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A Cross-sectional Study on Vitamin D Levels, Body Mass Index, Physical Activity Level and Life-style Factors in Postmenopausal Women

Postmenopozal Kadınlarda Vitamin D Seviyeleri, Vücut Kitle İndeksi, Fiziksel Aktivite Düzeyi ve Yaşam Tarzı Faktörleri Üzerine Kesitsel Bir Çalışma

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Abstract

Objective: The aim of this study was to evaluate the vitamin D levels, body mass index (BMI), physical activity levels and life-style factors in postmenopausal women and investigate the correlation between vitamin D levels, BMI and physical activity.
Materials and Methods: A total of 100 postmenopausal women were included in this cross-sectional study. Sociodemographic features, life-style factors such as calcium and vitamin D supplementation and sun exposure, and BMI, and 25 hydroxyvitamin vitamin D [25(OH)D3] levels of the participants were recorded. The [International Physical Activity Questionnaire (IPAQ) Short Form (SF)] was applied to all participants. The correlation between 25(OH)D3, BMI, and IPAQ scores has been investigated. Forty postmenopausal healthy individuals were included in the study for the comparison of physical activity level with the patient group.
Results: The mean 25(OH)D3 level of the postmenopausal participants was 18.97±10.0 ng/mL, the mean BMI was 27.93±5.19, and the IPAQ score was 316.15±370.42. Compared with the IPAQ-SF score of the control group, the activity level of the postmenopausal patients was lower (p<0.001). A negative significant correlation between 25(OH)D3 levels and BMI (p<0.001) and a positive significant correlation was observed between 25(OH)D3 levels and IPAQ-SF scores in postmenopausal women (p<0.001).
Conclusion: BMI and physical activity levels seem to be associated with vitamin D levels in the postmenopausal period. The importance of vitamin D deficiency, weight control, life-style factors, and physical activity in the postmenopausal period should be emphasized in patients.
Keywords: Vitamin D, body mass index, physical activity

Öz

Amaç: Bu çalışmanın amacı postmenopozal kadınlarda D vitamini düzeylerini, vücut kitle indeksini (VKİ), fiziksel aktiviteyi ve yaşam tarzı faktörlerini değerlendirmek ve D vitamini düzeyleri ile VKİ ve fiziksel aktivite arasındaki korelasyonu araştırmaktır.
Gereç ve Yöntem: Bu kesitsel çalışmaya toplam 100 postmenopozal kadın dahil edildi. Katılımcıların sosyodemografik özellikleri, kalsiyum ve D vitamini takviyesi ve güneş maruziyeti gibi yaşam tarzı faktörleri, VKİ'leri ve 25 hidroksivitamin D [25(OH)D3] düzeyleri kaydedildi. Katılımcılara ayrıca [Uluslararası Fiziksel Aktivite Anketi (IPAQ) Kısa Formu (SF)] uygulandı. 25(OH)D3 düzeyleri ile VKİ ve IPAQ skorları korelasyonu araştırıldı. Postmenopozal hasta grubunun fiziksel aktivite düzeyini karşılaştırmak için 40 postmenopozal sağlıklı birey çalışmaya dahil edildi.
Bulgular: Postmenopozal kadınların ortalama 25(OH)D3 düzeyi 18,97±10,0 ng/mL, ortalama VKİ 27,93±5,19 ve IPAQ skoru 316,15±370,42 idi. Kontrol grubunun IPAQ skoruyla karşılaştırıldığında postmenopozal hastaların aktivite düzeyi daha düşüktü (p<0,001). Postmenopozal kadınlarda, 25(OH)D3 düzeyleri ile VKİ arasında negatif anlamlı korelasyon vardı (p<0,001), 25(OH)D3 düzeyleri ile IPAQ-SF skorları arasında ise pozitif yönde anlamlı bir ilişki gözlendi (p<0,001).
Sonuç: VKİ ve fiziksel aktivite seviyeleri postmenopozal dönemde D vitamini düzeyleri ile ilişkili görünmektedir. Postmenopozal dönemde vitamin D eksikliğinin, kilo kontrolünün, yaşam tarzı faktörlerinin ve fiziksel aktivitenin önemi hastalara vurgulanmalıdır.
Anahtar kelimeler: Vitamin D, vücut kitle indeksi, fiziksel aktivite

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Introduction

Vitamin D is included in the group of fat-soluble vitamins while it is also biologically synthesized in the human body. It performs an active role in calcium phosphorus metabolism and contributes to bone mineralization. Vitamin D deficiency and insufficiency, as an important global health problem, is predicted as a possible risk factor for many acute and chronic diseases with a broad spectrum (1).

