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Serum Lipid, Vitamin D Levels, and Obesity in Perimenopausal and Postmenopausal Women in Non-Manual Employment

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Background: Increasing age, increased body mass index (BMI), and abnormal lipid profiles contribute to an increased risk of vitamin D deficiency. Women who have a perimenopausal and postmenopausal reduction in estrogen levels are a high-risk group for vitamin D deficiency. The aims of this study were to compare the serum vitamin D levels, lipid profile, and BMI between perimenopausal and postmenopausal women in non-manual employment, and to determine whether there were any interdependent factors.

Material/Methods: Three hundred women in non-manual employment, aged between 44–66 years, were divided into three groups: early perimenopausal; late perimenopausal; and postmenopausal. Laboratory tests included measurement of serum lipid profiles and vitamin D levels, the BMI, waist-hip ratio (WHR) and body fat were measured. Statistical analysis included F-test analysis of variance and the least significance difference (LSD) test was used for multiple comparisons.

Results: For the 300 women who were in non-manual employment, and in the early and late perimenopausal and postmenopausal periods, serum vitamin D levels were reduced (mean 16.8±8.7 ng/mL); 29% of women had abdominal obesity; 41% had excessive body fat accumulation; and 56% had an increased body mass index (BMI) (>25 kg/m^2) with raised total cholesterol, low-density lipoprotein (LDL) cholesterol, LDL/high-density lipoprotein (HDL), and total cholesterol/HDL ratios ($p<0.05$).

Conclusions: The findings of this study showed that in perimenopausal and postmenopausal women in non-manual employment, serum vitamin D levels were associated with serum lipid profile and degrees of obesity.

MeSH Keywords: **Lipids • Menopause • Obesity • Vitamin D**

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Background

The maintenance of calcium and phosphorus homeostasis and promotion of bone mineralization are important functions of vitamin D. The presence of specific vitamin D receptors (VDR) outside the skeletal system, supports the important role of vitamin D in the regulation of immune and inflammatory processes and modulation of cell growth [1–3].

Normal vitamin D levels might have a protective effect against not only osteoporosis, but also metabolic disturbances, including abdominal obesity, dyslipidemia, and hyperglycemia, as well as cardiovascular disease. However, the previously published studies remain controversial on the beneficial effects of vitamin D supplementation on cardiovascular clinical outcomes [4]. Previously published epidemiological studies have shown that being overweight and obese are associated with reduced serum vitamin D levels [5]. One of the major complications of obesity is dyslipidemia, which can also lead to vitamin D deficiency.

Due to reduced estrogen levels and other hormonal changes, perimenopausal and postmenopausal women are particularly prone to develop low vitamin D levels, as well as increased risk of metabolic abnormalities and cardiovascular disease [6,7]. The prevalence of vitamin D deficiency in postmenopausal women has been reported to be between 31–70% [2]. In menopausal women, the reduced ability of the skin and kidneys to produce the active form of vitamin D, as well as decreased intestinal absorption, are responsible for changes in vitamin D metabolism [2].

Although several previously published studies have been conducted, the relationship between blood vitamin D concentrations and the individual components of metabolic syndrome (hypertension, hyperlipidemia, diabetes) in menopausal women remains unclear. However, the serum concentrations of vitamin D may depend on many various factors, including specific lifestyle factors and those related to the type of work done. The reason for this may be that women working in non-manual jobs are less exposed to the sunlight and usually have little physical activity during working hours.

Therefore, the aims of this study were to compare the serum vitamin D levels, lipid profile, and BMI between perimenopausal and postmenopausal women in non-manual employment, and to determine whether there were any interdependent factors. The findings of this study may contribute to the development of practical measures to prevent serious complications of vitamin D deficiency to improve the health and quality of life in this population.

Material and Methods

Study population

The study was conducted at the Institute of Rural Health in Lublin and included 300 women aged between 44–66 years. Informed consent for participation in the study was obtained from all women. The study was approved by the Ethics Committee of the Institute of Rural Medicine in Lublin, Poland.

