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Culture, Sun Exposure and Vitamin D Deficiency in Benghazi Libya

Mariam Omar[1*], Faiza Nouh[1], Manal Younis[2], Moftah Younis[3], Nesma Nabil[1], Marwa Saad[1] and Munyah Ali[1]

[1]Department of Nutrition, Faculty of Public Health, University of Benghazi, Benghazi, Libya.
[2]University College Cork, Ireland.
[3]University of Saskatchewan, Canada.

Authors' contributions

This work was carried out in collaboration between all authors. Author MO designed and conducted the study, wrote the protocol, managed the literature search and drafted the manuscript. Author FN performed the study analyses, data reporting and tabulation and contributed to literature search. Authors MO, NN, MS and MA collected data and provided technical support in clinics. Authors FN, Manal Younis and Moftah Younis participated in the critical revision of the article. All authors read and approved the final manuscript.

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ABSTRACT

Background: Vitamin D is produced from sunlight exposure through ultraviolet B radiation of the skin. Several factors affect sunlight exposure include time of day, seasonal variation, lower absorption of vitamin D due to dark skin color, sunscreen use, clothing and coverage for cultural or religious reasons along with behavioral attitudes. There is a dearth of studies looking into socio-cultural and behavioral reasons for vitamin D deficiency in the Middle East particularly in Libya. The aim of this study was to identify sun exposure and cultural influences on vitamin D status among patients attending three out patient clinics in Benghazi.
Methods: A cross-sectional sample of 287 subjects who were attending three polyclinics in Benghazi. 258 females, and 29 males. Data on participants' attitudes and behaviors in relation to sun exposure, cultural and skin tone preference were collected using interviews and questionnaires.

**Corresponding author: E-mail: mariam.Omar@uob.edu.ly; Mariamelsaltani@gmail.com;*

Results: Duration of sun exposure, use of sun block, wearing long sleeves, believing lighter skin is more attractive than darker and feeling unhappy if the sun made the skin darker were all significantly different between different serum vitamin D level groups and predicted lower vitamin D levels. Vitamin D deficiency was 76.1%, insufficiency was 15.2% and Vitamin D sufficiency was 8.7% in our study.
Conclusion: Culture, attitudes and sun exposure behavior could be major contributing factors to the observed high prevalence of VDD in this study. Circulating concentrations of 25(OH)D was significantly lower in subjects with less sun exposure and in those exhibiting negative attitudes toward sunlight. A more accurate measure for culture, behavior and knowledge and sun exposure in a controlled environment is needed to confirm these findings.

Keywords: Vitamin D; deficiency; sun exposure; culture; attitudes.

1. INTRODUCTION

Vitamin D is increasingly becoming a public health concern as sufficient sun exposure to prevent vitamin D deficiency (VDD) would avoid a larger burden of disease [1].

Vitamin D is important for musculoskeletal health, and deficiency causes rickets in children and osteomalacia in adults [2]. More research has linked the deficiency with other major diseases as coronary heart disease [3], different types of cancer [4,5], type 1 and 2 diabetes [6-8], hypertension, rheumatoid arthritis, Alzheimer's [4,9], mental health deterioration [9] and multiple sclerosis [10].

Skin exposure to sunlight is the main determinant of vitamin D status [11]. The vitamin is endogenously produced from ultraviolet B radiation of the skin (UV-B, 280–315 nm) [12,13], with diet contributing only to a small amount of circulating vitamin D levels [11].

Restriction of sunlight resulting from decreased ambient light and living in northern latitudes is easily understood. Other phenomena affecting sunlight exposure include time of day when exposed to sunlight, seasonal variation, lower absorption of vitamin D due to dark skin color, sunscreen use, clothing and coverage due to cultural or religious reasons when outdoors [14-16], and behavioral attitudes [18-20]. High prevalence of vitamin D deficiency has been reported even in sunny climates [4,9,21-23].

The prevalence of vitamin D deficiency and rickets is estimated to be greater across the Middle East than Western countries [22]. A large meta-analysis showed that 20–80% of apparently healthy individuals in the Middle East are vitamin D deficient. Cultural traditions [4], and behavioral attitudes whereby Muslim communities avoid body exposure have been recognized as factors for the scarcity of sun exposure [16,24].

