Saudi Pharmaceutical Journal 27 (2019) 200–207

Contents lists available at ScienceDirect

Saudi Pharmaceutical Journal

journal homepage: www.sciencedirect.com

Original article

Vitamin D status in relation to age, bone mineral density of the spine and femur in obese Saudi females – A hospital-based study

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ARTICLE INFO

Article history:
Received 5 August 2018
Accepted 16 October 2018
Available online 17 October 2018

Keywords:
Vitamin D
Secosteroids
25-Hydroxyergocalciferol
Calcifediol
Osteoporosis
Osteopenia

ABSTRACT

The aim of the present study was to evaluate the association between Bone mineral density in lumber spine and femoral neck with serum total levels of vitamin D, sun exposure and Consumption of vitamin D Supplement in obese Saudi females aged between 30 and 54 years old. Recent attention to the high prevalence of osteoporosis and its association with low vitamin D levels in adults has raised the importance of vitamin D evaluation. A low level of vitamin D is considered to be one of the most important risk factors for osteoporosis. In this study; 120 obese Saudi females with no diagnosed chronic diseases attending the Outpatient clinic at king Khalid University hospital in Riyadh. Saudi Arabia, recruited randomly in period of 12 months. In this study, Serum levels of total Vitamin D were considered to be severe deficient if it was lower than 25 ng/mL, mild to moderate deficient if it was between 25 and 60 ng/mL and optimum level if it was 61–200 ng/mL. The results showed that; sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects. In addition, daily consumption of Vitamin D supplement was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study. Moreover, the results showed that; 50% of the age group (40–49 years old) having severe deficiency of Vitamin D. While, 50% of the age group (50–59 years old) having optimal level of Vitamin D. And these results mean that age is not Correlated with vitamin D deficiency in subjects of this study.

1. Introduction

Vitamin D is a group of fat-soluble secosteroids responsible mainly for increasing intestinal absorption of calcium, magnesium, and phosphate. Vitamin D plays a critical role in bone metabolism and many cellular and immunological processes. Low levels of vitamin D have been associated with various chronic diseases especially rickets in children and osteoporosis in adults. Adequate intake of vitamin D is of paramount importance to protect against bone metabolic diseases and prevent the occurrence of complications like bone pains and fracture (Holick, 2004). In humans, the most important compounds in this group are vitamin D_2 (ergocalciferol) which is obtained from plant and foods such as mushrooms, fish and egg yolk, and vitamin D_3 (cholecalciferol) which is formed in the skin after exposure to sunlight or ultraviolet light (Calvo et al., 2005; Cashman, 2007).

Vitamin D obtained from diet or skin synthesis is biologically inactive; it needs enzymatic conversion (hydroxylation) in the liver and kidney for activation. Cholecalciferol is converted in the liver to calcifediol (25-hydroxycholecalciferol) while ergocalciferol is converted to 25-hydroxyergocalciferol. These two forms of vitamin D metabolites (called 25-hydroxyvitamin D or 25(OH)D) are measured in serum to determine a person's vitamin D status (LTO, 2013, Hollis, 1996). Calcifediol is further hydroxylated by the kidneys to form calcitriol (also known as 1,25-dihydroxycholecalciferol), the biologically active form of vitamin D (Holick et al., 1971). Calcitriol circulates as a hormone in the blood, having a major role regulating the concentration of calcium and phosphate, and promoting the healthy growth and remodeling of bone. Calcitriol also has other effects, including some on cell growth, neuromuscular and immune functions, and reduction of inflammation (NIH, 2017).

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.jsps.2018.10.004
1319-0164/

Vitamin D deficiency is caused by many factors which could be related to either decreased synthesis and bioavailability, or increased catabolism and urinary loss (Holick, 2007). Saudi Arabia is one of the sunniest areas of the world and exposure to sunlight might be assumed to be sufficient to maintain adequate vitamin D status. However, according to some earlier studies, vitamin D deficiency is common among the Saudi population (Woodhouse & Norton, 1982; Sedrani et al., 1983, 1992). Recent attention to the high prevalence of osteoporosis and its association with low vitamin D levels in adults has raised the importance of vitamin D evaluation. In addition, among many other risk factors, a low level of vitamin D is considered to be one of the most important risk factors for osteoporosis and related fractures (Holick & Chen, 2008).

