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Full Length Research Paper

Sun avoidance among indoor employees leading to vitamin D deficiency and depression in the United Arab Emirates

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Vitamin D deficiency has been linked to chronic diseases among different populations worldwide. However, these relationships are still unclear and have not been explored within the United Arab Emirates (UAE) population. In this study, the relationship between vitamin D, risk for depression symptoms, and sun avoidance inventory was explored. The prevalence of vitamin D deficiency among a sample of employees working in Abu Dhabi (the capital of UAE) was first assessed and then the influence of demographic factors (age, gender and ethnicity) on vitamin D status was examined. A random sample of 141 employees from two different major oil companies within Abu Dhabi was selected and tested for vitamin D deficiency. All participants worked indoors and reflected the multi-ethnic nature of Abu Dhabi residents. Serum levels of vitamin D [25(OH)D] were measured and depression was assessed using the Beck Depression Inventory version 2. Moreover, the sun avoidance inventory (SAI) was used to assess attitudes towards sun avoidance in the context of vitamin D deficiency. There was a significant negative correlation between vitamin D levels and sun avoidance scores ($r=-0.45$, $p<0.0001$). Sun avoidance scores were also significantly positively correlated with depression symptoms scores ($r=0.33$, $p<0.001$). This study demonstrated that sun avoidance behaviors were the major risk factor for vitamin D deficiency among Abu Dhabi employees and that these were also positively associated with depressive symptoms.

Key words: Vitamin D deficiency, United Arab Emirates, indoor employees, sun avoidance inventory, Beck depression inventory.

INTRODUCTION

The role of vitamin D in maintaining optimal health has been well established (Holick, 2009). Nonetheless, vitamin D deficiency has reached epidemic levels in many parts of the world, affecting both genders across all age groups (Holick, 2004, 2005; Holick et al., 2011). Populations at risk of deficiency include those with decreased sun exposure due to limited outdoor activities. The list of individuals meeting these criteria is extensive, indoor-workers, students and even those who extensively apply sunscreens or wear extensive clothing when exposed to the sun (Holick, 2004; Grant, 2009; Glerup et al., 2000).

Sun avoidance among many individuals, is attributable

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to the arguably, iatrogenic public health messages focused on the adverse effects of sun exposure. Such messages generally ignore the potential benefits of sun exposure. Such warnings focus public attention on the adverse consequences associated with exposure of ultraviolet (UV) radiation such as melanoma and skin aging (Grant, 2007). In the past few decades however, research has also documented many benefits associated with exposure to UV radiation, highlighting the necessity of adequate sun exposure for healthy vitamin D levels. There is growing evidence supportive of the protective role vitamin D plays in seasonal variations in depressive symptomatology. In some nations, depression is more common during the winter, which parallels the nadir for vitamin D deficiency as well. Two recent studies explored the relationship between vitamin D levels and depression among older adults (Hoogendijk et al., 2008; Wilkins et al., 2009). These studies compared the level of vitamin D among depressed and non-depressed individuals, and found vitamin D levels to be significantly lower in depressed individuals compared to non-depressed individuals (Hoogendijk et al., 2008; Wilkins et al., 2009).

There are relatively few studies exploring vitamin D and its health implications within the context of the United Arab Emirates (UAE). Despite the availability of sunshine in the UAE, vitamin D deficiency represents a critical maternal/infant health problem. A study conducted at Al-Ain, UAE, showed that vitamin D deficiency (serum level, 25 ± 11 nmol/L) is common (36% frequency) in women of childbearing age (n = 33) in Arab communities residing in the UAE (Dawodu et al., 2001, 1998). Vitamin D deficiency is a common maternal-infant health problem in Arab communities residing in Al-Ain, UAE (Dawodu et al., 1998). Moreover, osteoporotic Emirati women suffer from mild to severe vitamin D deficiency (Saadi et al., 2006). A recent study undertaken in the Emirate of Abu Dhabi, UAE, found a high prevalence of vitamin D deficiency among young adult Emirati University students associated with self-reported sun avoidance behaviors (Al Anouti et al., 2011). Furthermore, in the region's first study exploring the relationship between depressive symptoms and vitamin D levels, a study of university students in Abu Dhabi found a negative correlation between vitamin D levels and depressive symptomatology (Thomas et al., 2010). This study aims to explore the relationship between vitamin D deficiency, depression symptoms, and sun avoidance behaviors among indoor workers residing in Abu Dhabi.

