesis that refers to the sequestering of vitamin D in fat compartments [6,9,17,25,26]. Also, slower mobilization of vitamin D from adipose tissues leads to less bioavailability of vitamin D in fatty individuals [10,25,26]. This suggestion was supported by the vitamin D levels returning to the normal range in those individuals who have undergone intestinal bypass [2]. It is reported that low circulating levels of 25(OH)D in obese individuals were due to feedback inhibition of hepatic hydroxylation of vitamin D by elevation of serum 1,25(OH)2D; therefore, after weight loss, the serum 1,25(OH)2D decreased, which allowed for 25(OH)D to return to normal values. On the

Table 5. Pearson correlation coefficient between different measured variables

Pearson Correlation		Serum 25(OH)D	Age	BMI	Total Body Fat %	Serum Calcium	Serum PTH	BMD Spine L1-L4	BMD Femur Neck
BMD	*r*	0.024	0.059	0.474	0.215	-0.126	0.029	0.772	0.712
Total Body	*P*	0.041*	0.554	0.000*	0.029*	0.215	0.847	0.000*	0.000*
BMD	*r*	0.161	-0.256	0.245	0.004	-0.155	0.021	0.689	
Femu	*P*	0.043*	0.004*	0.007*	0.965	0.094	0.870	0.000*	
Neck									
BMD	*r*	0.116	0.229	0.263	0.126	-0.078	0.127		
Spine L1-L4	*P*	0.032*	0.066	0.003*	0.198	0.405	0.314		
Serum PTH	*r*	-0.018	-0.071	0.352	0.460	-0.321			
	P	0.039*	0.460	0.004*	0.001*	0.010*			
Serum	*r*	-0.062	-0.160	-0.342	-0.323				
Calcium	*P*	0.514	0.085	0.000*	0.001*				
Total Body	*r*	-0.066	0.342	0.810					
Fat%	*P*	0.048*	0.000*	0.000*					
BMI	*r*	-0.063	0.294						
	P	0.049*	0.001*						
Age	*r*	0.179							
	P	0.051							

**Significant Correlation (P < 0.05)*

other hand, the availability of the vitamin D-25-hydroxylase enzyme in subcutaneous adipose tissues in obese individuals is lower than in normal weight individuals [2].

Previous studies found a significant association between obesity and vitamin D deficiency [9,10, 12,17,26,28,31,33,34,35,36]. Ardawi et al. [33] found a strong relationship between vitamin D status and BMI. Also Lee et al. [12] found an inverse relationship between vitamin D status and BMI and WC. In the present study, we found a negative correlation between the circulating vitamin D level and BMI, but not significant, because 91.5% of normal weight individuals had vitamin D deficiency (serum 25(OH)D < 50 nmol/L); thus, the significant difference in mean serum 25(OH)D between different BMI categories disappears. Our results are in agreement with Arunabh et al. [37], who also found no statistical significant differences in circulating vitamin D levels between different categories of BMI in their participants. Chang et al. [38] also did not find significant differences in the mean circulating vitamin D levels between their obese and control groups, and they attributed the reason of this result to sampling strategy and small sample size. Also, Coney et al. [5] found no significant difference in circulating vitamin D levels between obese Blacks and normal weight Blacks, while they found significant differences in circulating vitamin D levels between obese Whites and normal weight Whites, indicating that dark skin plays an important role in vitamin D deficiency [25]. Surprisingly, Al-Elq et al. [31] found a negative relationship between circulating vitamin D levels and BMI in men, but in women they found a positive relationship between circulating vitamin D levels and BMI.