Osteopenia is a condition of bone mass thinning. While this decrease in bone mass is not usually considered "severe," it is considered a very serious risk factor for the development of osteoporosis. The diagnostic difference between osteopenia and osteoporosis is the measure of bone mineral density. Osteoporosis, the "fragile bone disease," is characterized by a loss of bone mass caused by a deficiency in calcium, vitamin D, magnesium and other vitamins and minerals.

Obesity, defined by the World Health Organization as a body mass index (BMI) of 30 kg/m^2 or more, is pandemic. The Kingdom of Saudi Arabia is one of the fastest-growing obesity rates in the world, according to a report published at 2014. The report also claims that 70–75% of Saudi adults are overweight, and around a third are obese (Ng et al., 2014). The association between reduced vitamin D concentrations and obesity is well-established. There is a consistent association in the published literature between obesity and lower serum vitamin D concentrations (Bell et al., 1985, Liel et al., 1988; Parikh et al., 2004, Lagunova et al., 2009). In addition, it has also been reported that body fat content is inversely related to serum vitamin D concentration (Arunabh et al., 2003).

Recent attention to the high prevalence of osteoporosis and its association with low vitamin D levels in adults has raised the importance of vitamin D evaluation. In addition to many other risk factors, a low level of vitamin D is considered to be one of the most important risk factors for osteoporosis. The aim of the present study was to evaluate the association between Bone mineral density in lumber spine and femoral neck with serum total levels of vitamin D, sun exposure and Consumption of vitamin D Supplement in obese Saudi females aged between 39 and 54 years old.

2. Materials and methods

2.1. Samples

This study included a random sample of 120 obese Saudi females with no diagnosed chronic diseases attending the outpatient clinic at king Khalid University hospital in Riyadh. Saudi Arabia, recruited randomly in period of 12 months; from January 2015 to January 2016.

2.2. Tools of the study

The study tools included an interview questionnaire, anthropometric measurements and blood biochemical tests.

2.3. Anthropometric measurements

Weight (kg), and height (cm) were selected for anthropometric evaluation as variables for calculating BMI.

2.4. Biochemical assessment

Blood (4 mL) was withdrawn by a nurse after an overnight fast (>12 h) and transferred immediately into non-heparinized tube. Serum samples were stored at −80 °C until required for analysis. Serum total levels of Vitamin D were measured by radioimmunoassay using Wallac1470 Gamma Counter (Wallac Inc., Gaithersburg, MD, USA).

The serum levels of total Vitamin D were considered to be severe deficient if it was lower than 25 ng/mL, mild to moderate deficient if it was between 25 and 60 ng/mL and optimum level if it was 61–200 ng/mL.

2.5. Bone mineral density measurements

BMD (grams/centimeter square) was determined for the anteroposterior lumbar spine (L1-L4) and mean of proximal right and left femur (total and sub-regions) by dual-energy X-ray absorptiometry (DXA), according to standard protocol. BMD values were classified according to WHO criteria; a T-score between −1 and −2.5 is indicative of osteopenia, while a T-score <−2.5 reflects osteoporosis and a T-score >−1 is considered normal (WHO, 1994).

2.6. Statistical analysis

Quantitative data were statistically represented in terms minimum, maximum, mean, standard division (SD).

Comparison between difference groups in the presents study was done using One-way ANOVA Test to compare between more than two parametric groups with (Dunnett test) as multiple comparison to compare each group with the control group using Kruskall-Wallis Test to compare between more than two nonparametric groups with (Mann-Whitney test) to compare each group with the control group.

Qualitative data were statistically represented in terms number and percent. Comparison between difference groups in the presents study was done using Chi-Square Test. A probability value (p value) less than or equal to (0.001) was considered significant. All statistical analysis was performed using statistical software SPSS (Statistical Package for Social Science) statistical program version (16.0).

3. Results and discussion

Among 120 selected subjects in this study, the ages were ranged from 30 to 54. Serum levels of total vitamin D were widely range from 9 to 111 ng/ml. BMI was ranged from 32 to 37 that indicates all subjects were obese as BMI over 30 is considered obese according to WHO. Minimum, maximum, mean and SD of all variables in this study are listed in Table 1.