The inclusion criteria were: working in a non-manual job (indoor work, low sun exposure); at least three out of ten menopausal symptoms, according to the Kupperman menopausal index [8]: hot flushes, excessive sweating, sleep disorders, irritability, depression, dizziness, lack of energy, osteoarticular pain, headaches, and cardiac arrhythmia. The exclusion criteria were the presence of chronic diseases, including diabetes mellitus, glucose tolerance disorders, thyroid dysfunction, vitamin D supplementation, drug addictions, or a diagnosis of mental disease.

Body weight, height, waist, and hip circumferences were measured in the study group, which allowed the calculation of the body mass index (BMI) and waist-hip ratio (WHR). The women in the study group were asked about their age and educational level. Their blood was collected to measure serum follicle-stimulating hormone (FSH), vitamin D, and serum lipid concentrations.

The 300 women were divided into three groups: early perimenopausal, who were menstruating, with a serum FSH <20 mlU/mL; late perimenopausal, who were menstruating, with a serum FSH ≥20 mlU/mL; and postmenopausal, who had not menstruated for at least 12 months. The classification system used was based on the Stages of Reproductive Aging Workshop (STRAW)+10 System criteria as well as on the Polish accredited laboratory standards (*https://www.alablaboratoria.pl*).

Serum lipid profiles

Blood samples were drawn for laboratory analysis of serum lipid profiles: total cholesterol (CHOL), high-density lipoprotein (HDL) cholesterol, and triglycerides (TG). Blood samples were promptly delivered to the laboratory.

LDL cholesterol=total cholesterol (CHOL)-HDL cholesterol-1/5 triglycerides, as well as TG/HDL, low-density lipoprotein (LDL)/HDL, and CHOL/HDL ratios were calculated.

The following lipid reference limits were used: total cholesterol (CHOL) <190 mg/dL; HDL cholesterol >45 mg/dL; triglycerides (TG) <150 mg/dL; and LDL cholesterol <115 mg/dL.

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Table 1. Standards of assessment of body fat accumulation (%).

Assessment of body fat accumulation	Age		
	40–49	50–59	60+
Very low	<18	<19	<20
Low	18–21	19–22	20–23
Optimal	22–30	23–31	24–32
High	31–33	32–34	33–35
Very high	>33	>34	>35

Lipid ratio intervals were: LDL/HDL normal <3, borderline 3–4, high >4; CHOL/HDL normal <4, borderline 4–5, high >5; TG/HDL normal <3, and above normal >3.

Measurements of body fat

Measurements of adipose tissue were performed using electronic body fat calipers. The measurements were performed in three locations: the thigh, biceps, and the abdominal fold. The percentage of body fat was compared with standard measurements (Table 1) [9].

Laboratory tests of serum vitamin D levels

Peripheral blood samples were collected from all the women for laboratory tests of serum vitamin D levels and were conducted in a certified laboratory. Standard limits of serum vitamin D concentration were: severe deficiency (<10 ng/mL), moderate deficiency (10–20 ng/mL), mild deficiency (20–30 ng/mL), and optimal (30–80 ng/mL).

Statistical methods

The data were statistically analyzed using STATISTICA software. The mean values (M) and standard deviations (SD) for continuous variables, and absolute (n) and relative numbers (%) of occurrence of items for categorical variables were used. The χ^2 test was used to compare the educational levels among three groups of women: in early and late perimenopausal and postmenopausal periods. Statistical analysis included F-test analysis of variance to compare lipid profiles, obesity levels, and serum vitamin D concentrations among the three groups, and to compare lipid profiles and obesity levels between the four intervals of serum vitamin D concentration: severe deficiency, moderate deficiency, mild deficiency, and optimal. Multiple comparisons were performed using the least significant difference (LSD) test. Since we were interested which groups were different from each other, in all analysis of variance, the fixed effect was estimated, but not the random effect where different groups were random samples from a larger set of groups. The value of $p<0.05$ was considered to be statistically significant. The total sample size of 300 women, with a significance level of 0.05, provided the power of the statistical test of a minimum 0.90 if the mean and standard deviation of serum vitamin D concentrations in the three groups of women were as estimated in this study.

