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ORIGINAL ARTICLE

Prevalence of Vitamin D Deficiency and the Association with Coffee Consumption among Female Employees of Imam Hossein Medical Center, Tehran, Iran

Giti Noghabaei[1], Maliheh Arab[2*], Sara Payami[3], Nasim Nouri[4], Behnaz Ghavami[5], Behnaz Nouri[6], Roya Parkhideh[7]

1. Internal Medicine Department, Imam Hossein Hospital Complex, Iran University of Medical Sciences, Tehran, Iran
2. Obstetrics and Gynecology Department, Imam Hossein Medical Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran
3. Emergency Medicine Department, Ziaeian Hospital, Tehran University of Medical Sciences, Tehran, Iran
4. Shahid Behehshti University of Medical Sciences, Tehran, Iran
5. Obstetrics and Gynecology Department, Arash Women`s Hospital, Tehran University of Medical Sciences, Tehran, Iran
6. Obstetrics and Gynecology Department, Shohada-e-Tajrish Hospital Clinic, Shahid Beheshti University of Medical Sciences, Tehran, Iran
7. Cardiology Department, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran

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**Corresponding author:*
Maliheh Arab, MD;
Imam Hossein Medical Centre,
Shahid Beheshti University of Medical Sciences,
Tehran, Iran.
Tel: +989121593277
Email: drmarab@sbmu.ac.ir; drmarab@yahoo.com
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ABSTRACT

Background: Measurement of serum vitamin D levels can assist healthcare providers in the provision of appropriate advice and management for low vitamin D status. This study determined the prevalence of vitamin D deficiency and the association with coffee consumption among female employees in Tehran, Iran.

Methods: Six hundred fifty-one female staff of Imam Hossein Medical Center, Tehran, Iran aged between 20 and 67 years were enrolled in a prospective cross-sectional study. Age, educational level, reproductive history, employment records and daily consumption of different types of food and beverages of all the participants were collected in a questionnaire. Serum level of 25-dihydroxy vitamin D was also measured.

Results: Four-hundred out of 651 working staff (61.5%) demonstrated vitamin D deficiency, while 46.4% suffered from a severe deficiency. No significant link was found between serum vitamin D level and dietary consumption of meat, nuts, vegetables, fruit, salad, and tea; but coffee consumption was significantly associated with a lower vitamin D level. Longer employment duration could significantly reduce the risk of vitamin D deficiency by 5% per year. Calcium-vitamin D and multivitamin supplements significantly decreased the risk of deficiency by 53% and 52%, respectively.

Conclusion: Vitamin D deficiency was highly prevalent among female employees of the medical center and was inversely associated with their age, duration of employment, and use of multivitamins and calcium-D supplements. Coffee drinking was correlated with a lower serum vitamin D level in the study population.

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Introduction

Vitamin D exerts several regulatory effects on body physiology. It contributes to improvement of processes such as cell differentiation, tissue inflammation, and tumor destruction, while it also promotes healthy growth by exerting its hormonal effects on bone remodeling (1). Serum 25-hydroxyvitamin D level less than 20 ng/mL was shown to be correlated with skeletal complications, such as bone loss and fractures; while levels below 12 ng/mL can expose patients to an increased danger of developing osteomalacia, rickets, and severe infections (2, 3). Innate and adaptive immunities, insulin resistance, blood pressure regulation, anthropometric index, obesity, autism, gut microbiota and neuromuscular physiology are some of the other areas where vitamin D has an important role to play (4-13).

Women with high vitamin D concentration were found to have a more favorable glucose profile (14). Vitamin D level has also been found to affect estrogen level. Significant gender disparity has been reported between vitamin D and autoimmune disorders. Women were shown to benefit more from the protective impact of vitamin D intake. In immune cells, vitamin D can decrease the expression of aromatase, an enzyme that catalyzes the conversion of testosterone to estrogen; and as a result vitamin D can reduce the estrogen level. On the other hand, a stronger anti-inflammatory response is expected in females, since estrogen augments the function and accumulation of vitamin D and enhances the expression of vitamin D receptors (15).

Globally, nearly one billion people are reported to have plasma vitamin D levels of less than 30 ng/mL (75 nmol/L) (16) that can be attributed to many factors, such as race, age, dietary habits (e.g. intake of calcium-D supplements/multivitamins, dairy products, meat, vegetables, coffee, and tea), medical conditions (e.g. malabsorption syndromes), geographical location (affecting sunlight exposure), and cultural status. Sunlight is an important element in production of vitamin D; thus limited sunlight exposure warrants additional dietary intake of vitamin D-rich sources or supplements. Measurement of serum vitamin D level can assist healthcare providers in provision of appropriate advice and management for low vitamin D status (17). Therefore, the current investigation was conducted to detect the prevalence of vitamin D deficiency among female employees of Imam Hossein Medical Center in Tehran, Iran. Also, the risk factors which exposed them to develop vitamin D deficiency were determined.