Vitamin D3 (cholecalciferol) is synthesized endogenously in the human body from 7 dehydrocholesterols in the skin by ultraviolet B (UVB) rays. Vitamin D can be taken externally as ergocalciferol (vitamin D2) from plants and as cholecalciferol (Vitamin D3) from animal sources (2,3). The main sources of vitamin D are; milk, yogurt, kefir, cheese, beef liver, fatty fish such as mackerel-trout-tuna-herring and egg yolk (4). Vitamin D is first converted to 25 hydroxyvitamin D [25(OH)D] with the enzyme 25 hydroxylase in the liver, and then to 1.25 dihydroxy vitamin D [1.25(OH)2D], known as calcitriol, with the enzyme 1 alpha hydroxylase in the kidneys (2, 3). Calcitriol preserves the blood calcium level by increasing calcium absorption from the small intestine and reducing calcium loss from the kidneys, which is the overall function (3,5). The half-life of calcitriol is short and its level in the blood is much lower than 25(OH)D3. Therefore, 25(OH)D3 levels, which show both endogenous production and exogenous intake, are used to evaluate vitamin D levels (2,5).

Vitamin D deficiency increases dramatically in older age (6). It is more prevalent, especially in the postmenopausal period. This situation may be due to thinning of the skin structure during menopause, decreased vitamin D absorption, and decreased hydroxylation of vitamin D in the liver and kidney. Furthermore, decrease in estrogen levels and other hormone changes in postmenopausal women also contribute to the development of low vitamin D levels. In light of researches conducted during the menopausal period, vitamin D deficiency was associated with an increased risk of fractures and decreased bone mass. In addition, osteoporosis rates were found to be greater in postmenopausal women with vitamin D deficiency (7).

Some of the previous researches have documented a negative correlation between body mass index (BMI) and vitamin D in postmenopausal women (8). The aim of our study was to evaluate the association between vitamin D levels, BMI and many other factors including physical activity levels, sun exposure and consumption of foods containing vitamin D and calcium.

Materials and Methods

This cross-sectional study was conducted between September 2021 and November 2021. A hundred postmenopausal women who admitted to the physical medicine and rehabilitation outpatient clinic for musculoskeletal pain were included in the study. The exclusion criteria were as follows: history of malignancy, presence of alcohol use, drug or substance abuse, dementia, cognitive dysfunction that interferes with the normal function of the central and peripheral nervous system. Age, gender, occupation, educational status, BMI, calcium and vitamin D supplementation, consumption amount of foods containing calcium and vitamin D, sun exposure hours and intervals (March-September), and smoking status of all participants were recorded.

[International Physical Activity Questionnaire-Short Form (IPAQ-SF)] was used to determine the physical activity levels of the participants. A control group of 40 healthy postmenopausal women without musculoskeletal pain has been included to compare IPAQ scores with postmenopausal patients. The IPAQ-SF is a widely used questionnaire to determine physical activity levels in various populations. It not only classifies physical activity levels in the last 7 days as vigorous activity, moderate activity and walking, but also records the sitting times of individuals (9). According to the formula proposed by Ainsworth et al. (10) the data were converted to Metabolic Equivalent minutes per week (MET-min/week). MET values are calculated as 3.3 METs for walking, 4.0 METs for moderate physical activity and 8.0 METs for vigorous physical activity The participants were classified as inactive, minimally active and sufficiently active according to the total values of all results (11).

Serum 25(OH)D3 levels of all participants were analyzed and vitamin D status was classified as <10 ng/mL: vitamin D deficiency, 10-20 ng/mL: vitamin D insufficiency, >20 ng/mL: sufficient level for bone health, and 30-50 ng/mL: sufficient level for extra-bone activity (12).