SUBJECTS AND METHODS

Study population and design

A total of 141 employees from two different major oil companies within Abu Dhabi participated in the study. The rationale behind choosing oil companies was their willingness to cooperate and improve the health of their employees. In addition, being major companies, their employees are representative of the employee subpopulation within Abu Dhabi. Convenience sampling was applied; participants were recruited voluntarily through electronic invitation cards that were sent to all employees a week before data collection. The study recruitment was conducted in October 2010 and May 2011. A certified phlebotomist collected blood samples. The Zayed University Human Subjects Committee and the Sheikh Khalifa Medical City Institutional Review Board approved the study. Written informed consent was obtained from all participants before study enrollment. Participation in the study was completely voluntary and confidential.

Analysis of serum 25(OH)D

Blood samples were taken from all subjects to analyze serum 25(OH)D as an indicator of vitamin D status (Haq et al., 2007; Haq et al., 2009). Questionnaire was offered in both Arabic and English. Serum concentrations of 25(OH)D were measured at two different techniques e.g. Diasorin (LIAISON) and high performance liquid chromatography (HPLC). The LIAISON 25(OH)vitamin D assay is a direct competitive chemiluminescence immunoassay (CLIA) for quantitative determination of total 25(OH)vitamin D in serum. Waters HPLC 2695 separation module with UV detection based Chromsystems kits (Chromsystems Instruments & Chemicals GmbH, Heimburgstrasse, Munich, Germany) was used as modified in our laboratory (Haq et al., 2009; Thomas et al., 2011). The intra-assay coefficient of variation was 4% and the inter-assay coefficient of variation was 5.8% (Al Anouti et al., 2011).

Exposure variables

Sun exposure was evaluated by using SAI, which is a questionnaire designed to assess attitude toward sun avoidance (Al Anouti et al., 2011; Thomas et al., 2010). Data collection involved a blood test and a previously validated questionnaire that had several components pertaining to socio demographic, medical history, and psychosocial aspects (Beck Depression Inventory (BDI) and Sun Avoidance Inventory (SAI)) (Thomas et al., 2010). The SAI assesses sun avoidance attitudes and behaviors across six factors: cosmetic/aesthetic, health and safety, transport, occupational, recreational and sartorial. The SAI uses a five point Likert scale to record participant's responses, from strongly agree, to strongly disagree, graded 0 to 4 depending on the item direction. A high overall score on the SAI indicates that the individual minimizes sun exposure, while a low score reveals that the individual maximizes exposure to sun (Thomas et al., 2010). Body mass index (BMI) was calculated as weight in kilograms divided by the height in meters square. Depression was assessed by using BDI (Beck et al., 1996a). The reason for using BDI is that it is one of the widest used measures of depressive symptomatology used in the research literature. Its psychometric properties have been extensively explored in both English and Arabic. The BDI is a 21-item self-report inventory assessing the severity and intensity of depressive symptoms. Each item reflects either a cognitive or somatic symptom of depression; items are rated from 0 to 3, with higher scores reflecting heightened symptom severity. The cognitive sub scale was obtained by summing 9 items, whereas the somatic-affective sub scale was obtained by summing 11 items. Amongst North American college students and hospital outpatients, BDI-II was found to have high internal consistency; the coefficient alphas were 0.93 and 0.92, respectively (Beck et al., 1996a, b).

Subsequent studies of the BDI's psychometric properties report favorably on the instrument's construct, convergent, and predictive validity, in various contexts, and across several nations (Al-Musawi, 2001). Questionnaire was administered by a single research assistant within the time frames. Both oil companies were located within the same geographic location in Abu Dhabi. All participants in

Table 1. Baseline characteristics of the employees that participated in the study.

Variable	N	Median	25-75 P
Age	141	43	35-49
*BDI	110	5	1-9
*BMI	102	26.2	24-29
SAI	103	41	36-46
*25(OH)D nmol/L	141	22.4	17-31

All values are shown as median and inter-quartile range (25-75 P); BMI: Body mass index; SAI: sun avoidance inventory; BDI: Beck depression inventory. *Non normal distribution.