Samples of the present study were categorized in each variable. According to age; 26.7% were 30–39 years old, 40% were 40–49 years old and 33.3% were 50–59 years old. Among the selected subjects; 66.7% are exposed daily to sun, 80% take vitamin D Supplement (1000 mg/day). According to serum total levels of Vitamin D (D_2 & D_3); 20% showed Severe Vitamin D deficiency (lower than 25 ng/ml), 66.7% have Mild to moderate Vitamin D deficiency (25–60 ng/ml), while 13.3% were in the Optimum level (61–200 ng/ml). By measuring Bone mineral density in lumber spine; 33.3% were normal (with t score bigger than −1), 46.7% showed Osteopenia (with t score −1 and −2.5), while 20% were recorded with Osteoporosis (with t score lower than −2.5) (Table 2).

According to age; 44.5 ± 6.7 mean age (years) were exposed to sun, 45.6 ± 6.0 were consume Vitamin D (1000 mg/day). Mean age (years) of 43.0 ± 5.5 suffer from Severe deficiency of Vitamin

Table 1
Variables of the study.

Variable	n	Minimum	Maximum	Mean	Std. Deviation
Age	120	30.0	54.0	44.0	6.8
Serum total levels of vitamin D (D_2 & D_3)	120	9.0	111.0	41.3	23.2
BMD in Lumbar spine	120	0.6	1.2	0.9	0.2
BMD in Femoral Neck	120	0.5	1.1	0.8	0.2
BMI	120	32	37	30	3.4

BMD (Bone mineral density).
BMI (Body mass index).

Table 2
General description of categorical variables.

Variable	Category	n	%
Sun exposure	Yes	80	66.7
	No	40	33.3
Consumption of vitamin D Supplement (1000 mg/day)	Yes	96	80.0
	No	24	20.0
Serum total levels of vitamin D	Severe deficiency (lower than 25 ng/ml)	24	20.0
	Mild to moderate deficiency (25–60 ng/ml)	80	66.7
	Optimum level (61–200 ng/ml)	16	13.3
T-score BMD L	Normal (bigger than −1)	32	26.7
	Osteopenia (−1 and −2.5)	68	56.7
	Osteoporosis (lower than −2.5)	20	16.7
T-score BMD F	Normal (bigger than −1)	40	33.3
	Osteopenia (−1 and −2.5)	56	46.7
	Osteoporosis (lower than −2.5)	24	20.0
Age	30–39 years old	32	26.7
	40–49 years old	48	40.0
	50–59 years old	40	33.3

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).

D, 44.0 ± 7.0 have mild to moderate deficiency while 45.5 ± 7.5 were in the optimal level. Mean age 46.4 ± 5.1 showed Osteoporosis according to t score of Bone mineral density in lumber spine and 46.5 ± 4.3 were Osteoporosis according to t score of Bone mineral density in femoral neck (Table 3).

In the present study; according to serum levels of total Vitamin D, it was found that, there was a significant difference in the serum level of vitamin D between the group that exposed to sun and the group that not exposed to sun. In addition, there was a significant difference in the serum level of vitamin D between the group that consume daily supplement of Vitamin D (1000 mg/day) and the other group that did not consume daily Vitamin D supplement. Furthermore, there was a significant difference between the groups of different T score value of Bone mineral density in lumber spine. While no significant differences in serum levels of total Vitamin D were reported between age groups, and between the groups of different T score value of Bone mineral density in femoral neck (Table 4).

In the present study, three groups were classified according to age (Table 5). In the first group (30–39 years old), 50% were

Table 3
Mean patient age (years) for each of the Sun exposure, consumption of vitamin D supplement (1000 mg/day), serum total levels vitamin D, T-score BMD L and T-score BMD F categories.