The study was initiated after ethical approval and a written informed consent was obtained from all participants. It was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical Analysis

All statistical analyses were performed by using IBM SPSS 22 (IBM Corp., Armonk, N.Y., USA). Data were presented as mean±standard deviation for continuous variables and count (n) and percentage (%) for categorical variables. Normality of variables was confirmed with the Kolmogorov-Smirnov test. Vitamin D and IPAQ values were compared with Student's t-test between two groups. For the variables which were not normally distributed, Mann-Whitney U test was used. For comparison of three or more groups Kruskal Wallis-H test was used and Dunn's test was applied as a post-hoc test. While determining the relations between Vitamin D and IPAQ or BMI, Spearman correlation coefficient was used. For graphical presentations box-plot and scatter plots were used. A p-value<0.05 was considered to be statistically significant for all tests.

Results

A hundred postmenopausal patients (mean age: 61.6±9.5, age range, 45-92 years) and 40 healthy individual were included in the analysis. The demographic and clinical data of the participants are summarized in Table 1. The mean 25(OH) D3 level of the postmenopausal patients was determined as 18.9+10.0. The mean values of BMI and IPAQ score were

Table 1. Demographic and clinical characteristics of postmenopausal and premenopausal women

		Postmenopausal patients (n=100)		Control group (n=40)	p
Age (Mean ± SD)		61.6±9.5		60.5±8.8	0.52
BMI (Mean ± SD)		27.9±5.2		26.2±4.9	0.07
IPAQ score (Mean ± SD)		316.1±370.4		545.304.2	<0.001
		n	**%**	**n**	**%**
Marital status	Married	90	90	32	80
	Single	10	10	8	20
Occupation	Out of home, indoor activity	5	5	8	5
	Field gardening (outdoor)	3	3	1	2.5
	Housewife	87	87	32	80
	Retired	5	5	5	8
	Unemployed	0	0	0	0
Way to work	On foot	4	50	1	2.5
	Special vehicle	0	0	0	0
	Public transport	4	50	4	10
	Sometimes by car, sometimes on foot	0	0	5	8
Education	Illiterate	14	14	10	25
	Primary school	73	73	14	35
	Secondary school	5	5	16	40
	High school	5	5	0	0
	University	3	3	0	0

BMI: Body mass index, IPAQ: International Physical Activity Questionnaire Short Form, SD: Standard deviation

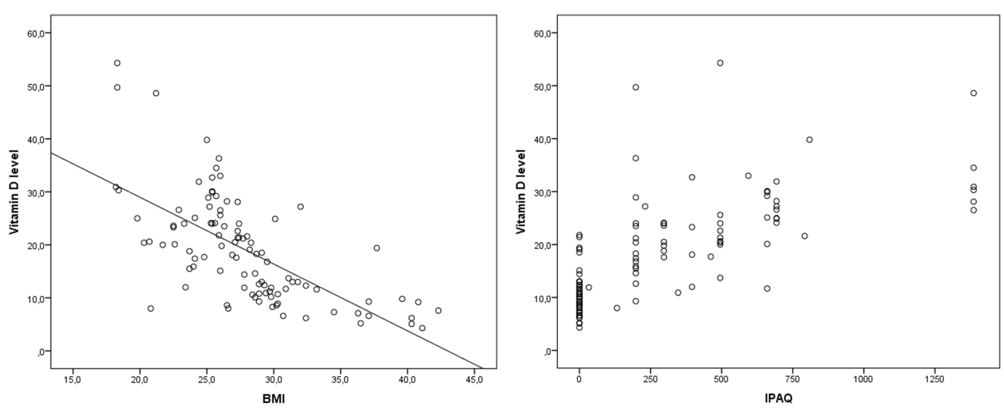

Figure 1. The correlation between 25(OH)D3 levels, BMI and IPAQ scores in postmenopausal patients
BMI: Body mass index, IPAQ: International Physical Activity Questionnaire Short Form

27.9±5.2 and 316.1±370.4 respectively. The postmenopausal patients' activity level was lower (p<0.001) when compared to the premenopausal control group's IPAQ score. The correlation between the postmenopausal patients' vitamin D levels and BMI, and IPAQ scores was statistically significant (Figure 1). Although BMI and vitamin D levels were negatively correlated, IPAQ scores and vitamin D levels were positively correlated (r: -0.698, p<0.001 for BMI; r: 0.777, p<0.001 for IPAQ). Additionally, multiple comparisons of BMI subgroups were found statistically significant and the results are summarized in Table 2.