Currently there is a dearth of studies looking into socio-cultural and behavioral reasons for vitamin D deficiency in the Middle East particularly in Libya. Libya; and Benghazi in particular, is located across the Mediterranean Sea (32.0948° N, 20.1879° E) and is sunny most of the year [25], thus sun exposure and levels of vitamin D are expected to be adequate. The aim of this study was to identify cultural and sun exposure behavior effects on vitamin D status among patients attending three out-patient clinics in Benghazi.

2. METHODOLOGY

2.1 Study Participants and Setting

In 2016, a cross sectional study was conducted to determine sun exposure, culture, and attitude and their influence on serum 25(OH)D levels (vitamin D) in a sample of 287 subjects recruited purposively from three polyclinics in Benghazi (Alkiesh polyclinic, Alfohyaht and Yakeen Health Center).

Subjects were eligible if they were (18-80) years old and live in Benghazi. Subjects taking any medications known to alter bone metabolism, and previously VDD diagnosed subjects and receiving VD treatment at the time of study or have received their last treatment less than one month before the study were all excluded. Data sets were also excluded if any parameter investigated was not recorded.

2.2 Procedure

The University Ethics Committee and the centers' administrations approved the study protocol. All potential participants were

fully informed of the study procedures and aims, and participants provided written informed consent.

Researchers conducted qualitative interviews and interview based questionnaires with individual participants between July the 1st to September 30th 2016. The interview and questionnaire aimed to probe for the participants' attitudes and behaviors in relation to sun exposure and protection, along with cultural and skin tone preference. The interviews and questionnaires proceeded for about 20 to 30 minutes, usually occurred in the clinic waiting room or at doctor's office, and were conducted by the researchers who underwent training sessions on interviewing skills, anthropometry taking and data coding and handling at Benghazi University. A small pilot study was conducted and tested, and sample selection and methodology were explained in more details previously [26].

Vitamin D test was collected as part of routine investigation for all subjects. For the current analysis, vitamin D deficiency (VDD) was defined as 25-OHD values of ≤20 ng/ml, insufficiency at 21-29 ng/l; and sufficient serum 25-OHD level at ≥30 ng/ml [27]. Subjects were accordingly divided into 3 diagnostic categories. To reduce bias of different vitamin D analysis techniques, ELISA, an enzyme-linked immunosorbent assay for 25(OH)D; which has been regarded as an accepted test [28], was used for being the most commonly available test in laboratories in Benghazi.

2.3 Statistical Analysis

SPSS version 21 was used for the description and analysis of data. Data was coded before entering into a computer. Chi-square t-test was performed to test the association of serum 25(OH)D with variables, based on predefined cut-points of serum 25(OH)D concentrations. Serum 25(OH)D was normally distributed, confidence intervals were set at 95% and level of significance was defined at p-value of ≤ 0.05. Bivariate correlation was carried out to test the relationships between serum 25(OH)D and other variables. Multiple logistic regression investigated predictors of vitamin D deficiency (serum 25(OH)D of ≤20 ng/ml). Multiple regression model and adjustments for confounding factors were also conducted. Covariates included sun exposure frequency and duration, dress codes, attitudes toward sun exposure, skin preferences, and use of sun cream and transportations. The goodness-of-fit of a model was assessed using Chi square test and multiple regression model.

3. RESULTS

3.1 Sample Demographics and Serum Vitamin D Level

Out of 319 surveys distributed, 89.9% (total n=287) questionnaires were completed by subjects who chose to participate in this study. 258 females (90%), and 29 males (10%) with mean age range (20-41). Standard deviation (SD) of 36.2 years ± 0.9 (37.4± 3.8) years for females and 29.2 ± 2.9 for males.

Overall, the estimated prevalence of vitamin D deficiency (≤20 ng/ml) was 76.1%, insufficiency (21-29 ng/ml) was 15.2% and the proportion of the sample population with sufficient vitamin D concentrations (≥30 ng/ml) was 8.7% as shown in Table 1.

3.2 Sun Exposure

With regard to sun exposure variation between subjects, as shown in (Table 1); majority of subjects use vehicles (cars) as a mean of transportation when leaving home (92%), all of those who reported no use of vehicles were females. Half of the whole sample reported not walking under the sun light, (51%) of all females, compared to only (24) % of males. Reasons for not walking were distributed as follows; (39%) of the whole sample mentioned long distance as the reason for not walking under sun light, with the remaining subjects either mentioning traditional and social restrictions as the reason or abstaining from answering the question. The majority of females abstained. While all males regarded long distance as the reason they do not walk under sunlight.