Arunabh et al. ([37] found a strong inverse association between total body fat and the serum 25(OH)D level. Chang et al. [38] found a negative correlation between body fat percentage and the circulating 25(OH)D level before and after their participants' intake of vitamin D supplements. Zhang et al. [2] found an association of abdominal indices, such as waist circumference (WC) and waist to hip ratio (WHR), were more related to vitamin D status than general obese indices such as BMI and body fat percentage. Also, Lagunova et al. [26] and others [13,28] found the relationship of adiposity measurements to vitamin D status stronger than BMI. Moreover, Tzotzas et al. [29] found vitamin D deficiency in obese individuals associated with an increase in total body and regional adipose tissues, indicating that the decreased circulating vitamin D in obese individuals is not dependent on the site of fat accumulation [34]. In the present study, we also found a negative correlation between circulating vitamin D levels and total body fat percentage, but not significant, because 89.4% of all participants suffered from an above-average total

body fat percentage (> 25%); even among normal body weight individuals, only 29.4% had a normal total body fat percentage (<25%).

Ardawi et al. [33] and others [10,31,34,36] found a positive relationship between BMI and PTH. In the present study, we found a positive correlation between PTH and total body fat percentage and BMI, but the mean serum PTH was within the normal range in all different BMI and fat percentage categories. Our results are in agreement with Snijder et al. [28] and Grineva et al. [7] who found a strong positive relationship between PTH and body fat percentage, rather than BMI. Also our results are in agreement with Lenders et al. [13] who found vitamin D deficiency in their obese individuals with normal PTH and bone mass. Elsammak et al. [39] did not find a correlation between vitamin D deficiency and PTH levels. Furthermore, Tzotzas et al. ([9] found a negative association between vitamin D and PTH levels in their total participants, but they also did not find different PTH levels between normal weight individuals and obese individuals. True vitamin D deficiency may be explained by increased PTH, while normal PTH in vitamin D deficient obese subjects may explain overall adiposity status [34]. Our results, which revealed normal mean baseline serum PTH, may explain the negative correlation between serum calcium level and total body fat percentage, BMI and PTH. Some studies suggested increases in PTH may lead to an increase in calcium influx into adipose tissues, which triggers lipogenesis and subsequently increases body fat percentage [17,25]. Existing vitamin D receptors in adipocytes play an important role in the regulation of lipogenesis and lipolysis in the body [7]. Pereira-Santos et al. [17] found that a deficiency in vitamin D was a predisposing factor to weight gain. Also, Grineva et al. [7] found that a deficiency in vitamin D could lead to fat accumulation.

Aging is one of the factors leading to decreased dermal synthesis and gut absorption of vitamin D [40]. In the present study, unexpectedly we found an insignificant positive correlation between circulating vitamin D levels and age. Our results are in agreement with Chang et al. [38] and Pereira-Santos et al. [17], who did not find a significant difference between age and circulating vitamin D levels in their participants. However, Al-Elq et al. [31] and Ardawi et al. [33] found an inverse relationship between age and circulating vitamin D levels.

In the present study, 67% of our participants consumed dairy product, but still had a high vitamin D deficiency rate. Our results are in agreement with Elsammak et al. [39] who did not find an association between vitamin D deficiency and a small intake of vitamin D; on the contrary, 90% of their participants consumed rich amounts of calcium and vitamin D fortified products. They attributed the cause of elevated vitamin D deficiency prevalence in Saudi Arabians to racial differences in gut absorption of calcium and vitamin D.

Lagunova et al. [26] found increased vitamin D deficiency in obese individuals regardless of the season. Especially in Saudi Arabia, the high percentage of vitamin D deficiency in the summer and spring may be due to the hotter seasons, when people escape the sunlight for the shadows, thereby contributing to an elevated vitamin D deficiency rate [10]. In the present study, the percentage of all participants who were exposed to sunlight did not exceed 14%, which may contribute to a high percentage of vitamin D deficiency. Nevertheless, the correlation between the percentage of sunlight exposure by different BMI categories and circulating vitamin D levels is positive, but it is still insignificant. This finding is supported by Arunabh et al. [37], who found that obesity itself had no influence on dermal production of vitamin D. Our results are also, in agreement with Elsammak et al. [39], who did not find a significant association between vitamin D deficiency and less exposure to sunlight. While Ardawi et al. [33] found a significant association between less exposure to sunlight and vitamin D deficiency, due to the hot climate in most months of the year in Saudi Arabia. Traditional Saudi clothes are also a factor which decrease skin area and, subsequently, less exposure to sunlight [10,25,26].

