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Risk factors and prevalence of vitamin D deficiency among Yemeni women attending Al-Zahrawi Medical Center in Sana'a City

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ABSTRACT: Vitamin D deficiency is taken into account a serious public unhealthiness that affects people across all life stages. Vitamin D deficiency is thought to affect over one billion people worldwide and currently considered a pandemic. This study aimed to determine the prevalence and assess risk factors of vitamin D deficiency in Yemeni women aged 15-75 in Sana'a City. The present cross-sectional study used a convenience sample of ninety-four women aged 15-75 years and conducted in Al-Zahrawi Medical Center in Sana'a City between August and November 2018. Serum 25-hydroxyvitamin D concentrations were measured in all participants after recruiting their sociodemographics, health, lifestyle, multivitamin and dietary intakes, and anthropometric data. Serum 25-hydroxyvitamin D concentrations were defined as normal (>30 ng/mL), insufficiency (20-30 ng/mL), deficiency (10-20 ng/mL), and severe deficiency (<10 ng/mL). IBM SPSS Statistics version 20 was used for data analysis. The results showed that the overall prevalence of hypovitaminosis D (25(OH)D <30 ng/mL) was 87.2%; 23.4% of them had severe deficiency (<10 ng/mL), 31.9% had deficiency (≥10-<20 ng/mL), and 31.9% had vitamin D insufficiency (≥20-<30 ng/mL). Symptoms of vitamin D deficiency and smoking were statistically associated with vitamin D status (P= 0.001 and 0.031), respectively. Therefore, it can be concluded that there are alarming levels of vitamin D deficiency in a sample of Yemeni women. There is an urgent need for intervention programs to increase vitamin D concentrations of these women. Also, many efforts must begin to prevent health effects related to vitamin D deficiency.

Keywords: Vitamin D deficiency; Prevalence; Risk factors; Sana'a; Yemen.

1. INTRODUCTION

Over the past decade, vitamin D has attracted higher levels of interest than the other micronutrient among researchers in the fields of health and biomedicine [1]. The level of vitamin D is regulated by the interaction of varied factors, as well as intestinal absorption, renal function, blood calcium level, and parathyroid hormone [2]. The hormonally active form of vitamin D, 1,25-dihydroxyvitamin D3 (cholecalciferol), plays a significant role in clinical medicine mainly due to its potent effects on calcium homeostasis and bone metabolism [3]. Vitamin D was known as the "sunshine hormone" has roles in the calcium-skeletal axis. There are five different biological sites including immune, pancreas, cardiovascular, muscle, and brain have Vitamin D receptors and are responsive to $1,25(OH)_2$ D. Sunlight fulfills about 50-90% of body requirements of Vitamin D, while a dietary source of Vitamin D provides only 20% of the total requirement [4]. Vitamin D is a secosteroid that plays an important role in many metabolic processes and may affect the reproductive functions of women. Therefore, insufficient serum concentrations of 25(OH)D might be associated with infertility factors, such as chronic anovulation, endometriosis, and even breast cancer [5].

Vitamin D deficiency is taken into account a serious public unhealthiness that affects people across all life stages together with otherwise healthy men and women, pregnant women, neonates, infants, children, adolescents, adults and also the aged even in sunny countries [6]. Vitamin D deficiency is known to affect more than 1 billion people worldwide and may be the cause of morbidity, mortality and increased health care expenses through related chronic diseases [7]. Among the deficiencies in all micronutrient, vitamin D deficiency is currently considered a pandemic [8]. Vitamin D deficiency was found to be a potential contributing cause of death in patients with cardiovascular diseases, cancers [9]. New evidence suggests that vitamin D deficiency is related to an increased risk of type 1 diabetes, multiple sclerosis, rheumatoid arthritis, hypertension, cardiovascular diseases, and cancer. Many studies additionally indicate the effective role of vitamin D supplementation in improving bone health [10].