Materials and Methods

In this cross-sectional study, 651 female employees of Imam Hossein Medical Center in Tehran, Iran aged 20-67 years were enrolled. The study population included physicians, nurses, technicians, and administrative staff. Data about their age, educational level, reproductive history, employment records, dietary habits, and a previous supplement intake was collected and completed in a questionnaire. Reproductive profile was consisted of the number of gestations, parities, and cesarean sections. Dietary habits and supplement intake including consumptions of meat, nuts, vegetables, fruit, salad, tea, coffee, calcium-vitamin D, and multivitamins were recorded by a trained person. Participants were asked to report all foods and beverages they consumed daily, and the amount of the portions (cups, bowls, plates, etc.). Food frequency estimation was based on the daily use of diverse foodstuffs including meat, vegetables, nuts, and beverages like tea and coffee. Meat products were considered as beef, chicken and fish. Furthermore, the subjects were requested to provide information about the type and frequency of calcium-vitamin D and multivitamins that they consumed.

The serum level of 25-dihydroxy vitamin D was measured by enzyme-linked immunosorbent assay (ELISA). Measurements of less than 12 ng/mL (<30 nmol/L), and 12-20 ng/mL (30-50 nmol/L), were defined as severe, and moderate vitamin D deficiency, respectively as described by US Institute of Medicine (IOM) and World Health Organization resources. Levels above 30 ng/mL (75 nmol/L) were considered as sufficient (18). Those with musculoskeletal complaints or a well-known metabolic bone disease, and those with an established record of long-lasting illnesses as well as diabetes mellitus, hypertension, renal and liver diseases, osteomalacia, thyroid and parathyroid diseases, malabsorption syndrome, osteoporosis, in addition to pregnancy and breast-feeding women, were excluded from the study. Approval of the ethics committee of Shahid Beheshti University of Medical Sciences was also obtained (IR.SBMU.RETECH.REC.1395.323) for this study.

The collected data were analyzed using SPSS software (version 21, Chicago, IL, USA). Frequency and percentage, mean, standard deviation (SD), median, and range were used to describe the data. A 95% confidence interval was utilized to express the accuracy of the estimates. Chi-square test, Fisher Mann-Whitney test, and t-test were employed to compare the relationship between different factors and vitamin D deficiency. The simultaneous effect of variables was investigated through a logistic regression. Significance was set at p value <0.05.

Results

A total of 651 women with age range of 20-67 years (mean: 36.58±8.9 years) were enrolled. Vitamin D deficiency (25(OH)D level <20 ng/mL) was detected in 400 cases (61.5%). While severe vitamin D deficiency was defined as 25(OH)D level <12 ng/mL, 302 women (46.4%) were determined as severe and 120 cases (18.4%) were in a normal range of vitamin D (more than 30 ng/mL) (Table 1). The mean serum 25(OH)D level for those with vitamin D deficiency (<20 ng/mL) was 11.73±2.64 ng/mL (Range: 2-19.9 ng/mL). Older women, those with longer duration of employment, and those using calcium-vitamin D or multivitamin supplements demonstrated a significant higher level of serum 25(OH)D (p<0.05). Coffee consumption was illustrated to have a significant association with lower levels of serum vitamin D (p<0.05) (Table 2). It was shown that the majority of participants (68.6%) had a university degree.

When the relationship between serum vitamin D level and the consumed foods were evaluated, women with vitamin D deficiency reported a significantly higher daily (p=0.046), and a significantly higher weekly amount of coffee consumption (p=0.048). No significant association was observed between serum vitamin D level and daily consumption of meat, nuts, vegetables, fruit, salad, and tea. Based on the findings of the multiple logistic regression model, variables of length of employment, use of calcium-vitamin D and multivitamin consumption showed significant association with vitamin D level. A year of increase in employment was exhibited to be associated with a 5% decrease in the risk of developing vitamin D deficiency (OR=0.953, 0.913-0.99, p=0.0264)). Also, calcium-vitamin D and multivitamin supplements increased the risk of vitamin D deficiency by 53% (OR=0.479, 0.266-0.862, p=0.014), and 52% (OR=0.482, 0.271-0.856, p=0.013), respectively. According to the findings of the multiple logistic models in the age group of older than 30 years, coffee consumption could improve the chance of vitamin D deficiency by 1.5 times (OR=1.55, p=0.034, Table 3).

