Vitamin D and Calcium Levels between Bahraini and Expatriate Laborers in Exposed and Non-exposed to the Sun

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Background: Vitamin D deficiency is a matter of concern among Bahrainis nowadays. The exposure period to the sun plays a significant role in vitamin D and calcium levels. Most Bahraini employees work indoors with limited exposure to the sun.

Objective: To evaluate vitamin D and calcium levels among Bahrainis and expatriate laborers in both exposed and non-exposed to the sun.

Design: An Observational Cross-Sectional Study.

Setting: Arabian Gulf University, College of Medicine and Medical Sciences, Physiology Department and Middle East Hospital, Bahrain.

Method: The study was carried out on four groups; non-exposed Bahrainis N=25 (Group 1), exposed Bahrainis N=94 (Group 2), non-exposed expatriates N=24 (Group 3), and exposed expatriates N=31 (Group 4) from 1 October 2018 and 30 September 2019. The levels of vitamin D and calcium in all four groups was evaluated. A blood sample of 5ml was obtained after securing the consent and approval. Vitamin D and calcium levels were evaluated in exposed and non-exposed Bahrainis (groups 1 and 2, respectively) and exposed and non-exposed expatriates (groups 3 and 4, respectively).

Data were analyzed using SPSS version 23.0. Two independent samples and an independent t-test were used to test the significant mean differences in different groups. P-value of less than 0.05 was considered statistically significant.

Result: Exposed Bahrainis have higher level of vitamin D, 20.35±0.84ng/ml compared to non-exposed Bahrainis, 14±0.71ng/ml, P=0.02. Unpredictably, exposed expatriates have lower vitamin D level, 16.92±0.72ng/ml compared to 21.62±2.00ng/ml for non-exposed expatriates, P=0.02. A significant difference in vitamin D level was found between the non-exposed groups 1 and 3, 14.30±0.71ng/ml and 21.62±2.00ng/ml, respectively, P=0.001. Whereas, exposed Bahrainis, group 2 have significantly higher vitamin d level, 20.35±0.84ng/ml compared to exposed expatriates, group 4, 16.92± 0.72ng/ml, P=0.002. However, no significant difference in calcium level was found between the exposed groups 2 and 4, 9.41±0.05mg/ml and 9.45±0.05mg/ml, respectively, P=0.6. Also, almost the same level of calcium was found in both non-exposed group1 and 3, 9.99±0.06mg/ml and 10.0±0.07mg/ml, respectively, P=0.002.

Conclusion: Exposed Bahraini workers have higher vitamin D level but the same calcium levels than the non-exposed Bahrainis. Unpredictably, among expatriate groups, exposed patriates have lower vitamin D compared to non-exposed but the same calcium levels, which contradicts the findings of other studies[3,7,15,37].

Short periods of exposure to the sun are effective enough to supply us with the sufficient amount of vitamin D[1-4]. Vitamin D deficiency has been a major field of interest in previous years, which affects almost 50% of the population worldwide[5]. Regional studies in the Arabian Gulf countries revealed that Bahrainis and Gulf Cooperation Council (GCC) citizens suffer from vitamin D deficiency[1,6,7]. An 81% of vitamin D deficiency among various age groups was shown in studies carried out in Saudi Arabia[8,9]. The new habits of lifestyle, like indoor shopping, virtual learning, online working, and indoor playgrounds could be a reasonable explanation for such low level of vitamin Din this region of the world as these practices minimize the duration of exposure to the sun. Studies by Lips et al revealed that exposure to Ultraviolet-B sunlight is required for vitamin D production in the skin[10].

Vitamin D is a fat-soluble vitamin. It shares the same properties of hormones. It also has receptors in most tissues and cells in the human body[11,12]. Vitamin D3 and vitamin D2 are the two biological inert precursors of vitamin D[13,14]. Both precursors can be obtained from two resources; exposure to sunlight and diet. Then they are converted to the active form by a two-step hydroxylation process, firstly by addition of hydroxyl group to carbon 25 in the liver followed by another hydroxyl group addition to carbon 1 in the kidneys.

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Vitamin D has a potent effect in increasing the absorption of calcium and phosphorous in both the gastrointestinal tract and the kidneys. It also plays an important role in bone deposition and bone resorption. Thence, it regulates calcium and phosphorous concentration in the blood. The main source of calcium and phosphorous in the human body is bone metabolism, which maintains the homeostasis of both calcium and phosphorous in the blood[39]. The availability of vitamin D enhances calcium absorption by 30-40% and phosphorus absorption by 80%[10,16].