Results

Characteristics of the women in the three study groups: early perimenopausal, late perimenopausal, and postmenopausal

A total of 300 women were studied, including 100 (33.33%) in the early perimenopausal group, 43 (14.33%) in the late perimenopausal group, and 157 (52.33%) in the postmenopausal group. The women in the early perimenopausal group were the youngest, those in the late perimenopausal period were older, and those in the postmenopausal period were the oldest ($p<0.001$) (Table 2). The educational levels of the women in the early and late perimenopausal groups were similar; the women in the postmenopausal group had lower average educational levels ($p=0.001$).

Lipid profiles

Serum total cholesterol and low-density lipoprotein (LDL) cholesterol concentrations increased significantly during the subsequent reproductive periods in the women in this study ($p<0.001$) (Table 3). The mean total cholesterol (CHOL) was 205 mg/dL in the early perimenopausal group; 211 mg/dL in the late perimenopausal group; and 224 mg/dL in the postmenopausal group. The mean LDL cholesterol was 118 mg/dL in the early perimenopausal group; 124 mg/dL in the late perimenopausal group; and 137 mg/dL in the postmenopausal group. A greater proportion of the women in the postmenopausal group had a total cholesterol and an LDL cholesterol above the normal range, compared with the women in the two perimenopausal groups.

In contrast, the high-density lipoprotein (HDL), total cholesterol (CHOL) and triglyceride (TG) concentrations did not differ

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Table 2. Age and educational level of the examined women.

Characteristics	Total women (N=300)	Early peri-menopausal women (N=100)	Late peri-menopausal women (N=43)	Post-menopausal women (N=157)	Test	p
Age (years), M±SD	53.1±4.8	48.6±2.7	51.6±3.3	56.4±3.4	F 194.211	<0.001
44–49, n (%)	89 (29.66)	69 (69.00)	13 (30.24)	7 (4.46)		
50–54	86 (28.66)	26 (26.00)	23 (53.49)	37 (23.57)		
55–59	94 (31.33)	5 (5.00)	6 (13.95)	83 (52.87)		
60–66	31 (10.33)	0 (0.00)	1 (2.33)	30 (19.11)		
Educational level, n (%)					χ^2 16.811	0.001
Secondary	106 (35.33)	24 (24.00)	11 (25.58)	71 (45.22)		
Tertiary	194 (64.66)	76 (76.00)	32 (74.42)	86 (54.78)		

Table 3. Lipid profile of the examined women.