Subgroup	Category	n	Mean ± SD	*p value*[*]
Sun exposure	Yes	80	44.5 ± 6.7	0.271
	No	40	43.0 ± 6.8	
Consumption of vitamin D Supplement (1000 mg/day)	Yes	96	45.6 ± 6.0	0.000
	No	24	37.3 ± 5.6	
Serum total levels of vitamin D	Severe deficiency	24	43.0 ± 5.5	0.525
	Mild to moderate deficiency	80	44.0 ± 7.0	
	Optimum level	16	45.5 ± 7.5	
T-score BMD L	Normal	32	41.1 ± 7.4	0.011
	Osteopenia	68	44.6 ± 6.6	
	Osteoporosis	20	46.4 ± 5.1	
T-score BMD F	Normal	40	42.9 ± 7.6	0.107
	Osteopenia	56	43.6 ± 6.9	
	Osteoporosis	24	46.5 ± 4.3	

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
[*] Student's *t* test for independent samples or one-way Anova.

Table 4
Serum levels of total vitamin D (ng/mL) for each age group, Sun Exposure, consumption of vitamin D supplement (1000 mg/day), T-score BMD L and T-score BMD F categories.

Variable	Category	n	Mean ± SD	p value*
Age (years)	30–39	32	42.4 ± 20.2	0.955
	40–49	48	40.8 ± 25.0	
	50–59	40	41.0 ± 23.8	
Sun exposure	Yes	80	46.2 ± 25.8	0.001**
	No	40	31.6 ± 12.4	
Consumption of vitamin D supplement (1000 mg/day)	Yes	96	43.8 ± 24.4	0.018*
	No	24	31.3 ± 14.4	
T-score BMD L	Normal	32	39.9 ± 13.2	0.000**
	Osteopenia	68	35.6 ± 16.7	
	Osteoporosis	20	63.0 ± 38.6	
T-score BMD F	Normal	40	37.4 ± 12.2	0.320
	Osteopenia	56	41.9 ± 25.4	
	Osteoporosis	24	46.3 ± 30.7	

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
* Student's *t* test for independent samples or one-way Anova. P < 0.05.
** P < 0.001.

Table 5
Association between each of the variables and age.

Variable	Category	30–39 years old		40–49 years old		50–59 years old		*p value**
		n	%	n	%	n	%	
Sun exposure	Yes	16	50	40	83.3	24	60	0.005**
	No	16	50	8	16.7	16	40	
Consumption of vitamin D supplement (1000 mg/day)	Yes	16	50	40	83.3	40	60	0.000**
	No	16	50	8	16.7	0	0	
Serum total levels of vitamin D	Severe deficiency	8	25	12	25	4	10	0.249
	Mild to moderate deficiency	20	62.5	32	66.7	28	70	
	Optimum level	4	12.5	4	8.3	8	20	
T-score BMD L	Normal	12	37.5	16	33.3	4	10	0.065
	Osteopenia	16	50	24	50	28	70	
	Osteoporosis	4	12.5	8	16.7	8	20	
T-score BMD F	Normal	12	37.5	20	41.7	8	20	0.003**
	Osteopenia	20	62.5	16	25	20	50	
	Osteoporosis	0	0	12	33.3	12	30	

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
* Chi-square test.
** P < 0.001.

exposed to sun and also 50% were consume daily supplement of Vitamin D, 25% were suffered from severe deficiency of Vitamin D, 62.5% with mild to moderate deficiency and 12.5% were in the optimal level. By comparing T score value of Bone mineral density in lumber spine; 12.5% were diagnosed with Osteoporosis, 50% with Osteopenia & 37.5% were normal. While according to T score value of Bone mineral density in femoral neck; 62.5% with Osteopenia & 37.5% were normal and no reported Osteoporosis cases.

In the second group (40–49 years old), 83.3% were exposed to sun and also 83.3% were consume daily supplement of Vitamin D, 25% were suffered from severe deficiency of Vitamin D, 66.7% with mild to moderate deficiency and 8.3% were in the optimal level. By comparing T score value of Bone mineral density in lumber spine; 16.7% were diagnosed with Osteoporosis, 50% with Osteopenia & 33.3% were normal. While according to T score value of Bone mineral density in femoral neck; 25% with Osteopenia, 41.7% were normal and 33.3% with Osteoporosis.