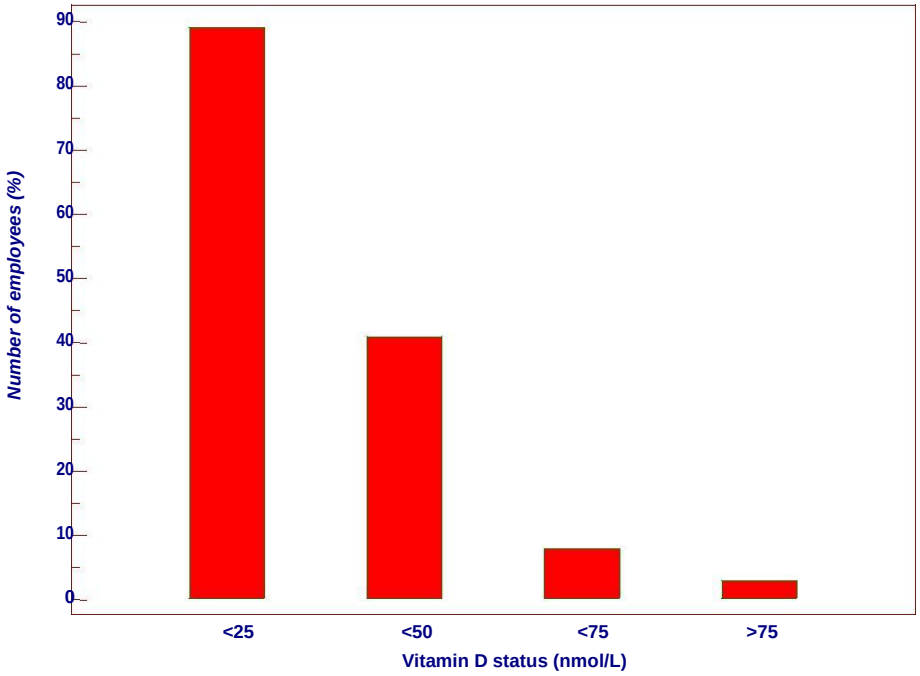

Figure 1. Group distribution according to vitamin D status among employees.

this study were indoor employees. There was a mixture of nationalities and ethnicities in both time frames when data was collected. Height and weight were measured using a digital height and weight scale (Seca, England). The survey was translated into Arabic and published (Thomas et al., 2011). The reference range for vitamin D was adopted from Grant et al. (2010) and Sabetta et al. (2010) and included deficiency, insufficiency, and sufficiency (<50, 50 to 75, and >75 nmol/L), respectively (Grant et al., 2010; Sabetta et al., 2010). The exclusion criterion was applied to all participants taking any form of vitamin D supplementation.

Statistical data analyses

Statistical analyses were performed using MedCalc for Windows, version 11.3.3.0 (MedCalc Software, Mariakerke, Belgium). Univariate analyses are described as median and interquartile range (IQR). Correlation analysis for normally distributed data was tested by the Pearson correlation coefficient. Differences between males and females for continuous variables were tested using the Mann-Whitney test. All hypotheses tested were 2 tailed and a p value of 0.05 was regarded as statistically significant.

RESULTS

The median age (IQR) of participants was 43 (35 to 49) years. Amongst the 141 participants, 23 were UAE nationals, 47 were non-Gulf Arabs, 7 Europeans, 2 Canadians and 62 were South Asians. Participants were from different ethnicities and from both genders (88% males and 12% females). Table 1 shows the distribution of the variables: age, BDI, BMI, SAI and vitamin D status among all participants. Based on the median (IQR) for BDI, most subjects showed only minimal levels of depressive symptoms (1 to 9). The median (IQR) BMI was 26 (24 to 29) with approximately 40% being overweight. Median (IQR) serum 25(OH)D concentration was 22 (17 to 31) nmol/L. Group distribution according to vitamin D status is as shown in Figure 1.

Only 2.1% of the participants (3 out of 141) were sufficient (serum 25(OH)D>75 nmol/L). All other participants were severely deficient (63.2%), deficient (29.1%)

Table 2. Correlation between variables in the context of 25(OH)D.

Variable		Age	BMI	BDI	SAI	25(OH)D (nmol/L)
Age	Correlation Coefficient	-	0.06	-0. 17	-0.25	0.19
	Significance Level P		0.51	0.080	0.01	0.02
	n		102	110	101	141
BMI	Correlation Coefficient	0.06	-	-0.04	-0.16	0.008
	Significance Level P	0.51	-	0.68	0.13	0.93
	n	102		102	94	102
BDI	Correlation Coefficient	0.17	-0.040	-	0.33	-0.11
	Significance Level P	0.08	0.68	-	0.001	0.23
	n	110	102	-	101	110
SAI	Correlation Coefficient	-0.25	-0.16	0.33	-	-0.45
	Significance Level P	0.010	0.12	0.001	-	<0.0001
	n	101	94	101	-	101
25(OH)D nmol/L	Correlation Coefficient	0.19	0.008	-0.11	-0.45	-
	Significance Level P	0.02	0.93	0.23	<0.0001	-
	n	141	102	110	101	-

Pearson correlation coefficient; BMI: Body mass index; SAI: sun avoidance inventory; BDI: Beck depression inventory; n: number of indoor employees.