The main risk factors of vitamin D deficiency include inadequate sunlight exposure, insufficient dietary intake of foods containing vitamin D, and malabsorption syndromes such as Crohn's disease and gastrointestinal disease [3]. However, the high availability of daylight in the Middle East does not adequately protect the population of D deficiency, where vitamin D deficiency has been found there, in particular among women at all age stages [11]. The higher prevalence of vitamin D deficiency in women compared to men attributed to socioeconomic and environmental factors [12]. Vitamin D deficiency in adults will precipitate or exacerbate osteopenia and osteoporosis, cause osteomalacia and muscle weakness, and increase the risk of fracture [9]. And even in infancy, it causes rickets and hypocalcemic fits [13]. Vitamin D deficiency is one of the important risk factors of an osteoporotic fracture in all age groups, especially among the elderly population [14]. Vitamin D has numerous effects on human health and plays a much-varied role in health and disease prevention [15, 16]. Prevention and early diagnosis and treatment of vitamin D deficiency have been identified as key tools for reducing the burden of health and promoting health, particularly in older people [9].

In Yemen, some studies pointed out to vitamin D deficiency as a potential risk of the country. The objective of this study was to determine the prevalence and assess risk factors of vitamin D deficiency in women aged 15-75 in Sana'a City, Yemen.

2. MATERIALS AND METHODS

A cross-sectional study was conducted in Al-Zahrawi Medical Center in Sana'a City between August to November2018. Using a convenience sample method (non-random opportunistic sample), 94 women aged 15-75 years that had attended the Al-Zahrawi Medical Center in the study time were suffering from diseases not associated with vitamin D deficiency and were conformity with inclusion criteria, were selected. The participants were asked to assess their eligibility and willingness to participate in the study. Oral consent was obtained from all participants after being fully informed of the study objectives and procedures.

The Committee of Ethics in the Ministry of Public Health approved the study, also consent was obtained from all participants. Exclusion criteria were all the women that they had a history of cancer, were currently pregnant or lactating, and were had a renal or hepatic failure.

Questionnaires were administered by individual interviews to assemble general data on socio-demographics (each participant's age, education, and occupation), pregnancy status (history of pregnancy, and never pregnant), menopause status (menopause was defined if menstruation had stopped at least 12 months earlier), consumption of multivitamin supplements, diet and supplementation (milk and fish consumption), chronic condition (hypertension, diabetes, and cardiovascular disease), lifestyle-related behavior (smoking, physical activity), healthcare access (insurance coverage, healthcare visit), skin color (light skin color, dark skin color), frequencies of the sun exposure [rarely (1-2 days/week), infrequently (3-5 days/week), frequently (daily)], daily exposed to the sun (minimum 30 minutes), parts of skin exposed to the sun (nothing, only hand, face, and hand), using the sun protection(never, sometimes, and always), parity (0 births, 1 birth, 2-3 births, >3 births), Khat chewing, and symptoms of vitamin D deficiency.

A pilot study of 10 women was conducted to test the validity and reliability of the questionnaire. Feedback obtained from the pilot study was considered. The participants in the pilot study were excluded.

Height was measured to the nearest 0.5 cm without shoes using a wall-mounted stadiometer and weight was measured to the nearest 0.1 kg using a calibrated scale. Body Mass Index (BMI) for each respondent was calculated by using the formula (weight [kg]/height [m^2]). Each participant's weight status was defined according to the World Health Organization's guidelines [an underweight (BMI: <18.5 kg/m^2), normal weight (BMI: 18.5-24.9 kg/m^2), overweight (BMI: 25-29.9 kg/m^2), or obese (BMI: ≥30 kg/m^2)] [18, 19].

A sample of 2 milliliters of blood was collected from each respondent, then serum 25-hydroxyvitamin D (25-OHD) concentrations were determined by an electrochemiluminescence technique (Modular Analytics E170; Roche nosology GmbH, Mannheim, Germany). The results generated were expressed in nanograms per milliliter (ng/mL). Serum 25-OHD concentrations were defined as a normal (>30 ng/mL), vitamin D insufficiency (20-30 ng/mL), vitamin D deficiency (10-20 ng/mL),and severe vitamin D deficiency (<10 ng/mL) [17, 19-21].

