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The Impact of Dietary Intake and Sun Exposure on Vitamin D Deficiency among Couples

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Background: The main sources of vitamin D are sun exposure and diet. There is a gap in our knowledge about the contribution of these factors to vitamin D level among couples in Bahrain.

Objective: To determine vitamin D dietary intake and sun exposure and their impact on vitamin D level.

Design: Cross-sectional study.

Setting: Maternity hospitals.

Method: Data were collected using an adapted pre-validated food frequency questionnaire. It was adjusted to reflect the local food items. Vitamin D intake below 600 IU was considered low. The level was assayed as 25(OH)D using chemiluminescence method. SPSS-20 was used for data analysis. P value < 0.05 was considered significant.

Result: Three hundred and twenty five couples were included in the study. The mean dietary intake of vitamin D was low, but not significantly different between men and women. Vitamin D level was <50 nmol/L in 209 (64.3%) men and 292 (89.8%) women. The mean 25(OH)D level in males (46.06 ± 12.97 nmol/L) was significantly higher than females (33.12 ± 13.48 nmol/L). There was a significant association between dietary intake and 25(OH)D levels in both men and women. Sun exposure was also found to be significantly associated with 25(OH)D level in males but not in females which is attributed to the use of veil.

Conclusion: Low vitamin D intake and inadequate sun exposure lead to hypovitaminosis D. There is a need to increase awareness and mandate the fortification of milk, dairy products and to supplement veiled women and those at risk of deficiency with vitamin D.

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Vitamin D deficiency is a worldwide epidemic[1]. Several studies have reported vitamin D deficiency or insufficiency[2-7]. The reemergence of rickets and high prevalence of osteoporosis highlight the importance of addressing the issue of supplementation and food fortification[8-9]. An evidence supported by several studies indicated a strong relationship between vitamin D level and the risk of diabetes mellitus, cancer, multiple sclerosis and rheumatoid arthritis[10].

Vitamin D is a fat soluble vitamin that exhibits hormonal properties. Vitamin D receptors are found in most tissues in the human body[11]. It can be produced endogenously by the skin via photosynthesis using ultraviolet B light (UVB) which converts 7-dehydrocholesterol (7-DHC) to pre-vitamin D_3. It can also be obtained from diet or from dietary supplements. However, few foods naturally contain vitamin D with the exception of fatty fish and fish liver oils; eggs, cheese and meats contain a small amount[12]. Whether obtained from an endogenous or exogenous source, this form of vitamin D is inert and must undergo hepatic and renal hydroxylation to convert it to its active form of 1,25-dihydroxyvitamin D also known as calcitriol[13].

Studies conducted to determine what constitutes an adequate amount of Vitamin D intake for optimal health had mixed outcomes[14]. Measuring serum levels of 25(OH)D is considered a good indicator of vitamin D levels because it is directly linked to both dietary intake and sunlight exposure[13-15]. The rationale for determining the 2011 daily recommended intake (DRI) for vitamin D were based on bone health outcome. The U.S. Institute of Medicine (IOM) revised the recommended intake of vitamin D for adults to 600 IU in order to achieve 25(OH)D level of 50 nmol/L which, according to IOM, meets the requirements of 97.5% of the healthy population[15].

A recent cross-sectional study among healthy adult blood donors in a military hospital in Bahrain identified vitamin D deficiency in 67.6% of the females and 31.2% of the males[16]. Another study revealed a high prevalence of vitamin D deficiency among pregnant women and their newborns (88.8% and 90.3% respectively)[17]. However, there are no published studies about the dietary intake of vitamin D and sun exposure among the population of Bahrain.

The aim of this study was to determine vitamin D dietary intake and sun exposure among couples in Bahrain.

METHOD

This was part of a cross-sectional multicenter study involving four public and four private Maternity hospitals in Bahrain. These eight hospitals are the catchment centers for 95% of all annual deliveries in Bahrain[18].

The study was conducted in the second and third weeks of April 2012. The study subjects were couples presenting to the participating maternity hospitals because the mother was in labor. Out of the 403 couples, 325 (80.6%) completed the dietary intake questionnaire. An informed consent was obtained from all participants.

Data collection method was based on an interview in which personal data, medical history and lifestyle factors were documented. This was followed by the administration of a pre-validated food frequency questionnaire to determine calcium and vitamin D intake[19]. The food frequency questionnaire was adjusted to reflect the local food items known to contain vitamin D and the various types of local fish consumed in the country.