or insufficient (5.7%). The median (IQR) SAI of 41 (36 to 46) indicated that most participants significantly avoided exposure to the sun. Bivariate correlations revealed a negative correlation between vitamin D levels and SAI scores ($r=-0.45$, $p<0.0001$). Sun avoidance scores were also significantly positively correlated with depression symptoms scores (BDI) ($r=0.32$, $p<0.001$). On further analysis into cognitive and somatic BDI sub scale scores, it was found that the cognitive component of BDI was moderately correlated with SAI ($r=0.03$, $p<0.001$) whereas the somatic component of BDI was not correlated ($p=0.09$). There was no statistical difference in vitamin D levels between participants scoring in the subclinical BDI range or in the range of minor depression. There was no significant correlation between age and depression ($r=-0.16$, $p<0.08$). SAI scores were negatively correlated with age ($r=-0.27$, $p<0.01$). Table 2 reports the correlation between all relevant variables. Females had significantly higher depression scores than males ($p=0.0003$) and lower SAI ($p=0.009$) and vitamin D concentrations ($p=0.003$). These comparisons are demonstrated in Box and Whisker plots in Figure 2.

DISCUSSION

The findings in this study suggest that vitamin D deficiency is prevalent among indoor employees within Abu Dhabi. The nature of work is associated with limited sun exposure, official working hours for most employees being between 8.00 am to 4.00 pm. Hence, employees spend most of the daytime (10.00 am to 3.00 pm) which is the optimum time for vitamin D production indoors. Guidelines of what constitutes healthy versus unhealthy levels of vitamin D are controversial. Various risk factors (e.g. limited sun exposure, inadequate intake of vitamin D, obesity and ethnicity) could account for the high prevalence of vitamin D deficiency (Grant et al., 2010). In the UAE and according to previous studies, these findings suggest that sun avoidance behaviors contributed to the prevalence of vitamin D deficiency. People in the UAE may not only intentionally avoid sun (because of extreme heat), but also may be at risk as a result of the cultural and traditional dress codes that minimize the body's exposure to the sun. This may explain why all UAE national (both males and females) had low vitamin D levels. Sun deprived individuals, such as indoor employees, who require 800 to 1000 IU of vitamin D daily to attain optimal vitamin D levels (Holick et al., 2011).

Approximately 23% of the participants suffered from chronic diseases, particularly hypertension and diabetes. Fourteen were hypertensive, six were diabetic, three were both hypertensive and diabetic, and two suffered from hypercholesterolemia. The correlation between vitamin D deficiency and these chronic illnesses warrants further evaluation for possible causality. Further exploration is necessary however, before any conclusions could be made.

Interestingly, the results demonstrated that depression is positively correlated with sun avoidance behaviors. The association can be looked at differently; sun avoidance behaviors could lead to depression or depression could