IBM SPSS Statistics version 20 was used for data analysis. Frequencies, percentages, and cross-tabulations for descriptive analysis were used. PearsonChi-Square, correlation, regression were performed to evaluate the association between vitamin D status (dependent variable) and age, education, occupation, BMI, pregnancy status, parity, menopausal status, skin color, symptoms of vitamin D deficiency, parts of skin exposed to the sun, consumption of multivitamin supplements, milk consumption, fish consumption, Hypertension, Diabetes, Khat chewing, and Cardiovascular disease (independent variable). Intra- and inter-assay coefficient of variation in the 25(OH)D measurement was used. The statistical significance level of the results was determined at P<0.05.

3. RESULTS

The total number of women's participants for the study were 94. All participants were in the 15 to 75 age groups. 31 (33%) of the respondents were in the age groups (15-19 years), and 25 (26.6%) were in the age groups (60-75 years). 27 (28.7%) of the respondents were illiterate while, 26 (27.7%) had a bachelor's degree, and 49 (52.1%) were housewives. Most of the respondents 66 (70.2%) had a history of pregnancy, 34 (36.2%) in the case of menopause, and 34 (36.2%) had more than three children.

Table 1. Distribution of demographic characteristics and risk factors variables of the respondents (n= 94).

Characteristics	N (%)	Characteristics	N (%)
Age category, years		Cardiovascular disease	
15-19	31 (33.0)	Yes	20 (21.3)
30-44	22 (23.4)	No	74 (78.7)
45-59	16 (17.0)	Smoking habit	
60-75	25 (26.6)	Yes	18 (19.1)
Educational level		No	76 (80.9)
Illiterate	27 (28.7)	Physical activity	
Literate	16 (17.0)	Yes	51 (54.3)
Secondary school	11 (11.7)	No	43 (45.7)
Diploma degree	14 (14.9)	Insurance coverage	
Bachelor degree	26 (27.7)	Yes	19 (20.2)
Occupational status		No	75 (79.8)
Housewife	49 (52.1)	Healthcare visits	
Employee	45 (47.9)	Yes	17 (18.1)
Pregnancy status		No	77 (81.9)
With a history of pregnancy	66 (70.2)	Skin color	
Never pregnant	28 (29.8)	White	43 (45.7)
Menopause		Dark	51 (54.3)
Yes	34 (36.2)	Daily exposure to the sun (30 minutes)	
No	60 (63.8)	Yes	67 (71.3)
Parity		No	27 (28.7)
0 birth	26 (27.7)	Sun frequency exposure	
1 birth	16 (17.0)	Rarely (1-2 days/week)	7 (7.4)
2-3 birth	18 (19.1)	Infrequently (3-5 days/week)	40 (42.6)
>3 birth	34 (36.2)	Frequently (daily)	47 (50.0)
Consumption of multivitamin supplements		Skin exposure to the sun	
Yes	54 (57.4)	Nothing	3 (3.2)
No	40 (42.6)	Only hands	15 (16.0)
Milk consumption		Hands and face	76 (80.9)
Never	36 (38.3)	Using sun protection	
1 time/day	57 (60.6)	Never	42 (44.7)
> 1 time/day	1 (1.1)	Sometimes	32 (34.0)
Fish consumption		Always	20 (21.3)
Never	66 (70.2)	BMI	
1 - 2 time/week	28 (29.8)	18.5-24.9 normal weight	31 (33.0)
Hypertension		25.0 - 29.9 overweight	59 (62.8)
Yes	23 (24.5)	> 30.0 obese	4(4.3)
No	71 (75.5)	Symptoms of vitamin D deficiency	
Diabetes		Yes	83 (88.3)
Yes	26 (27.7)	No	11 (11.7)
No	68 (72.3)	Khat chewing	
		Yes	24 (25.5)
		No	70 (74.5)

54 (57.4%) of respondents consumed multivitamin, 57 (60.6%) consumed milk one time daily, while 28 (29.8%) consumed fish one to two times per week. 23 (24.5%) were hypertensive, 26 (27.7%) had diabetes mellitus (fasting blood glucose level greater than 125 mg/dL), and 20 (21.3%) of the respondents had cardiovascular diseases.