Discussion

A significant portion of residents in low- and middle-income nations were reported to suffer from severe vitamin D deficiency (25(OH)D level <12 ng/mL). In Pakistan, 66.2% of non-pregnant women (n=5,402) were announced to have severe vitamin D deficiency with serum levels less than 8 ng/mL (< 20 nmol/L) as described in the National Nutrition Survey. The majority of the populations living in three large cities of Pakistan were found to have severe vitamin D deficiency, with prevalence rates of 53.5% among males and 69.7/70.7% in females, and a total of 66.1% in the cities. On the contrary,

Table 1: Frequency of serum vitamin D level in the study population.

Variable		Frequency	Percent	Cumulative percent
Vitamin D ng/mL	<12	302	46.4	46.4
	12-20	98	15.1	61.5
	20-30	131	20.1	81.6
	>30	120	18.4	100

Table 2: Comparison of data obtained from the study population about the vitamin D level.

Variable	Vitamin D deficiency (Vitamin D level<20 ng/mL)		*P* value
	No	Yes	
Age (mean±SD)	37.59±9.02	35.95±8.78	0.023
Duration of employment [median (IQR)]	12(7 - 20)	10(5 - 17)	0.005
Gestation number [median (IQR)]	1(0 - 2)	1(0 - 2)	0.265
Parity number [median (IQR)]	0(0 - 1)	0(0 - 1)	0.125
Last parity (yrs) [median (IQR)]	9 (4 - 16)	8 (4 -15)	0.370
CS number [median (IQR)]	0(0 - 1)	0(0 - 1)	0.617
Calcium-D consumption	34 (13.5)	23 (5.8)	0.001
Multivitamin intake	32 (12.7)	27 (6.8)	0.009
Coffee drinking	171 (68.1)	301 (75.3)	0.048
Tea drinking	163 (64.9)	274 (68.5)	0.347
Nuts usage	229 (91.2)	360 (90.0)	0.601
Meat consumption	248 (98.8)	399 (99.8)	0.133
Vegetable intake	213 (84.9)	339 (84.8)	0.970
Fruit use	18 (7.2)	27 (6.8)	0.837
Salad consumption	244 (97.7)	391 (97.8)	0.666

Table 3: The relationship between the assessed variables and vitamin D deficiency in the study population.

Variable		Regression coefficient	Standard deviation	*P* value	OR	95% CI for OR	
						Lower	Upper
Age		0.021	0.019	0.250	1.02	0.985	1.06
Duration of employment		0.048	0.022	0.026	0.953	0.913	0.994
Calcium- vitamin D Use		0.736	0.300	0.014	0.479	0.266	0.862
Multivitamin intake		0.730	0.293	0.013	0.482	0.271	0.856
Coffee consumption	Older than 30	0.440	0.207	0.034	1.55	1.03	2.33
	Younger than 30	0.316	0.450	0.482	0.729	0.302	1.76

moderate to severe vitamin D deficiency was shown to affect 24% of Americans, 37% of Canadians, and 13-40% of European populations (19-21).

A multicenter study conducted in Tehran, Iran revealed that 85.2% of reproductive-age women had serum 25(OH) D levels of less than 8 ng/mL (<20 nmol/L) (22). In 2017, the prevalence of vitamin D deficiency was reported to be 75.1% and 72.1% among Iranian women and men, respectively (23). Our findings showed that 61.5% of women worked in a medical center in Tehran, Iran suffered from vitamin D deficiency (25(OH)D level <20 ng/mL), while in 46.4% of the studied population, the deficiency was severe (25(OH)D level <12 ng/mL). The results of our study are compatible with these Iranian reports in neighboring countries revealing lower levels of serum vitamin D in their cohort studies. These findings have public health importance for measures and awareness programs to improve the average serum level of vitamin D, and to prevent the unfavorable consequences of vitamin D deficiency in the general population. The mean age of vitamin D deficient women in our study was 35.95±8.78 suggesting that the majority of subjects were in child-bearing age. Older women and those with longer records of employment had significantly higher serum 25(OH)D levels (p<0.05). Employment duration of these women in each year was linked to 5% decrease in the risk of vitamin D deficiency. It seems that screening of serum 25-hydroxyvitamin D is needed for further vitamin D supplementation and sunshine exposure to improve the health status of women in the area.