In the third group (50–59 years old), 60% were exposed to sun and 100% were consume daily supplement of Vitamin D, 10% were suffered from severe deficiency of Vitamin D, 70% with mild to moderate deficiency and 20% were in the optimal level. By comparing T score value of Bone mineral density in lumber spine; 20% were diagnosed with Osteoporosis, 70% with Osteopenia & 10% were normal. While according to T score value of Bone mineral density in femoral neck; 50% with Osteopenia, 20% were normal and 30% with Osteoporosis.

The association between each variables and sun exposure was determined (Table 6). From this table, it was found that; the age group (40–49 years old) was significantly the most group exposed to sun in all the three groups. In addition, 85% from subjects were consumed daily supplement of Vitamin D and were exposed to sun, while 30% were neither consumed daily supplement of Vitamin D nor exposed to sun.

From the subjects that exposed to sun, there was 20% in the optimal level of serum Vitamin D, 60% with mild to moderate deficiency and 20% with severe deficiency. On the other hand, from the subjects that were not exposed to sun, there were 80% with mild to moderate deficiency and 20% with severe deficiency, it means that sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study.

Moreover, the results showed that; 80% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in lumber spine and 60% of subjects

Table 6
Association between each of the variables and sun exposure.

Variable	Category	Yes		No		*p value*[*]
		n	%	n	%	
Age	30–39 years old	16	20	16	40	0.005[**]
	40–49 years old	40	50	8	20	
	50–59 years old	24	30	16	40	
Consumption of vitamin D supplement (1000 mg/day)	Yes	68	85	28	70	0.053
	No	12	15	12	30	
Serum total levels of vitamin D	Severe deficiency	16	20	8	20	0.008[**]
	Mild to moderate deficiency	48	60	32	80	
	Optimum level	16	20	0	0	
T-score BMD L	Normal	28	35	4	10	0.001[**]
	Osteopenia	36	45	32	80	
	Osteoporosis	16	20	4	10	
T-score BMD F	Normal	32	40	8	20	0.064
	Osteopenia	32	40	24	60	
	Osteoporosis	16	20	8	20	

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
[*] Chi-square test.
[**] P < 0.001.

Table 7
Association between each of the variables and consumption of vitamin D Supplement 1000 mg/day.

Variable	Category	Yes		No		p value[*]
		n	%	n	%	
Age	30–39 years old	16	16.7	16	66.7	0.000[***]
	40–49 years old	40	41.7	8	33.3	
	50–59 years old	40	41.7	0	0	
Sun exposure	Yes	68	70.8	12	50	0.053
	No	28	29.2	12	50	
Serum total levels of vitamin D	Severe deficiency	12	12.5	12	50	0.000[***]
	Mild to moderate deficiency	68	70.8	12	50	
	Optimum level	16	16.7	0	0	
T-score BMD L	Normal	24	25	8	33.3	0.049[**]
	Osteopenia	52	54.2	16	66.7	
	Osteoporosis	20	20.8	0	0	
T-score BMD F	Normal	28	29.2	12	50	0.014[**]
	Osteopenia	44	45.8	12	50	
	Osteoporosis	24	25	0	0	

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
[*] Chi-square test.
[**] P < 0.05.
[***] P < 0.001.

that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in femoral neck. This means that sun exposure was significantly affect and Correlate with Osteopenia.

The association between each variables and consumption of vitamin D Supplement 1000 mg/day was carried out (Table 7). The obtained results showed that the age group (30–39 years old) was significantly the least group that consume daily supplement in all the three groups 66.7%. In addition, 70.8% of subjects that consumed daily supplement of Vitamin D were exposed to sun.

From the subjects that consumed daily supplement of Vitamin D, there was 16.7% in the optimal level of serum Vitamin D, 70.8% with mild to moderate deficiency and 12.5% with severe deficiency. On the other hand, from the subjects that were not consumed daily supplement of Vitamin D, there were 50% with mild to moderate deficiency and 50% with severe deficiency. And it means that daily consumption of Vitamin D supplement was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study.

Moreover, the results showed that; 66.7% of subjects that were not consumed daily supplement of Vitamin D were having Osteopenia according to T score value of Bone mineral density in lumber spine and 50% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in femoral neck.