18 (19.1%) of the respondents were smokers, and 51 (54.3%) were physically active. 19 (20.2%) of the respondents have health insurance, and only 17 (18.1%) had to visit doctors periodically. Most of the respondents 51 (54.3%) had dark skin color, while 43 (45.7%) had a white skin color. Mostly 67 (71.3%) had daily exposure to the sun, 47 (50%) had frequency exposure to the sun, 76 (80.9%) had to expose her hands and face, and 20 (21.3%) always using sun protection. Among the respondents, 31 (33%) were normal weight (BMI 18.5-24.9 kg/m^2), while only 4 (4.3%) were obese (BMI >30 kg/m^2). 83 (88.3%) had symptoms of vitamin D deficiency (Table 1).

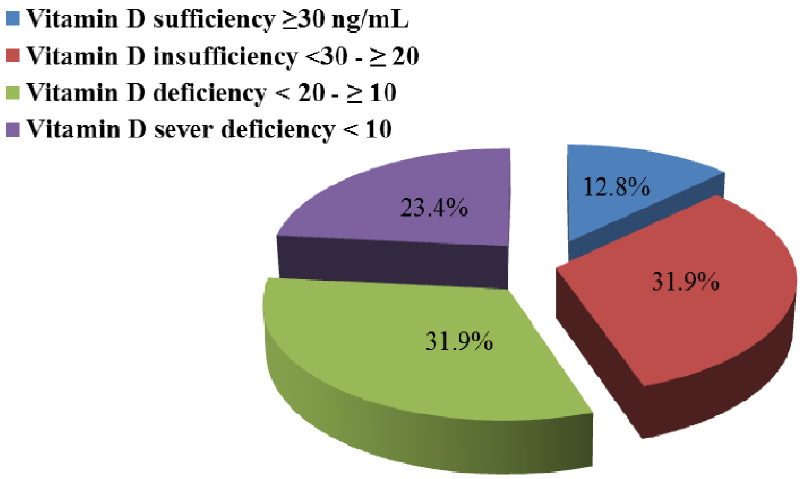

Figure 1. Vitamin D status of the participants (n= 94).

Table 2. Correlation between participants' socio-demographic variables and vitamin D status (n= 94).

Variable	Category	Vitamin D level					x^2	P-value
		A*	B**	C***	D****	Total		
Age groups	15-19 years	7	8	9	7	31 (33%)	11.915	0.22
	30-44 years	3	8	5	6	22 (23.4%)		
	45-59 years	0	8	7	1	16 (17%)		
	60-75 years	2	6	9	8	25 (26.6%)		
	Total	12	30	30	22	94 (100%)		
Education level	Illiterate	1	8	11	7	27 (28.7%)	10.216	0.59
	Literate	3	6	3	4	16 (17%)		
	Secondary school	0	5	5	1	11 (11.7%)		
	Diploma degree	3	3	4	4	14 (14.9%)		
	Bachelor degree	5	8	7	6	26 (27.6%)		
	Total	12	30	30	22	94 (100%)		
Occupational status	Housewife	6	15	18	10	49 (52.1%)	1.214	0.75
	Employee	6	15	12	12	45 (47.9%)		
	Total	12	30	30	22	94 (100%)		

A* = Sufficiency >30 ng/mL, B** = Insufficiency <30 - >20 ng/mL, C*** = Deficiency <20 ng/mL, D**** = Severe deficiency <10 ng/mL.

Figure 1 shows that 23.4% of the respondents had vitamin D sever deficiency in concentrations lower than 10 ng/mL, 31.9% had vitamin D deficiency (≥10-<20 ng/mL), and 31.9% had vitamin D insufficiency (≥20-<30 ng/mL), while only12.8% had vitamin D sufficiency (≥30 ng/mL).

Table 2 shows the association between sociodemographic variables and vitamin D status. The age groups, education level, and occupational status were not associated with vitamin D status (*P*= 0.22, 0.59, 0.75), respectively.

Table 3 shows the association between common risk factors and vitamin D status. The symptoms of vitamin D deficiency and smoking were significantly associated with vitamin D status (*P*=0.001 and 0.031) respectively. While pregnancy status, menopause status, skin color, BMI, parts of the skin exposed to the sun, parity, physical activity, consuming multivitamin, consuming milk, consuming fish, hypertension, diabetes, Khat chewing, and cardiovascular disease were not associated with vitamin D status (*P*>0.05).