Majority of sample (73.5%) reported exposure to sun light in peak hours (10 am to 4 pm), while (74%) reported direct exposure to sun light less than 15 minutes per day, with only 4.88% more than 2 hours per day. (77%) reported always wearing hats, veil/head cover, the majority was females. Only (10%) use sun block creams/products on a regular basis. (41%) of males reported using it sometimes, while (61%) of females never do. (79.44%) always wear long sleeved clothes, and (85%) cover their legs.

3.3 Culture and Attitudes

(44.6%) of the sample believe fair skin is more attractive than dark; (43.7%) of females agree and strongly agree compared to (51%) among males. (38%) are unhappy "strongly agree" if sun made their skin darker, with (42%) females strongly agreeing to the statement, while (43%) of males disagree.

(58%) of the subjects tend to be careful when going out so their complexion or skin wont look "bad", 63% of females strongly agree, and 34% males disagree. 14.6% and 8% strongly agree on avoiding sun because fear of wrinkles and cancer.

3.4 Correlation and Predictors of Serum 25(OH) Level

Out of the 287 participants, serum 25(OH)D concentrations were provided by 190 subjects; six subjects were tested by immune essay and thus were excluded. 184 subjects provided test by ELISA with an effective participation rate of 64%.

Duration of sun exposure was significantly different across different vitamin D status, those with vitamin d deficiency had the least sun expose duration. Time of sun exposure did not differ significantly, while means of transportation- though not statistically significant- were more in those with less than normal vitamin D level. Detailed in (Table 2).

Occupation and nature of work, walking under sun, using sun block, wearing long sleeves, believing fair skin is more attractive than dark and feeling unhappy if the sun made the skin darker, were all significantly different between different vitamin D groups, with more subjects using sun blocks and holding negative beliefs and attitudes in the vitamin deficiency or insufficiency groups. However, wearing hijab/ face veil or hat, and fear of skin cancer and wrinkles were not significantly different across groups.

Correlation and Significant predictors of vitamin D deficiency are summarized in (Table 2). In the full model, preference of light skin associated with higher odds of deficiency (OR 2.31, CI 4.01- 1.139), using sun block (OR 1.723, CI 3.982- 0.9874), feeling unhappy if the sun made skin darker (OR 1.563 CI 2.01- 1.239), wearing long sleeves (OR 1.39 CI 2.741- 0.495) were associated with higher odds of deficiency, while duration of sun exposure (OR 0.641 CI 2.182- 0.374) nature of work; out door work (OR 0.531CI 1.92- 0.271) occupation (OR 0.39 CI1.72- 0.131) and walking under sun (OR 0.27 CI 2.02- 0.116) were associated with lower odds of the deficiency. When gender was accounted for, similar level of statistical significance, correlation and OR was obtained, including skin preference, dress code, and sun exposure attitudes, however among male gender employment and work type did not differ across different Vitamin D levels. Furthermore, no difference was shown with regard to date of vitamin D test during the study (data not shown).

4. DISCUSSION

This study allowed the examination of sun exposure attitudes and cultural influences on serum 25(OH)D concentrations. Negative attitude toward sun exposure and cosmetic concerns appear to be major contributing factors to the high prevalence of low vitamin D status reported in this sample. It appears that preference of fair skin in both genders especially among females and the tendency to avoid sun light due to fear of darkening of skin were the main attributing factors in this study. Subjects preferring fair skin in both males and females had twice the odds of vitamin D deficiency (OR 2.31). Feeling unhappy if skin was made darker by sun exposure predicted vitamin D deficiency (OR 1.5) in both genders, more among females.

This finding is in accordance with other studies carried in Saudi Arabia, Pakistan, and among Korean and Chinese immigrants in Australia [17,29,30] these studies reported that subjects with VDD longed for fairer completion and tended to avoid sun in fear of darkening the skin.

The idealization of fair complexion, particularly for females, has a long history in many Arabic and East Asian countries. Historically, a fair skin was an indication of privilege, beauty, social status, and femininity. Those from poor, working class families, who had to work outdoors, had rough, sun-tanned skin; fair skin was regarded as "noble" and "aristocratic" and became a symbol of higher social class [31]. In modern times, this idealization has been more related to standards of beauty [32].

In addition, a fear of dark skin complexion or sunburn prompts the use of sunscreen and ointments in individuals as a measure of avoiding adverse effects of sun exposure [33-36].