The intake of vitamin D was calculated by multiplying the frequency of consumption of each unit of food by vitamin D content of the specified portions. Vitamin D values of food items were based on the food composition tables for Arab Gulf countries and the food composition tables for the Kingdom of Bahrain[20-21]. Values for non-local foods (tuna and salmon) were obtained from the US Department of Agriculture data[22]. Low vitamin D intake is defined as the daily intake of <600 IU as recommended by the IOM[15]. Vitamin D level is considered deficient when the level is <50 nmol/L.

Approximately 5ml of blood was collected and vitamin D was assayed as 25(OH)D using chemiluminescence method on Architect (Abbott). This method (in our laboratory) has correlation coefficient with high performance liquid chromatography (HPLC) assay of 0.92[16].

SPSS statistical package (version-20) was used for data entry and analysis. Differences between subgroups were analyzed using Chi-Square test or Student's *t* test as appropriate. Linear regression analysis was used to evaluate independent predictors of 25(OH)D level. *P* value < 0.05 was considered significant.

RESULT

The mean age for men was 34.34 and for women was 28.75. The mean dietary intake of vitamin D in men was 180.06 ± 155.30 IU and in women 186.67± 148.61 IU, the difference was not significant, see table 1. However, the mean 25(OH)D serum level in males (46.06 ± 12.97 nmol/L) was significantly higher than in females (33.12 ± 13.48 nmol/L), P value of 0.001. Vitamin D level was deficient in 209 (64.3%) men and 292 (89.8%) women.

There is a significant association between dietary intake and 25(OH)D levels in both men and women, see tables 2 and 3. Furthermore, linear regression analysis revealed that the dietary intake of vitamin D was significantly and independently associated with 25(OH)D deficiency in both men and women. Sun exposure was found to be significantly associated with 25(OH)D levels in males but not in females. The latter was attributed to the use of veil in 87% of women.

The mean daily intake of vitamin D among the population of this study was comparable with the mean daily intake among many other international populations[23-28], see table 4.

Table 1: Mean Daily Intake of Vitamin D and Serum Level of 25(OH)D

	Mean (SD)	**Range**	**P value**
Mean daily intake of Vitamin D (IU)			
Male*	180.06 (155.3)	15.0 – 1159.0	0.441
Female*	188.67 (148.6)	06.0 – 1464.0	
Mean serum Level of 25(OH) D (nmol/L)			
Male*	46.06 (12.97)	15.0 - 84.1	0.001
Female*	33.12 (13.48)	10.7- 87.9	

*Total number: 325

Table 2: Association of Vitamin D Level with Oral Intake and Sun Exposure for Men

Variables		Total (%)	Vitamin D level Nmol/L		P value	Linear Regression
			< 50	≥ 50		
Participants (%)			209 (64.3)	116 (35.7)		
Vitamin D intake (IU)	< 100	97 (29.8)	75 (77.3)	22 (22.7)		
	100 – 199	139 (42.8)	79 (56.8)	60 (43.2)		
	200 – 399	67 (20.6)	41 (61.2)	26 (38.8)	**.013**	**.023**
	> 400	22 (6.5)	14 (63.6)	8 (36.4)		
	Total	325 (100)	209 (64.3)	116 (35.7)		
Sun Exposure	Yes	258	156 (60.5)	102 (39.5)		
	No	63	52 (82.5)	11 (17.5)	**.001**	**.001**
	Total	321*	208 (64.8)	113 (35.2)		

*Missing data

Table 3: Association of Vitamin D Level with Oral Intake and Sun Exposure for Women

Variables		Total (%)	Vitamin D level Nmol/L		P value	Linear Regression
			< 50	≥ 50		
Participants (%)		325 (100)	292 (89.8)	33 (10.2)		
Vitamin D intake (IU)	< 100	75 (23.1)	72 (96.0)	3 (4.0)		
	100 – 199	139 (42.8)	126 (90.6)	13 (9.4)		
	200 – 399	87 (26.8)	78 (89.7)	9 (10.3)	**.001**	**.001**
	> 400	24 (7.4)	16 (66.7)	8 (33.3)		
	Total	325 (100)	292 (89.8)	33 (10.2)		
Sun Exposure	Yes	134 (41.5)	116 (86.6)	18 (13.4)		
	No	189 (58.5)	174 (92.1)	15 (7.9)	**.079**	**.066**
	Total	323 (100)*	290 (89.8)	33 (10.2)		
Use of Veils	Yes	283 (87)	259 (91.5)	24 (8.5)		
	No	42 (13)	33 (78.6)	9 (21.4)	**.023**	**.001**
		325 (100)	292 (89.8)	33 (10.2)		