Table 3. Correlation between risk factors of vitamin D and 25(OH)D concentrations (n= 94).

Variable	Category	Vitamin D concentrations					x^2	P-value
		A*	B**	C***	D****	Total		
Pregnancy status	With a history of pregnancy	10	19	20	17	66 (70.2%)	2.371	0.49
	Never pregnant	2	11	10	5	28 (29.8%)		
	Total	12	30	30	22	94 (100%)		
Menopause status	Yes	1	12	12	9	34 (36.2%)	4.623	0.20
	No	11	18	18	13	60 (63.8%)		
	Total	12	30	30	22	94 (100%)		
Skin color	White skin color	4	15	12	12	43 (45.7%)	2.049	0.56
	Dark skin color	8	15	18	10	51 (54.3%)		
	Total	12	30	30	22	94 (100%)		
Symptoms of vitamin D deficiency	Yes	3	28	30	22	83 (88.3%)	54.159	0.001
	No	9	2	0	0	11 (11.7%)		
	Total	12	30	30	22	94 (100%)		
BMI	<25.0	5	11	10	5	31 (33%)	7.656	0.26
	25.0-29.9	6	16	20	17	59 (62.8%)		
	>30.0	1	3	0	0	4 (4.2)		
	Total	12	30	30	22	94 (100%)		
Parts of skin exposed to the sun	Nothing	1	1	1	0	3 (3.2%)	12.617	0.05
	Only hand	4	8	3	0	15 (16%)		
	Face and hand	7	21	26	22	76 (80.8%)		
	Total	12	30	30	22	94 (100%)		
Parity	0 birth	2	11	8	5	26 (27.7%)	15.437	0.08
	1 birth	5	2	4	5	16 (17%)		
	2-3 births	2	4	10	2	18 (19.1%)		
	>3 births	3	13	8	10	34 (36.2%)		
	Total	12	30	30	22	94 (100%)		
Physical activity	Yes	8	14	18	11	51 (54.3%)	2.000	0.572
	No	4	16	12	11	43 (45.7%)		
	Total	12	30	30	22	94 (100%)		

Variable	Category	Vitamin D concentrations					x^2	P-value
		A*	B**	C***	D****	Total		
Current smoking	Yes	1	11	3	3	18 (19.1%)	8.907	0.031
	No	11	19	27	19	76 (80.9%)		
	Total	12	30	30	22	94 (100%)		
Consumption of multivitamin supplements	Yes	5	15	18	16	54 (57.4%)	4.084	0.253
	No	7	15	12	6	40 (42.6%)		
	Total	12	30	30	22	94 (100%)		
Milk consumption	Never	2	7	16	11	36 (38.3%)	11.104	0.085
	1 time/day	10	22	14	11	57 (60.6%)		
	>1 time/day	0	1	0	0	1 (1.1%)		
	Total	12	30	30	22	94 (100%)		
Fish consumption	Never	6	22	24	14	66 (70.2%)	4.313	0.230
	1 - 2 time/week	6	8	6	8	28 (29.8%)		
	Total	12	30	30	22	94 (100%)		
Hypertension	Yes	2	10	6	5	23 (24.5%)	2.031	0.566
	No	10	20	24	17	71 (75.5%)		
	Total	12	30	30	22	94 (100%)		
Diabetes	Yes	1	11	8	6	26 (27.7%)	3.473	0.324
	No	11	19	22	16	68 (72.3%)		
	Total	12	30	30	22	94 (100%)		
Khat chewing	Yes	2	10	6	6	24 (25.5%)	1.974	0.578
	No	10	20	24	16	70 (74.5%)		
	Total	12	30	30	22	94 (100%)		
Cardiovascular disease	Yes	2	5	7	6	20 (21.3%)	1.081	0,782
	No	10	25	23	16	74 (78.7%)		
	Total	12	30	30	22	94 (100%)		

A* = Sufficiency >30 ng/mL, B** = Insufficiency <30->20 ng/mL, C*** = Deficiency <20 ng/mL, D**** = Severe deficiency <10 ng/mL.