Table 1. Age, gender, sun exposure, and cultural attitudes among 287 subjects selected from 3 outpatient clinics in Benghazi

Characteristics	Male n (%)	Female n (%)	Total n (%)
Age (years)			
>20	3 (1.05)	34(1.18)	37(12.9)
20-40	18(6.3)	153 (53.3)	171(60)
>40	8(2.8)	71 (24.7)	79 (27.5)
Total	29(10)	258(90)	287 (100)
Mean ± SD	29.2 ± 2.9	37.4± 3.8	36.2 ± 0.9
Occupation			
No	5(1.7)	172(59.9)	177(61.6)
Employed	20(7)	75(26.1)	95(33.1)
Free lance	4(1.4)	11(3.8)	15(5.3)
Nature of work			
Indoor	20(18.2)	80(72.7)	100 (90.9)
Outdoor	9 (8.2)	1 (0.9)	100(9.1)
Transportation Use			
Yes	29(10)	238(82.9)	267(93)
No	0(0)	20(7)	20(7)
Walking under sun			
Yes	23 (8)	124(43.5)	147(51.2)
No	7(2)	133(46.5)	140(48.4)
Reason for not walking in sun			
Abstain	0	80(33.3)	80(33.3)
Cultural restrictions	0	66(27.5)	66(27.5)
Long distance	29(121.1)	65(27.1)	94(39.2)
Duration of direct sun exposure			
<15 minutes	7(2.44)	208(72.47)	215(74.91)
15- 30 minutes	9(3.14)	30(10.45)	39(13.59)
1-2 Hours	8(2.79)	11(3.83)	19(6.62)
> 2 Hours	5(1.74)	9(3.14)	14(4.88)
Time of sun exposure			
6-10 AM	3(1.05)	37(12.89)	40(13.94)
10-12 AM	7(2.44)	143(49.83)	150(52.26)
12-4 PM	10(3.48)	51(17.77)	61(21.25)
After 4 PM	9(3.14)	11(3.83)	20(6.97)
No Exposure	0	16(5.57)	16(5.57)
Wear hijab/veil or hat			
Always	4(1.39)	218(75.96)	222(77.35)
Most times	6(2.09)	6(2.09)	12 (4.18)
Sometimes	9(3.14)	3(1.05)	12(4.18)
Rarely	10(3.48)	2(0.7)	12(4.18)
Never	0	30(10.45)	29(10.10)
Use of sun block			
Always	0	31(10.8)	29(10.1)
Most times	0	34(11.85)	34(11.85)
Sometimes	12(4.18)	30(10.45)	42(14.63)
Rarely	13(4.53)	4(1.39)	17(5.92)
Never	4(1.39)	159(55.4)	163(56.79)
Wear long sleeves			
Always	8(2.79)	220(76.66)	228(79.44)
Most times	5(1.74)	23(8.01)	28(9.76)
Sometimes	7(2.44)	6(2.09)	13(4.53)
Rarely	9(3.14)	1(0.35)	10(3.48)
Never	0	8(2.79)	8(2.79)

Characteristics	Male n (%)	Female n (%)	Total n (%)
Wear long legged			
Always	11(3.83)	233(81.18)	244(85.02)
Most times	7(2.44)	12(4.18)	19(6.62)
Sometimes	3(1.05)	7(3.14)	10(3.48)
Rarely	4(1.39)	2(0.7)	6(2.09)
Never	4(1.39)	2(0.7)	8(2.79
Light skin is more attractive than darker			
Strongly agree	9(3.1)	42(14.6)	51(17.8)
Agree	6(2.1)	71(24.7)	77(26.8)
Neutral	8(2.8)	120(41.8)	128(44.6)
Disagree	6(2.1)	5(1.7)	11(3.8)
Strongly disagree	0	20(7)	20(7)
Feeling unhappy with darkening of skin due to sun exposure			
Strongly agree	2(0.7)	109(38)	111(38.7)
Agree	7(2.4)	77(26.8)	84(29.3)
Neutral	7(2.4)	58(20.2)	65(22.7)
Disagree	10(3.5)	2(0.7)	12(4.2)
Strongly disagree	3(1.1)	12(4.2)	15(5.3)
Being cautions to skin when going out			
Strongly agree	2(0.7)	165(57.5)	167(58.2)
Agree	5(1.7)	78(27.2)	83(28.9)
Neutral	10(3.5)	1(0.35)	11(3.8)
Disagree	5(1.7)	4(1.4)	9(3.14)
Strongly disagree	7(2.4)	10(3.5)	17(5.9)
Avoidance of sun exposure for fear of wrinkles			
Strongly agree	3(1.1)	39(13.6)	42(14.6)
Agree	2(0.7)	63(22)	65(22.6)
Neutral	8(2.8)	117(40.8)	125((43.6)
Disagree	9(3.1)	2(0.7)	11(3.8)
Strongly disagree	7(2.4)	37(12.9)	44(15.3)
Avoidance of sun due to cancer risk			
Strongly agree	1(0.35)	22(7.67)	23(8)
Agree	6(2.09)	36(12.5)	42(14.6)
Neutral	9(3.14)	114(39.7)	123(42.9)
Disagree	7(2.44)	8(2.8)	15(5.2)
Strongly disagree	6(2.09)	78(27.2)	84(29.3)
Vitamin D status			
<20ng/ml	2(1.1)	138(75)	140(76.1)
21-29 ng/ml	5(2.7)	23(12.5)	28(15.2)
≥30 ng/ml	10(3.3)	6(3.3)	16(8.7)
Total	17(9.2)	167(90.8)	184(100)