Ardawi et al. [10] found a significant association between a sedentary lifestyle and vitamin D deficiency. In the present study, 62% of our participants were physically inactive. Elshafie et al. [8] said one of the factors leading to an increase in vitamin D deficiency in Saudi Arabia was a sedentary lifestyle [8]. Limited availability of suitable and safe places for walking and participating in physical activity may lead to an increase in adiposity and a decrease to exposed sunlight, which subsequently may lead to a decrease in the serum 25(OH)D level [9,25]. Also Nam et al. [6] attributed the decline in circulating

vitamin D in obese individuals to a sedentary lifestyle.

One important action to correct the elevation of vitamin D deficiency in Saudi Arabia is to increase the intake of fortified vitamin D products [30,39]. Also, the intake of vitamin D supplements, especially during summer and spring [10], and increased doses of vitamin D supplements for obese individuals are required [25,41]. Other important actions to elevate vitamin D levels are to increase physical activity to more than two hours per week and follow a weight-loss program [30,37].

The significant roles of the active form vitamin D in maintenance of bone integrity and proper health are well documented. Lower serum 25 (OH) vitamin D is well documented to be associated with lower BMD values [42].

The positive correlations between serum 25 (OH) vitamin D and BMD parameters (total body, femur neck and spine) observed in the current study are found previously by Ardawi et al. [33]. They reported such positive correlation in Saudia Arabian postmenopausal women. Nearly similar correlations were reported in studies carried out on men subjects in Finland [43], Austria [44] and white American men [45].

Moreover, the lowered bone mineral density values in obese subjects observed in our study is recently documented in a study by Ripka et al. [46] and Shi et al. [47]. Additional findings presented in the form of associated lowered serum calcium and increased serum PTH levels in obese individuals than the other two groups (normal and overweight) this could explain the resulted decreased BMD in those individuals as both vitamin and deficiency and the relative hypocalcemia induced high PTH level may lead to induction of bone loss by stimulating the process of bone resorption to maintain and stabilize calcium homeostasis [48,49].

5. CONCLUSION

From the current study, it could be concluded that vitamin D deficiency prevalence in Saudi Arabian men is high, regardless of differences in BMI. Elevations in total body fat percentages in different BMI categories could play an important role in elevated vitamin D deficiency rates. A sedentary lifestyle and elevated adiposity contribute to the elevation of the vitamin D deficiency rate. We advice Saudi Arabian men to increase their intake of products that are fortified with vitamin D, take vitamin D supplements, increase physical activity, and increase their exposure to sunlight.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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QUESTIONNAIRE

Center of Excellence for Osteoporosis Research
(OSTEOPOROSIS STUDY)

1. BASIC DATA

1.1 ID (Name): _____ 1.2 Serial No.: _____

1.3 Hospital No.: _____ 1.4 Date of Exam: _____

1.5 Age: _____ 1.6 Sex (M/F): _____

1.7 District/Adu: _____ 1.8 Occupation: _____

1.9 Referral: _____ 1.10 Tel No./ email: _____

2. MEDICAL HISTORY:

2.1 Hepatic: [ ] Yes [ ] No [ ] DN (Specify: _____)

2.2 Ricket in childhood: [ ] Yes [ ] No [ ] DN

2.3 Renal: [ ] Yes [ ] No [ ] DN (Specify: _____)

2.4 Other endoctrine disorders: [ ]Yes [ ]No [ ] DN (Specify: _____)

2.5 Hypertension: [ ] Yes [ ] No [ ] DN

2.6 Rheumatic disorder: [ ] Yes [ ] No [ ] DN (Others, specify: _____)

2.7 Blood disorder(s): [ ]Yes [ ]No [ ]DN (Others, specify:_____)

2.8 Thyroid disorder : [ ] Yes [ ] No [ ] DN

2.9.1 Previous diagnosis of Osteoporosis: [ ] Yes [ ] No [ ] DN (When? _____)

2.9.2 Did you have DEXA done? [ ] Yes [ ] No [ ] DN

2.10 Fracture: [ ] Yes [ ] No [ ] DN (Site: _____)

What age? _____ (Specify cause: _____)