The crystalline salts of the bone are composed of calcium and phosphate which makes bone metabolism the major source of calcium and phosphorous in the human body. Bone metabolism plays a significant role in maintaining the homeostasis of both calcium and phosphorous in the blood (Guyton)[9,13,14.] Without vitamin D, only 10-15% of dietary calcium and about 60% of phosphorus are absorbed[15]. Calcium, phosphorous, and bone metabolism are highly affected by vitamin D deficiency which can cause a concomitant decrease in calcium and phosphorous absorption. The decrease in calcium and phosphorous concentration leads to an increase in parathyroid hormone secretion which enhances both calcium and phosphorous absorption.[10,20,21.]
Poor diet or low intake of calcium and phosphorous products causes resorption and demineralization of bones and may result in skeletal defects, rickets and muscle weakness in children[22-25].

It has been reported that rickets in infants and osteomalacia in adults can be caused by vitamin D deficiency[22,23]. In the elderly, it could result in increasing sway and more frequent falls[26,27].

Several studies revealed that there is a relationship between the color of the skin and the production of vitamin D. The darker the skin, the more protection a person gets against the sunlight. Therefore, people with dark skin are less efficient in producing vitamin D, which requires them to expose themselves to the sun for at least three to five times longer than lighter-skinned individuals[15,18,19]. The majority of expatriates in this study were from the Indian subcontinent and of darker skin compared to the Bahrainis who were in general of lighter skin.

Previous studies revealed that people who stay indoors for long periods are prone to have lower levels of vitamin D. Also, people with certain occupations which limit their exposure to the sun are unlikely to produce the required amount of vitamin D[30-32]. Other studies revealed that vitamin D deficiency was 67.6% and 31.2% in females and males, respectively[11,28,29]. However, there are no published studies comparing vitamin D and calcium levels among foreign outdoor workers and Bahraini citizens under similar conditions.

This study is a comparative study to evaluate the effect of sunlight exposure on the level of both vitamin D and calcium among Bahrainis and expatriate workers. One aim of this study was to evaluate vitamin D and calcium levels and sun exposure among Bahrainis and expatriate workers.

METHOD

The study was carried out on four male groups: non-exposed Bahrainis (Group 1), exposed Bahrainis (Group 2), non-exposed expatriates (Group 3), and exposed expatriates (Group 4) from 1 October 2018 and 30 September 2019. The levels of vitamin D and calcium in all four groups were evaluated. A blood sample of 5ml was obtained after securing the consent and approval. Vitamin D and calcium levels were evaluated in exposed and non-exposed Bahrainis (Groups 1 and 2) and exposed and non-exposed expatriates, (Group 3 and 4).

Data were entered and analyzed using SPSS version 23.0. Quantitative variables were presented as Mean±SD. Two independent samples t-test were used to test the significant differences in means of the different groups. P-value of less than 0.05 was considered statistically significant.

The ADVIA Centaur Vitamin D assay is one-pass competitive immunoassay that uses anti-fluorescein labeled (FITC) monoclonal antibody covalently bound to paramagnetic particles, one monoclonal antibody labeled with Acridium ester, and a vitamin D analog labeled with fluorescein. An inverse relationship exists between the amount of Vitamin D present in the patient sample and the amount of relative light (RLUs) measured by the system. The assay demonstrates equimolar cross-reactivity with 25(OH) D3 (100.7%) and 25(OH)D2 (104.5%). It has a broad dynamic range of 4.2 to 150 ng/ml (10.5 to 375nmol/L). The reference procedure for the Vitamin D Standardization Program (VDSP) has been used, as was previously applied in reported research by Sempos et al and Thienpont et al[33,34].

RESULT

The effect of exposure to sunlight was evaluated in both exposed Bahrainis and exposed expatriates (groups 2 and group 4) see table 1 and 2. The vitamin D and calcium ions concentrations were measured in exposed Bahraini and exposed expatriate workers who were working outdoors. Two-sample t-test indicated that there was a statistically significant difference between the mean levels of vitamin D between the groups. The Bahrainis who were working outdoors, thus exposed to sunlight during their work, showed statistically significantly higher levels of vitamin D in their blood compared to the expatriates under the same working conditions; 20.4±0.8 ng/ml in the Bahrainis, n=94 (75.2%) compared to 16.9±0.7 ng/ml in the Expatriates. n= 31 (24.8%), P-value=0.002, (groups 2 and 4, respectively).