Published studies suggest that regular use of sunscreen may increase vitamin D deficiency risk [37]. Sunscreens prevent absorption of UV-B radiation and thus sun burning, cancer of the skin and premature aging. Nonetheless; the blocked UV-B radiation is also responsible for the photosynthesis of vitamin D_3. Studies indicate that sunscreens interfere with the cutaneous production of vitamin D_3 [38,39].

Using sun block in our study was associated with a reduction of serum vitamin D to deficiency levels, which corresponds to other studies. Our result is in agreement with other similar studies performed in Saudi Arabia [34], Vietnam [35], Oman [36], and Kuwait [40] where (males and females) exhibited negative attitude towards sunlight exposure by regular use of sunscreens, and embracing other sun protective measures in their daily life leading towards inadequate amount of vitamin D level.

The high prevalence of of Vitamin D deficiency has been attributed in many countries with adequate sunshine as Lebanon, Jordan, Saudi Arabia, Tunisia, and Kuwait to clothing factor [40-46]. Wearing hijab/veil or hats did not differ significantly with vitamin D level and this could be

Table 2. Correlation and predictors of serum 25(OH) among 184 patients in relation to sun exposure, culture and attitudes

Variables	Percentage of subjects			OR	CI**
	Sufficient (≥30 ng/ml)	Insufficiency 21-29 ng/ml	Deficiency (≤20 ng/ml)		
Walking under sun*				0.27 [a]	2.02- 0.116
Yes	30.1	27	42.9		
No	25	29.1	45.9		
Occupation *				0.39 [b]	1.72- 0.131
No	32	23	45		
Employee	35.2	21	43.8		
Free work	46	17	37		
Nature of work *				0.531[c]	1.92- 0. 271
Indoor	36.1	15	48.9		
Outdoor	57.3	18	28.7		
Duration sun exposure *				0.641[d]	2.182- 0. 374
15 minutes	7	20.1	72.9		
15- 30 minutes	13.7	17	69.3		
1-2 Hours	24.6	15	60.4		
> 2 Hours	31	12	57		
Wear long sleeves *				1.39 [e]	2.741-0.495
Always	18	26.9	55.1		
Most times	21	29	50		
Sometimes	27	33	40		
Rarely	31	35	34		
Never	38	31	31		
Unhappy with darker skin*				1.563[f]	2.01- 1.239
Strongly agree	7	31	62		
Agree	11	28	61		
Neutral	17	24	59		
Disagree	24	21	55		
Strongly disagree	31	19	50		

Variables	Percentage of subjects			OR	CI**
	Sufficient (≥30 ng/ml)	Insufficiency 21-29 ng/ml	Deficiency (≤20 ng/ml)		
Using of sun block *				1.723[g]	3.982-0.9874
Always	9	39	52		
Most times	14	36	50		
Sometimes	23	32	45		
Rarely	29	30	41		
Never	34	27	39		
Fair skin is more attractive*				2.31[h]	4.01- 1.139
Always	17.2	28.1	54.6		
Most times	25	24	51		
Sometimes	30	22	48		
Rarely	39	16	45		
Never	49	11	40		

** P ≤0.05,** CI= confidence interval.*

OR reference groups [a] compared to subjects walking under sunlight, [b] compared to workers, [c] outdoor workers, [d] ≥1 hour of sun exposure, [e] most times wearing long sleeves, [f] agree to unhappy with darker skin, [g] using sunblock sometimes most times and always

attributed to the large representation of females wearing hijab in the sample. On the other hand, wearing long-sleeved clothes predicted VDD in both genders. Area of skin exposed and duration of sunlight exposure strongly correlated with Vitamin D levels in this study as shown similarly by other studies [42,47,48]. Sun exposure of skin areas of face and hands may partially provide synthesis of vitamin D, but may not be adequate to prevent vitamin D deficiency [48], especially considering the short duration of sun exposure reported in this study.