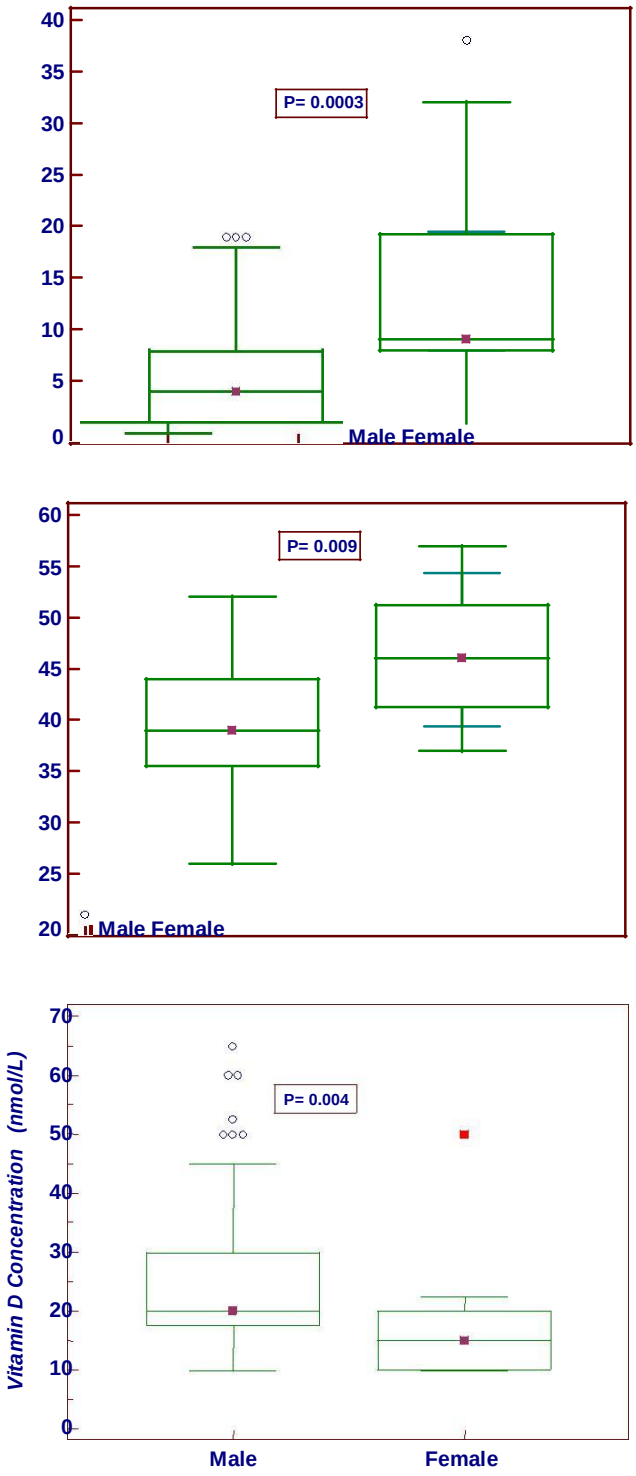

Figure 2. Data comparison graph (box and whisker plots) of male versus female for BDI score, SAI score and 25(OH)D concentration.

make people avoid sun or even there could be another mediator factor between depression and sun avoidance behaviors. Further research to explore such relationships is needed. This is because the relation could be bi-directional. Shortage of sunlight or limited sun exposure could lead to depression (Grant et al., 2010). On the other hand, depressed lifestyles including loss of interest and the feelings of sadness tend to make depressed individuals prone to social withdrawal and being fairly house-bound. Studying such association is worthwhile, because the rate of depression is increasing globally at the same time when people start to avoid the sun exposure as a consequence of industrialization and urbanization (Sabetta et al., 2010). The lack of correlation between 25(OH)D and BDI may be explained by the relatively small sample size. Another explanation is that only about 10% of the sample had a vitamin D level >50 nmol/L, which makes it unlikely that any positive correlation would be detected. It is possible that the subjects under reported the psychological symptoms to avoid stigmatization or fear of jeopardizing their future employment prospects. However, the relationship between BDI and sun avoidance could be explained by other confounding variables, that is, low physical activity levels, behavioral withdrawal and sedentary life style may be associated with depressive episodes rather than vitamin D deficiency (Grant, 2009, 2011; Berk et al., 2007; Hoang et al., 2011; Hoogendijk et al., 2008; Jaddou et al., 2012; Opländer et al., 2009; Yapislar et al., 2012; Bertone-Johnson et al., 2011). Seasonal affective disorder is less likely as vitamin D levels are at peak during the winter months and do not change considerably during the year (Saadi et al., 2006; Saadi and Dawodu, 2007).

An interesting area of future research would be to look at the possible mutual exacerbation hypothesis. The sample as expected was chosen among normal office workers where depression rates are not expected to be high. Overall most of the subjects reported very few depressive symptoms and those with higher BDI scores were only marginally elevated (minor depression). However, looking at how the onset of depressive symptoms might increase sun avoidance or possibly lower vitamin D levels could prove informative to therapies aimed at alleviating depression. Depressed individuals tend to withdraw socially and deactivate behaviorally which may lead to social withdrawal and a sedentary indoor lifestyle.

Limitations in this study must be considered. For instance, convenience sampling was utilized. This is why our samples were not comparable in terms of age, gender and nationality. However, in terms of ethnicities, this sample is considered representative of populations in the UAE. According to the 2005 census, the total population of UAE was 4,798,491 million, of whom 19% were UAE nationals, 23% were Arabs, 50% were South

Asians, and 8% were Westerners (CIA-The World Factbook, 2009).

This study demonstrated that vitamin D deficiency is a major health concern among indoor employees in the UAE. As in previous studies, sun avoidance behaviors were the major risk factor for vitamin D deficiency in the UAE. Sun avoidance behaviors were also positively associated with depressive symptoms. Strategies to increase the stores of vitamin D should include vitamin D supplementation and fortification of food and drinks with vitamin D. An important public health message would be for indoor employees to take appropriate vitamin D supplements as well as ingesting food and drink fortified with vitamin D. Additionally, public awareness and education leading to changes in sun behaviors would also be highly desirable. Further research should be undertaken to explore the proposed links between vitamin D and chronic lifestyle disorders such as diabetes and depression.

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