Table 1: Vitamin D Level among Bahrainis (n=94) and Expatriates (n=31) Exposed to Sunlight Two independent samples t-test indicates that there is a statistically significant difference in the mean levels of vitamin D of Bahraini and Expatriates who exposed to the sun (P-values = 0.002).

		Vitamin D Levels(ng/ml)		P-value
Group	Nationality	Mean	SE	
Exposed	**Bahrainis (n=94)**	20.35	0.84	0.002
	Expatriates (n=31)	16.92	0.72	

However, the calcium ions mean levels in the plasma of both groups were not statistically significantly different; 9.41±0.1mg/dl in exposed Bahrainis (group 2), n=94 (75.2%), compared to 9.45±0.1mg/dl in exposed expatiates (group 4), n=31 (24.8%), and P-value = 0.602, see table 2.

Table 2: Comparison of Calcium Levels in Exposed according to Nationality.
Two independent samples t-test indicates that there is no statistically significant difference in the mean levels of Calcium of Bahraini and Expatriates who exposed to the sun (P-values = 0.602).

Group	Nationality	**Calcium Levels**(mg/dl)		P-value
		Mean	SE	
Exposed	**Bahrainis (n=94)**	9.41	0.05	0.602
	Expatriates (n=31)	9.45	0.05	

The levels of vitamin D in the non-exposed Bahraini indoor workers (group 1) were compared to the non-exposed expatriate workers under the same working conditions (group 3). Two-sample t-test showed a significant lower level in the Bahrainis (14.3±0.7 ng/ml), n= 25 (51%) compared to the expatriates (21.6±2 ng/ml), n=24 (49 %), P-value=0.002, see table 3.

Table 3: Comparison of Vitamin D Levels in Unexposed to Sunlight According to Nationality

	Vitamin D Levels (ng/ml)		P-value
Nationality	Mean	SE	
Bahrainis (n=25)	14.30	0.71	0.001
Expatriates (n=24)	21.62	2.00	

Similarly, the mean calcium level in the unexposed indoor workers in the two groups was not statistically significantly different for the Bahraini (9.99±0.06 mg/dl), n=94, and the expatriates (10.0±0.7 mg/dl), n=31, P-value=0.919, see table 4.

Table 4: Comparison of Calcium Levels in Unexposed to Sunlight According to Nationality

Nationality	Calcium Levels(mg/dl)		P-value
	Mean	SE	
Bahrainis (n=25)	9.99	0.06	0.919
Expatriates (n=24)	10.00	0.07	

Table 5: Comparison of Vitamin D Levels (ng/ml) among Bahrainis and Expatriates for Both Exposed and Unexposed to Sunlight

Nationality	Group	Vitamin D Levels (ng/ml)		P-value
		Mean	SE	
Bahrainis	**Non-Exposed (n=25)**	14.30	0.71	**< 0.0005**
	Exposed (n=94)	20.35	0.84	
Expatriates	**Non-Exposed (n=24)**	21.62	2.00	**0.035**
	Exposed (n=31)	16.92	0.72	

Table 5 presents the difference in vitamin D levels in the Bahraini, and expatriates in both exposed and unexposed groups. Vitamin D level in exposed outdoor Bahraini workers is significantly higher (20.35±0.8 ng/ml), n=94 (78.99%) than unexposed Bahrainis (14.30±0.7ng/ml), n=25 (21%), respectively, P< 0.0005. However, this relationship is reversed in the expatriate workers, as unexposed to sunlight expatriates have higher vitamin D level of 21.62±2.0ng/ml, n=24 (33.64%) compared to vitamin D level in exposed expatriates (n=31) of 16.92±0.72ng/ml, P=0.035.

Under these work conditions, vitamin D levels in the Bahraini workers were significantly higher than in unexposed Bahrainis.

When measuring the calcium ion levels, (table 6), in exposed and unexposed Bahrainis; calcium level in unexposed Bahrainis have higher calcium level of 9.99±0.06 mg/dl, n=25, (12.2%) compared to exposed Bahrainis' level of 9.41±0.05 mg/dl, 31 (75.2%), P < 0.0005. The unexposed expatriates had calcium level of 10.00±0.07 mg/dl, (n=25) (43.64%) compared to 9.45±0.05 mg/dl, (n=31) (56.36%) in exposed expatriates, P value > 0.0005.