There was no significant correlation between marital status, occupation and education level, and both vitamin D levels and IPAQ scores. Vitamin D levels were greater in those who used calcium or vitamin D supplements, as was expected. Additionally, individuals who took calcium or vitamin D supplements had statistically significantly higher IPAQ scores. Similarly, the amount of consumption of foods containing vitamin D contributed positively to vitamin D levels and IPAQ scores. The association of vitamin D and IPAQ scores with sunlight exposure time, exposure intervals to sunlight, and sunlight exposure were investigated. The results are shown in Table 3.

Table 2. Comparisons of BMI subgroups in terms of 25(OH)D3 levels and IPAQ scores in postmenopausal patients

		Mean 25(OH)D3±SD	p	Mean IPAQ±SD	p
BMI	<18.5: Weak	41.3±12.4	**<0.001**	866±612	**<0.001**
	18.5-24.9: Normal weight	22.1±8.9		485±307	
	25-29.9: Overweight	20.2±7.9		326±362	
	30-39.9: Obese	11.6±5.9		114±229	
	>40: Morbid obese	6.4±1.9		0	

BMI: Body mass index, IPAQ: International Physical Activity Questionnaire Short Form, SD: Standard deviation

Table 3. The association between 25(OH)D3 levels, IPAQ scores and other factors in postmenopausal patients

		25(OH)D3		p Mean	IPAQ		p
Mean		SD			SD		
Marital status	Married	18.8	10.2	0.418	310.6	367.9	0.546
	Single	20.6	8.3		366.3	409.7	
Occupation	Out of home (indoor)	13.9	9.4	0.192	346.6	600.2	0.179
	Field gardening (outdoor)	23.8	3.6		495.0	198.0	
	Housewife	19.4	10.2		321.9	367.8	
	Retired	14.2	9.1		79.2	108.4	
Education	İlliterate	18.3	8.7	0.694	310	294.3	0.753
	Primary school	19.6	10.3		327.5	379.3	
	Secondary school	13.1	9.2		198	305.1	
	High school	18	12		158.4	258.2	
	Bachelor's degree	19.3	10		528	749.6	
Calcium supplement intake	Yes	35.1	12	**<0.001**	630	520.2	**<0.001**
	No	17.0	7.7		277.4	331.3	
Vitamin D supplement intake	Yes	39.0	8,7	**<0.001**	823.4	515.5	**<0.001**
	No	16.8	7.3		259.8	306.0	
Daily vitamin D consumption	Little	16.8	7.3	**<0.001**	233.2	249.7	**<0.001**
	Moderate	31.6	12.8		685.4	537.4	
	Very	33.6	6.7		1193.7	333.1	
Sunlight exposure hours	Less than 15 minutes	14.6	6.6	**<0.001**	191.6	274.4	**<0.001**
	15 minutes-60 minutes	24.7	10.8		492.4	416.3	
	Over 60 minutes	25.0	11.0		465.7	430.2	
Sunlight exposure intervals	06:00-09:00	18.6	10.3	**<0.001**	240.9	240.4	**0.012**
	09:00-12:00	28.5	10		553.8	468.9	
	12:00-15:00	22.9	9.4		419.8	440,0	
	15:00-18:00	14.3	6.8		225.6	309.5	

25(OH)D3: 25 hydroxyvitamin vitamin D, IPAQ: International Physical Activity Questionnaire, SD: Standard deviation