It was shown that factors such as lack of vitamin D supplementation, obesity, a lower socioeconomic status, and absence of the daylight exposure can contribute to a low vitamin D level (24)xQ°. Normally, the body source of vitamin D is due to the effect of the sun light UV-B rays to the skin and thus vitamin D production is affected by geographical, cultural, and seasonal factors. An Australian study displayed that daily exposure of the face, arms, and hands to spring daylight for 10-15 minutes resulted in vitamin D production equivalent to 15 µg of dietary vitamin D (25); yet the chances of adequate UV exposure decreases in indoors works during the day. Compared to Europe and America, the Middle East has higher rates of vitamin D deficiency in women, despite having numerous sunny days per year; and this can be attributed to the cultural norms such as Hijab in these nations (26-28). All women participating in the present study had indoor work and were deprived of sunlight exposure for a significant part of their working days, resulting in a bigger chance of developing vitamin D deficiency. Sowah *et al.* have also found higher rates of vitamin D deficiency among women working indoors (29).

In the present study, it is extremely surprising that 68.6% of the employees had a university degree, but only 18.4% had a normal vitamin D serum level. Further evaluations are needed to determine the cause of high prevalence of vitamin D deficiency in highly educated working women. Nonetheless, the great incidence of vitamin D deficit in these individuals may suggest that a proper nutritional diet alone cannot meet their body requirements. Vitamin D-rich dietary sources in these subjects have been restricted, and usually inadequate to meet their body needs. Most people do not have such sources in their daily dietary regimens and their food sources rich in vitamin D usually belong to animal origin such as fish, meat, offal, egg, mushroom, cod liver and marine oils. Also, small amount of vitamin D is found in milk and dairy products they consume. It is necessary to mention that the vitamin D level in processed fresh meat and its fat content are the two determinants of vitamin D content in meat products. So limited amounts of vitamin D are found in cooked and dried ham (30, 31).

In populations with low dietary intake of vitamin D and those with limited sun exposure, usage of vitamin D supplements should be encouraged to optimize the serum level of vitamin D. Adequate levels endorsed by the US Institute of Medicine are unlikely to be achieved solely from dietary resources; thus, the recommendation is made to fortify food supplies with suitable vitamin D content. The US Institute of Medicine has recommended a daily dose of 5-15 µg for vitamin D supplements (32-35). We found no significant association between

serum vitamin D level and daily consumption of meat, nuts, vegetables, fruits, salad, and tea. Also, women who used calcium-vitamin D or multivitamin supplementations had significantly greater levels of serum vitamin D. Though most of the participants held university degrees expecting their higher understanding of the importance of appropriate nourishment, but there was a high prevalence of vitamin D deficiency in this group that suggests the inadequacy of a proper diet to fulfill their body requirements for this vitamin. Daily consumption of more than 3 portions of meat, vegetables, and other foods was demonstrated not to be associated with a higher vitamin D serum level. This nutritional inadequacy can be overcome by vitamin D fortification of foodstuffs along with the addition of vitamin D supplements to a regular diet. So the results of the current study might help the public health authorities to evaluate and institute necessary food fortification policies for women.

In our study, we established a great association between coffee consumption and lower serum vitamin D level. The women with vitamin D deficiency showed a significantly more daily and weekly coffee drinking habits suggesting that high caffeine intake can affect the calcium balance by decreasing its renal reabsorption. Moreover, through its effect on vitamin D receptors, caffeine may facilitate renal and intestinal calcium losses; such deleterious effects on calcium homeostasis that can lead to a low bone mineral density (BMD) and can raise the possibility of osteoporotic fractures (36-39).

The findings of study in Korean women in 2017 suggested a possible correlation between the frequency of coffee drinking and a lower vitamin D level. In this investigation, 20-30 years old women drinked more than 2 daily cups of coffee suggesting the lower plasma vitamin D level in this population (40). In our study, we found that in women older than 30 years old, the coffee consumption increased the chance of developing vitamin D deficiency by 1.5 times. It seems that adequate information on diet is deficient in our population, and we lacked details on the type of coffee and food products they consumed. These factors can be considered as major confounders that can affect the serum level of vitamin D among women.

Conclusion

Vitamin D deficiency was common among the female employee of our medical center; so screening of serum vitamin D level, use of vitamin D supplementation, and encouraging more sunlight exposure can be the strategies to help tackle this issue. The study revealed that coffee consumption reduced the serum vitamin D level; while vitamin D deficiency was inversely linked with age, duration of employment, and use of multivitamins and calcium-vitamin D supplementation.

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Authors' Contribution

All authors contributed to developing the study's framework, design, and planning. B.N, N.N collected the data. G.N, N.N, S.P, and M.A wrote the manuscript and provided critical revisions to ensure its intellectual rigor. N.N, B.G, and M.A prepared Tables1-3. R.P and M.A supervised the project. Each author has endorsed the final version of the manuscript.

Conflict of Interest

The authors declared no conflicts of interest.

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