Table 8 showed association between each variables and serum total levels of vitamin D. From this table, it was found that; 100% of subjects that exposed to sun have optimal level of serum Vitamin D. In addition, 60% of subjects with mild to moderate deficiency of Vitamin D are exposed to sun and 66.7% with severe deficiency of Vitamin D are exposed to sun. And it means that sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects of our study.

From the subjects that consumed daily supplement of Vitamin D, 100% were in the optimal level of serum Vitamin D. On the other hand, 85% with mild to moderate deficiency and 50% with severe

Table 8
Association between each of the variables and serum total levels of vitamin D.

Variable	Category	Severe deficiency		Mild to moderate deficiency		Optimum level		*p value*[*]
		n	%	n	%	n	%	
Sun exposure	Yes	16	66.7	48	60	16	100	0.008[***]
	No	8	33.3	32	40	0	0	
Consumption of vitamin D supplement (1000 mg/day)	Yes	12	50	68	85	16	100	0.000[***]
	No	12	50	12	15	0	0	
Age	30–39 years old	8	33.3	20	25	4	25	0.249
	40–49 years old	12	50	32	40	4	25	
	50–59 years old	4	16.4	28	35	8	50	
T-score BMD L	Normal	8	33.3	24	30	0	0	0.000[***]
	Osteopenia	12	50	52	65	4	25	
	Osteoporosis	4	16.4	4	5	12	75	
T-score BMD F	Normal	8	33.3	32	40	0	0	0.005[***]
	Osteopenia	12	50	36	45	8	50	
	Osteoporosis	4	16.4	12	15	8	50	

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
[*] Chi-square test.
[**] P < 0.05.
[***] P < 0.001.

deficiency were consumed daily Vitamin D supplement. And it means that daily consumption of Vitamin D supplement was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study.

Moreover, the results showed that; 50% of the age group (40–49 years old) having severe deficiency of Vitamin D. While, 50% of the age group (50–59 years old) having optimal level of Vitamin D. And these results mean that age is not Correlated with vitamin D deficiency in subjects of our study.

It was found that; 50% of subjects that with severe deficiency of Vitamin D were having Osteopenia according to T score value of both Bone mineral density in lumber spine and femoral neck. However; the results showed that 75% and 50% of subjects with optimal serum level of Vitamin D have Osteoporosis according to T score value of Bone mineral density in lumber spine and femoral neck respectively.

The association between each variables and T-score of Bone mineral density in lumber spine was determined (Table 9). From this table, it was found that; the age groups (30–39 & 40–49 years old) were more subjected to Osteoporosis (40% in each group), while 41.2% of the third age group (50–59 years old) are subjected for Osteopenia. In addition, there is a direct correlation between T-score of Bone mineral density in lumber spine and T-score of Bone mineral density in femoral neck.

Table 10 showed association between each variables and T-score of Bone mineral density in femoral neck. From this table, it was found that; the age groups (40–49 & 50–59 years old) were more subjected to Osteoporosis (50% in each group). Furthermore, in this study, subjects with Osteoporosis were 100% consumed supplement of Vitamin D, 66.7% were exposed to sun and 50% showed Mild to moderate deficiency of Vitamin D. In addition, there is a direct correlation between T-score of Bone mineral density in femoral neck and T-score of Bone mineral density in lumber spine.

Generally, it is believed that the Saudi Arabia are among countries with rampant Vitamin D deficiency. There was a study in 2011

Table 9
Association between each of the variables and T-score BMD L.

Variable	Category	Normal		Osteopenia		Osteoporosis		*p value*[*]
		n	%	n	%	n	%	
Sun exposure	Yes	28	87.5	36	52.9	16	80	0.001[***]
	No	4	12.5	23	47.1	4	20	
Supplement of vitamin D 1000 mg/day	Yes	24	75	52	76.5	20	100	0.049[**]
	No	8	25	16	23.5	0	0	
Age	30–39 years old	12	37.5	16	23.5	4	20	0.065
	40–49 years old	16	50	24	35.3	8	40	
	50–59 years old	4	12.5	28	41.2	8	40	
Serum total levels of vitamin D	Severe deficiency	8	25	12	17.6	4	20	0.000[***]
	Mild to moderate deficiency	24	75	52	76.5	4	20	
	Optimum level	0	0	4	5.9	12	60	
T-score BMD F	Normal	24	75	16	23.5	0	0	0.000[***]
	Osteopenia	8	25	40	58.8	8	40	
	Osteoporosis	0	0	12	17.6	12	60	

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
[*] Chi-square test.
[**] P < 0.05.
[***] P < 0.001.