2.11 Mother had fracture? [ ] Yes [ ] No [ ] DN (Site: _____)

What age? _____

2.12 Father had fracture: [ ] Yes [ ] No [ ] DN (Site: _____)

What age? _____

2.13.1 Back pain [ ] Yes [ ] No Since when? _____

2.13.2 Does it require medication? [ ] Yes [ ] No

2.14 Diabetes: [ ] Yes [ ] No

2.14.1 Type of diabetes: [ ] Non-insulin dependent [ ] Insulin dependent [ ] History of GDM

2.14.2 Therapy: [ ] Diet alone [ ] Diet + oral [ ] Oral alone [ ] Diet + insulin

3. ANTHROPOMETRIC MEASUREMENT:

3.1 Body wt.: _____ kg. 3.2 Body ht.: _____ cm

3.3 Triceps skin fold: _____ mm 3.4 Mid upper arm circumference: _____ cm

3.5 Hip circumference: _____ cm 3.6 Waist: _____ cm

3.7 H/W ration: _____ 3.8 BMI: _____ kg./m^2

4. LIFE STYLE:

4.1 Exercise: [ ] Yes [ ] No

4.2 Type of exercise: _____

4.3 Why? _____

Medical reasons _____

Social reasons _____

4.4 Regular: [ ] Yes [ ] No

Others _____

Attitude _____

4.5 Frequency: _____

4.6 Duration/Session: _____

4.7 Smoking : [ ] Yes [ ] N

			Frequency
4.8 Cigarette:	[ ] Yes [ ] No	Duration: _____	No./day _____
4.9 Cigar:	[ ] Yes [ ] No	Duration: _____	No./day _____
4.10 Pipe:	[ ] Yes [ ] No	Duration: _____	No./day _____
4.11 Shessa	[ ] Yes [ ] No	Duration: _____	No./day _____
4.12 Moasiel	[ ] Yes [ ] No	Duration: _____	No./day _____
4.13 Sun exposure	[ ] Yes [ ] No	Duration: _____	Time _____

5. DRUG HISTORY:

5.1	Do you use regular medication?	[ ] Yes	[ ] No
5.2	- Calcium	[ ] Yes	[ ] No
5.3	- Vitamin D	[ ] Yes	[ ] No
5.4	- Steroids	[ ] Yes	[ ] No
5.5	- Phenytoin	[ ] Yes	[ ] No
5.6	- Antacids	[ ] Yes	[ ] No
5.7	- Oral contraceptives	[ ] Yes	[ ] No
5.8	- Other drugs (specify)	_____	
		_____	
		_____	
		_____	

11. SAMPLES COLLECTED:

11.1 Urine [ ] Yes [ ] No
11.2 Blood [ ] Yes [ ] No

Diet Questionnaire

No.	*Food Item*	*Amount/day*	*Calcium*	*Remarks*
1	Milk cup			
2	Yogurt cup			
3	Ice-cream spoon			
4	Cheese Spread			
5	White cheese			
6	Cheddar Cheese			
7	Macaroni and Cheese			
8	Almond cup			
9	Caffeine cup			
10	Tea			
11	Soft drink			
12	Pizza			

12. DEXA EXAMS: [ ] Yes [ ] No

12.1 Shoulder [ ] Yes [ ] No 12.2 Hip [ ] Yes [ ] No

12.3 L2 – L4 [ ] Yes [ ] No

13. Normal [ ] Osteopenic [ ] Osteoporotic [ ]

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