Discussion

Previous studies have demonstrated that vitamin D deficiency increases in the postmenopausal period and hormonal changes, and BMI can affect vitamin D levels in the postmenopausal women (7). This study aimed to raise awareness of patients in the early period by investigating the factors affecting vitamin D levels in postmenopausal women. BMI, physical activity levels, sunlight exposure hours, and sunlight exposure intervals all affect vitamin D levels in postmenopausal women, according to the results of this study. Vitamin D insufficiency has been linked to several chronic conditions including obesity and low plasma 25(OH)D3 concentrations have been shown as a modest mediator of obesity. An inverse connection has been reported between vitamin D and BMI >30 kg/m^2 (13). However, the role of vitamin D metabolites in regulating obesity-related disorders remains unclear (14). The ability of vitamin D to modulate gene expression linked to the adipogenesis process, inflammation, oxidative stress, and metabolism in adult adipocytes might be one proposed molecular explanation for the association between obesity and vitamin D deficiency (15). Moreover, Weishaar et al. (16) stated that a probable effect of dilution owing to body size has been proposed to explain the link between low vitamin D status and obesity. As a result, it's been hypothesized that oral vitamin D may be able to treat vitamin D insufficiency in obese subjects, but that greater dosages may be needed Wortsman et al. (17) Conducted a study to assess the bioavailability of vitamin D in obese individuals and found that obese people exhibited considerably lower basal 25(OH)D3 levels and significantly higher parathyroid hormone levels than age-matched healthy controls. They also revealed that 24 hours after exposure to ultraviolet-B irradiation, obese participants had a 57% lower increase in vitamin D levels than non-obese people. On the other hand, another study found that obese people with hypovitaminosis D benefit more from vitamin D replacement than normal weight controls, implying that obese people with vitamin D insufficiency may benefit more from vitamin D replacement than normal weight controls (18).

Physical exercise is defined as a practical way to elevate vitamin D levels, especially when performed outside. The combination of ultraviolet light with 7-dehydrocholesterol in the skin enhances vitamin D production during regular outdoor physical exercises. The indoor physical activity may also increase vitamin D levels through other biological pathways. There is evidence that regular exercise can increase vitamin D's anti-inflammatory action and its low status in postmenopausal women. Based on the available data, regular exercise can improve anti-inflammatory effects of vitamin D and its deficiency in postmenopausal women (19,20). Several studies have found that higher levels of physical activity are linked to higher levels of serum 25(OH)D3 in line with our results (21,22). Tanabe et al. (23) examined the relationship between 25(OH)D3 status and activities of daily living in the elderly hospitalized patients at a regional care hospital. Low 25(OH)D3 levels were linked to lower daily living activity scores, suggesting that vitamin D insufficiency may have an impact on physical activity. The majority of hospitalized elderly patients were vitamin D deficient. Similarly, a prospective long-term study of Scott et al. (24) and colleagues demonstrated a favorable relationship between changes in serum 25(OH)D3 and physical activity measured by accelerometry-irrespective of sun exposure. This observed association was attributed to beneficial changes in body composition such as adiposity and skeletal muscle mass as a result of physical exercise. Hansen et al. (25) used the Physical Activity Rating Questionnaire to evaluate physical activity in forensic inpatients and showed that individuals with a vitamin D level over 75 nmol/L engaged in considerably more physical activity than those with a vitamin D level below 46.7 nmol/L. In contrast, another relevant study showed no relationship with serum 25(OH)D3 concentration and weekly physical activity assessed by IPAQ (26). Similarly, in the study of Sun et al. (27) serum 25(OH)D concentrations were not significantly associated with vitamin D intake.

Osteoporosis risk can be reduced by adopting a healthy lifestyle that includes adequate levels of dietary calcium, vitamin D and physical activity (28). This study has confirmed that vitamin D deficiency is common and associated with BMI, sunlight exposure hours, sunlight exposure intervals and physical activity in postmenopausal women. The results of this study may have important clinical implications for postmenopausal women with inadequate vitamin D levels. Vitamin D intake should be emphasized for those with limited sun exposure, which remains an important determinant of vitamin D status in postmenopausal women as well as dietary factors.

Study Limitations

A limitation of this study could be explained by the cross-sectional study design and numerous factors that may influence physical activity levels. Furthermore, another limitation is that due to the study design and no cause-effect relationship could be determined between physical activity and vitamin D status. Studies with larger sample sizes will be required in future studies.

Conclusion

Adequate vitamin D levels and lifestyle factors may positively affect functions, muscle and bone mass in postmenopausal women. To this regard, vitamin D and calcium supplementation combined with regular physical activity should be included in the treatment of postmenopausal women. There is also a need to educate postmenopausal women about the optimal sun exposure hours and duration.

Ethics

Ethics Committee Approval: Approval for the study was granted by the Erzincan Binali Yıldırım University Clinical Research Ethics Committee (decision no: 10, date: 27.09.2021).

Informed Consent: Consent form was obtained from all patients participating in the study.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Concept: E.E.E., Design: E.E.E., Data Collection or Processing: E.E.E., Analysis or Interpretation: E.E.E., G.S., Literature Search: E.E.E., G.S., Writing: E.E.E., G.S.

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