Sun exposure amount required to produce the recommended amount of vitamin D among individuals varies both individually and according to time of day, time of year, and latitude. White people at 40 degrees' latitude with Type II skin can achieve their annual requirements of vitamin D by spending about 15 minutes in the sun with exposed face, arms and legs 2 to 3 times per week between 11 a.m. and 3 p.m. during the months of May through October [49,50]. People with darker skins require more time in the sun to produce their requirements of the vitamin [3]. The majority of subjects in this study reported exposure to sun light during peak hours, however this was not shown to differ with nor predict serum 25(OH) D levels, and this was explained when duration of sun exposure was taken into consideration; the majority had sun exposure duration less than 15 minutes, longer durations predicted an improvement in serum vitamin level in the studied sample which comes in accordance with the findings of others who reported a corresponding increase in plasma vitamin D concentrations with increasing duration of sun exposure [18,51-53].

Some explanation for the high prevalence of low vitamin D status is assumed to result from the fact that contemporary humans are adapted to lifestyle changes that have occurred over the past years. Urbanization and fast life style pattern lead to more use of cars rather than walking and direct exposure to sunlight [54,55]. In most of the Middle East countries, indoor lifestyle plays a major role in predisposing the adults and children towards vitamin D deficiency [4]. In this study majority of the subjects with VDD reported using cars when commuting under sun rather than walking. A possible reason for this attitude and behavior can be justified by the rapid socio-economic growth of Arab countries including Libya which affected their traditional lifestyle [56]. This is further verified by the majority of this sample who reported long distance as the reason for not walking outdoors. A problem we apparently share with other Arab countries in general. Avoidance and restriction of sunlight exposure has been reported as a major cause of vitamin D deficiency especially in females in Oman [36] Kuwait [40], and Saudi Arabia [57].

The problem maybe further aggravated by working patterns [58]. Working patterns influence our lifestyle and health and determine much of how we use our time [59]. As a substantial proportion of time in adult life is spent working indoors, this has a major influence on sunlight exposure of an individual [60]. Our results add strength to this argument as unemployed and indoor workers in our study had lower vitamin D level, but interestingly this was found in women but not in men. This corresponds to the 1958 British birth cohort which suggested that work may have and adverse influence on Vitamin D status in women but not in men. Women where shown to spend less time outdoors and had less leisure time than men [60,61]. Women are still responsible for most of the housework and family responsibilities and as a result have less leisure time than their male partners [61].

We have previously reported contributing factors for VDD in this same sample [23], which included female gender, older age, obesity, and low consumption of Vitamin D rich food sources. Cultural beliefs and negative attitudes toward sun exposure, working indoors, and low sun exposure shown in this paper also explain the high reported prevalence of VDD and call for nationwide intervention and prevention strategies.

The authors acknowledge several limitations. Data were collected in one season in a cross sectional approach, which could limit the generalizability of the results. Furthermore, data on sun exposure were based on self-administered questionnaires and recall history, which could be crude and subject to recall bias. Lack of literature on Libyan population in relation to vitamin D and cultural attitudes has limited our ability to compare results. And the unequal Male/female distribution in the sample that resulted from random sampling approach is another limitation. Despite these caveats, this study has merits in being the first to examine differences in serum 25(OH)D with regards to culture and attitudes in Libya. Further research is needed in this area in order to establish causal patterns between vitamin D and lifestyle factors

in Libya and to allow advocacy for this public health problem.

5. CONCLUSION

In conclusion, our study demonstrated that circulating concentrations of 25(OH)D was significantly lower in subjects with less sun exposure and in those exhibiting negative attitudes toward sunlight. Identified factors included duration of sun exposure, occupation and type of work, preference of fair skin, feeling unhappy if the sun made the skin darker, use of sun block, and dress code. These factors resulted in excessive sun-avoidance among participants. Culture could be a major contributing factor to the observed high prevalence of VDD in this study. A more accurate measure for culture, behavior, knowledge and sun exposure in a controlled environment are needed to confirm these findings.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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