Table 10
Association between each of the variables and T-score BMD F.

Variable	Category	Normal		Osteopenia		Osteoporosis		p value*
		N	%	n	%	n	%	
Sun exposure	Yes	32	80	32	57.1	16	66.7	0.064
	No	8	2	24	42.9	8	33.3	
Supplement of vitamin D 1000 mg/day	Yes	28	70	44	78.6	24	100	0.014**
	No	12	30	12	21.4	0	0	
Age	30–39 years old	12	30	20	35.7	0	0	0.003***
	40–49 years old	20	50	16	28.6	12	50	
	50–59 years old	8	20	20	35.7	12	50	
Serum total levels of vitamin D	Severe deficiency	8	20	12	21.4	4	16.7	0.005***
	Mild to moderate deficiency	32	80	36	64.3	12	50	
	Optimum level	0	0	8	14.3	8	33.3	
T-score BMD F	Normal	24	60	8	14.3	0	0	0.000***
	Osteopenia	16	40	40	71.4	12	50	
	Osteoporosis	0	0	8	14.3	12	50	

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
* Chi-square test.
** P < 0.05.
*** P < 0.001.

that conclude a high prevalence of a vitamin D deficiency in sample of Saudi Arabians despite >65% of participants having adequate exposure to sunlight and >90% reporting adequate intake of dairy products (Elsammak et al., 2011). In the present study; from the subjects that were not consumed daily supplement of Vitamin D, there were 50% with mild to moderate deficiency and 50% with severe deficiency. And it means that daily consumption of Vitamin D supplement was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study. Moreover, the results showed that; 66.7% of subjects that were not consumed daily supplement of Vitamin D were having Osteopenia.

An early study at 1984 Correlated between the inadequate exposure to sunlight and vitamin D deficiency in Saudi Arabian women (Fonseca et al., 1984). Furthermore, Ardawi et al., at 2011 concluded that; vitamin D deficiency is rather highly prevalent among both pre- and post-menopausal otherwise healthy Saudi women. The main risk factors appear to be largely attributed to obesity, poor exposure to sunlight, poor dietary vitamin D supplementation, and age. Moreover, vitamin D deficiency is associated with low BMD values at both the lumbar spine (L1-L4) and neck femur and increased bone turnover as indicated by changes in BTMs (Ardawi et al., 2011).

These results are in agreement with the results of this study, as from the subjects that were not exposed to sun, there were 80% with mild to moderate deficiency and 20% with severe deficiency. And it means that sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects of our study. Moreover, the results showed that; 80% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in lumber spine and 60% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in femoral neck.

In the current study it was found that; 50% of subjects that with severe deficiency of Vitamin D were having Osteopenia according to T score value of both Bone mineral density in lumber spine and femoral neck. However; the results showed that 75% and 50% of subjects with optimal serum level of Vitamin D have Osteoporosis according to T score value of Bone mineral density in lumber spine and femoral neck respectively. And these results mean that there is no association between Serum total levels of vitamin D and Bone mineral density in lumber spine and femoral neck. These results are in agreement with previous study that reported no correlation between 25OHD level and BMD at any of the sites examined. Moreover, BMD in the subgroup with severe hypovitaminosis D did not significantly differ from BMD of the rest of the cohort (Ghannam et al., 1999).

Furthermore, in this study, subjects with Osteoporosis were 100% consumed supplement of Vitamin D, 80% were exposed to sun and 60% showed optimal level of serum vitamin D. This could be due to the Obesity-associated vitamin D insufficiency as obesity decreased bioavailability of vitamin D3 from cutaneous and dietary sources because of its deposition in the body fat compartments (Vimeswaran et al., 2013, Wortsman et al., 2000).

Acknowledgments

This research project was supported by a grant from the "Research Center of the Female Scientific and Medical Colleges", Deanship of Scientific Research, King Saud University.

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