*Missing Data

Table 4: Comparison of the Daily Mean Dietary Intake of Vitamin D in Various Countries with Bahrain

Country	Daily Mean Dietary Intake of Vitamin D (IU) Males	Females	Age in Years
Bahrain	180	187	19-65
United States[23]**			
I. White	228	174	20-49
II. African American	196	147	
III. Mexican	194	159	
United Kingdom[26]	148	112	19-64
Australia[24]	80-88	104-120	Adults
Norway[25]	156*	120*	25-69
Lebanon[27]	128**	88**	30-50
Tunisia[28]	82	52**	20-60

*Value of dietary vitamin D subtracted from total vitamin D intake including supplements.

** Values of dietary vitamin D converted from mcg to IU

DISCUSSION

This study revealed that dietary intake of vitamin D was inadequate to meet the body's requirement for vitamin D, 180.06 ± 155.30 IU in males and 188.67± 148.61 IU in females. It is less than one third of the 600 IU intake of vitamin D as recommended by the IOM[15]. In addition, the dietary intake of vitamin D was not significantly different between men and women.

Despite the comparable dietary intake of vitamin D between men and women, the mean serum 25(OH)D level was significantly lower in women compared to men. This is most likely to be due to the use of veil that was documented in 87% of the women and was found to be significantly and independently associated with vitamin D deficiency (P value of 0.001).

The use of veil reduces sun exposure and vitamin D synthesis in the skin; this finding is similar to other studies, which concluded that veiled women had lower 25(OH)D levels[29-31]. However, it is important to note that the traditional male Arab garments are also covering the whole body including the head but the fabric is lighter and the color is white while the women's hijab is usually thicker and black. Clothes' fabric thickness has been shown to influence the ultraviolet rays' penetration to the skin, which is further reduced by darker color fabric[32-34]. Furthermore, many local men wear Western clothes and expose some parts of their body in non-formal occasions while most veiled women, when in public, are strictly covered all the time. This is most likely to explain the significantly lower mean serum 25(OH)D level among women in comparison with men despite the comparable oral intake of vitamin D.

However, the excess heat and humidity in Bahrain inhibit people from direct exposure to the sun. Furthermore, the synthesis of vitamin D from sunlight exposure is influenced by several factors such as latitude, altitude, season, time of the day and environmental factors such as air pollution, cloud cover and ozone level[35-38]. In addition, cutaneous vitamin D synthesis is also influenced by clothing, the use of sunscreen and dark skin[39-41].

The mean dietary intake of vitamin D in this study is comparable with the intake in United States, United Kingdom, Australia, Norway, Lebanon and Tunisia[23-28]. In Bahrain, the dietary intake of vitamin D was insufficient to meet the body requirements for vitamin D.

Milk and other dairy products, if fortified with vitamin D, can contribute to an improved overall dietary vitamin D intake. In Bahrain the fortification of milk with vitamin D by production companies is voluntary while milk and dairy products imported from neighboring Saudi Arabia are fortified with 400 IU vitamin D per liter of milk; however, a study conducted in Saudi Arabia concluded that it was not sufficient enough to prevent vitamin D deficiency in the Saudi population[42]. In Canada the fortification of foods with vitamin D is mandatory; in the United States it is voluntary with the exception of milk that is labeled as fortified[23]. Australia mandates the fortification of edible oil spreads such as margarine but fortification of other foods is voluntary; in Europe fortification of vitamin D varies significantly from Norway fortifying edible spreads and the United Kingdom fortifying cereals[24,26].

CONCLUSION

The present study revealed that dietary intake of vitamin D among couples in Bahrain is insufficient to meet the minimum daily requirements of 600 IU. Furthermore, the limited sun exposure exasperate vitamin D deficiency in otherwise healthy men and women. Although, there were no significant differences in the mean daily intake of vitamin D between males and females, vitamin D deficiency is more prevalent among women and it is attributed to less sun exposure and the use of veil. There is an urgent need to mandate vitamin D fortification of milk and dairy products and to give it as a supplement to veiled women and those at risk of deficiency with vitamin D. Further research is needed to identify vitamin D contents of various local foods and the impact of food fortification with vitamin D.

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