4. DISCUSSION

Our results have shown that vitamin D deficiency is a health threat to Yemeni women. The overall prevalence of hypovitaminosis (25(OH)D <30 ng/mL) was 87.2%; 23.4% of the participants had vitamin D sever deficiency inconcentrations lower than 10 ng/mL, 31.9% had vitamin D deficiency (≥10-<20 ng/mL), and 31.9% had vitamin D insufficiency (≥20-<30 ng/mL), while only 12.8% had vitamin D sufficiency (≥30 ng/mL). The high prevalence of vitamin D deficiency might be attributable to improper lifestyle, unhealthy nutritional habits, and the role of women's hijab in decreasing exposure to sunlight.

This result is consistent with previous studies. A study conducted in Saudi Arabia indicated that the overall prevalence of hypovitaminosis D (25(OH)D <30 ng/mL) was 77.4% [1]. Another study conducted in Saudi Arabia among female university students indicated that, the hypovitaminosis D (25(OH)D <30 ng/mL) prevalence was 80.6% [19]. A study conducted in Tehran, Iran indicated that the overall prevalence of hypovitaminosis D (25(OH)D <30 ng/mL) was 85.2% [10]. A study conducted in Egypt among healthy Egyptian females showed that the overall prevalence of hypovitaminosis D (25(OH)D <30 ng/mL) was 72% [11]. This might be attributed to the similarity between women's dress traditions covering most parts of the body of Yemen, Iraq, Iran, and Egypt.

However, it is incompatible with the results obtained from a study conducted in the Southwest Region of Cameroon indicated that, the overall prevalence of hypovitaminosis D(25(OH)D <30 ng/mL) was 25.8% [17]. The low prevalence of vitamin D deficiency in the Southwest Region of Cameroon may be attributed to difference in lifestyle, especially dressing style.

In the present study, the age groups, education level, and occupational status were not associated with vitamin D status (P>0.05). This is attributed to the traditions associated with the clothing of women in Yemen, that covers the whole body, regardless of age, education level or occupational status. Therefore, it is normal in this study to show no relationship between these variables and vitamin D status. This finding is incompatible with previous studies. A study conducted in Saudi Arabia indicated that the age groups was significantly associated with vitamin D status (P=0.001) [9]. A study conducted in Kuwait indicated that the age groups was significantly associated with vitamin D status (P=0.001) [22]. A study conducted in the USA indicated that the age groups was significantly associated with vitamin D status (P=001) [3].

This study showed that smoking and symptoms of vitamin D deficiency were significantly associated with vitamin D status in women (P<0.05). This finding is in agreement with a previous study conducted in Kuwait indicated that smoking habit was significantly associated with vitamin D status (P=0.036) [22]. However, it is incompatible with a previous study conducted in the USA indicated that smoking was not associated with vitamin D status (P=0.131) [3].

The present study showed that the other multiple factors were not associated with vitamin D status among these women. This result is consistent with previous studies. A study conducted in the USA indicated that hypertension was not associated with vitamin D status (P=0.136) [3]. A study conducted in the Southwest Region of Cameroon indicated that vitamin D status was not influenced by the number of hours spent outdoors and the percentage of a body covered by clothing [17]. However, it is incompatible with the results obtained from other studies. A study conducted in Saudi Arabia indicated that skin color (P=0.036), physical activity (P=0.001), taking vitamins (P=0.001), and body mass index (P=0.001) were significantly associated with vitamin D status [9]. A study conducted in Kuwait indicated that taking a vitamin D supplement was significantly associated with vitamin D status (P=0.022) [22].

5. CONCLUSION

Based on this study's results, there are alarming levels of vitamin D deficiency in a sample of Yemeni women. There is an urgent need for intervention programs to increase vitamin D concentrations of these women. Also, many efforts must begin to prevent health effects related to vitamin D deficiency. Authors recommend the implementation of large population-based studies that can lead to reform action by decision-makers on vitamin D fortification and the establishment of evidence-based local guidelines to address the epidemic.

Authors Contributions: GMAA carried out the study design, performed the statistical analysis, and writing the manuscript. AYAA carried out the data collection, participants' examination, and performing the laboratory tests. Both authors read and approved the final manuscript.

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