Table 6: Calcium level among Bahrainis and Expatriates in Both Exposed and Unexposed to the Sunlight

	Nationality	Calcium Levels (mg/dl)		P-value
Nationality		Mean	SE	
Bahrainis	Non-Exposed (n=25)	9.99	0.06	**< 0.0005**
	Exposed (n=94)	9.41	0.05	
Expatriates	Non-Exposed (n=24)	10.00	0.07	**< 0.0005**
	Exposed (n=31)	9.45	0.05	

DISCUSSION

Previous studies revealed that the use of the veil was found to contribute significantly to a lower vitamin D level in women[11,35,36]. Other studies revealed that the type of dress did not play a significant role in vitamin D level between covered and uncovered females[36]. We have not paid any emphasis in this study to the type of dress for all groups.

The results of the exposed workers in between Bahrainis (group 2) and expatriates (group 4) revealed higher levels of vitamin D (20.4±0.8 ng/ml) in exposed Bahrainis who work outdoors (group 2) compared to outdoor expatriate workers (group 4) (16.9±0.7 ng/ml). Previous studies stated that the more time a person is exposed to the sun, the more vitamin D is formed and hence, the more calcium absorption takes place which consequently elevates the blood calcium level[3,7,37]. In our study, the higher level of vitamin D was not congruent with a higher level of calcium as there was no significant difference in calcium level in both groups.

Indoor unexposed Bahraini workers had lower vitamin D levels (14.3±0.7 ng/ml) compared to expatriates under the same conditions (21.6±2 ng/ml), which did not result in a similarly elevated calcium level in expatriates. Vitamin D level in non-exposed expatriates was higher than the level of vitamin D for non-exposed Bahrainis, whereas for the same two groups, the calcium levels were not significantly different. This finding does not comply with the other studies which revealed that a high vitamin D level leads to a high calcium level[38]. This could be attributed to compensation by the type of food consumed by expatiates which is rich in vitamin D than the type of food consumed by non-exposed Bahrainis. One possible explanation is that in both non-exposed groups, the level of calcium is maintained at its normal level by the parathyroid hormone which activates bone resorption and consequently maintaining normal calcium level. The homeostasis of blood calcium is achieved by either a high level of vitamin D which stimulates calcium absorption from the small intestine and the kidneys or by the effect of the parathyroid hormone by resorption of calcium from the bones. It can also be attributed to the fact that the decrease in vitamin D in non-exposed Bahrainis leads to less calcium absorption from the gastrointestinal tract which in turn eventually leads to lower calcium levels in the blood. The low blood calcium level will in return lead to higher parathyroid hormone secretion bringing back the calcium level to normal.

But when comparing vitamin D levels among only Bahrainis (exposed with non-exposed) it was found that there is a significant difference between the two groups with higher level of vitamin D in exposed Bahrainis, but conversely the calcium level was lower in exposed Bahrainis who were not exposed to the sun had higher vitamin D and calcium compared to Bahrainis who were exposed to the sun. Unpredictably, there was a higher vitamin D level for unexposed expatriates compared to vitamin D level for exposed expatriates. The calcium level on the other hand is higher in non-exposed expatriates. This contradicts other findings from other studies which reported that exposure to the sun leads to higher vitamin D level and consequently higher calcium level[3,7].

Sizar et al classified the severity of vitamin D deficiency into three categories, depending on the concentration of vitamin D: mild (20 ng/ml), moderate (10 ng/ml) and severe (5 ng/ml)[38]. Therefore, the level of vitamin D obtained in our study ranges between 20.35 ng/ml in exposed expatriates and 16.95 ng/ml in exposed Bahrainis is mildly deficient.

LIMITATIONS OF THE STUDY

There are different ethnic groups in the expatriate groups with different nutritional diets, a fact that could affect the levels of vitamin D in these groups. Also, the parathyroid hormone levels were not taken to relate the differences in calcium levels.

CONCLUSION

Our results showed that Bahraini outdoor workers have higher vitamin D, but lower calcium levels compared to indoor Bahraini workers, whereas, in expatriate groups, even though the vitamin D level is lower in exposed workers, the calcium level is higher in the unexposed workers. Our results indicate that other factors besides exposure to sun play significant roles in vitamin D and calcium levels such as nutrition and parathyroid hormone levels in the blood.

RECOMMENDATION OF THE STUDY: We recommend more exposure to the sun in the early morning and vitamin D-rich-diet or vitamin D supplementation of 1000 IU in case of vitamin D deficiency.

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