Parameter	Total women	Early peri-menopausal women	Late peri-menopausal women	Post-menopausal women	Comparisons between groups	
					F	p
CHOL (mg/dL), M ±SD	215.80±37.99	205.05±36.69	211.00±38.84	223.96±36.86	8.355	<0.001
Normal, n (%)	75 (25.00)	36 (36.00)	14 (32.56)	25 (15.92)		
Above normal, n (%)	225 (75.00)	64 (64.00)	29 (67.44)	132 (84.08)		
HDL (mg/dL), M ±SD	65.92±14.70	65.11±16.42	67.88±14.49	65.90±13.60	0.534	0.587
Below normal, n (%)	21 (7.00)	11 (11.00)	2 (4.65)	8 (5.10)		
Normal, n (%)	279 (93.00)	89 (89.00)	41 (95.35)	149 (94.90)		
LDL (mg/dL), M ±SD	128.70±33.17	118.17±28.64	124.33±34.59	136.59±33.56	10.488	<0.001
Normal, n (%)	104 (34.67)	46 (46.00)	19 (44.19)	39 (24.84)		
Above normal, n (%)	196 (65.33)	54 (54.00)	24 (55.81)	118 (75.16)		
TG (mg/dL), M ±SD	105.89±52.64	108.86±54.69	93.91±42.93	107.28±53.57	1.331	0.266
Normal, n (%)	253 (84.33)	83 (83.00)	36 (83.72)	134 (85.35)		
Above normal, n (%)	47 (15.67)	17 (17.00)	7 (16.28)	23 (14.65)		
LDL/HDL, M ±SD	2.05±0.70	1.91±0.61	1.92±0.69	2.17±0.74	5.300	0.005
Normal, n (%)	267 (89.00)	94 (94.00)	39 (90.70)	134 (85.35)		
Borderline, n (%)	31 (10.33)	6 (6.00)	4 (9.30)	21 (13.38)		
High, n (%)	2 (0.67)	0 (0.00)	0 (0.00)	2 (1.27)		
CHOL/HDL, M ±SD	3.40±0.85	3.28±0.76	3.22±0.83	3.53±0.90	3.747	0.025
Normal, n (%)	232 (77.33)	85 (85.00)	36 (83.72)	111 (70.70)		
Borderline, n (%)	52 (17.33)	12 (12.00)	5 (11.63)	35 (22.29)		
High, n (%)	16 (5.33)	3 (3.00)	2 (4.65)	11 (7.01)		
TG/HDL, M±SD	1.76±1.20	1.85±1.27	1.52±1.00	1.77±1.20	1.149	0.318
Normal, n (%)	261 (87.00)	85 (85.00)	39 (90.70)	137 (87.26)		
Above normal, n (%)	39 (13.00)	15 (15.00)	4 (9.30)	20 (12.74)		

significantly between the two perimenopausal groups (p=0.587 and p=0.266, respectively) and the means were 66 mg/dL and 106 mg/dL, respectively; 7% of the total number of women had an HDL cholesterol below normal, and 16% had triglyceride (TG) levels that were above normal.

The LDL/HDL and CHOL/HDL ratios in the postmenopausal group were significantly higher compared with those in women in the two perimenopausal groups (p=0.005 and p=0.025, respectively). The mean LDL/HDL ratio was 2.2 in the postmenopausal group, and 1.9 in the perimenopausal groups. In the total number of women studied, the mean TG/HDL was 1.76, which did not differ between the three study groups (p=0.318).

Obesity

In the total number of 300 women studied, the mean body mass index (BMI) was 26 kg/m^2, the mean waist-hip ratio (WHR) was 82%, and the mean percentage of body fat was 30%. These characteristics did not differ significantly between the three

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Table 4. Obesity of the examined women.

Parameter	Total women	Early peri-menopausal women	Late peri-menopausal women	Post-menopausal women	Comparisons between groups	
					F	p
BMI (kg/m²), M ±SD	26.24±4.62	26.39±5.14	25.47±4.27	26.36±4.36	0.709	0.493
Underweight, n (%)	1 (0.33)	1 (1.00)	0 (0.00)	0 (0.00)		
Normal, n (%)	131 (43.67)	44 (44.00)	22 (51.16)	65 (41.40)		
Overweight, n (%)	118 (39.33)	41 (41.00)	13 (30.23)	64 (40.76)		
Obese, n (%)	50 (16.67)	14 (14.00)	8 (18.60)	28 (17.83)		
W/H ratio (%), M ±SD	81.90±5.99	82.46±6.50	79.85±4.91	82.11±5.83	3.101	0.046
<85%, n (%)	212 (70.67)	65 (65.00)	35 (81.40)	112 (71.34)		
≥85%, n (%)	88 (29.33)	35 (35.00)	8 (18.60)	45 (28.66)		
Body fat accumulation (%), M ±SD	30.06±6.10	29.33±6.25	30.30±5.76	30.45±6.08	1.076	0.342
Very low, n (%)	6 (2.00)	3 (3.00)	1 (2.33)	2 (1.27)		
Low, n (%)	19 (6.33)	7 (7.00)	2 (4.65)	10 (6.37)		
Optimum, n (%)	153 (51.00)	48 (48.00)	21 (48.84)	84 (53.50)		
High, n (%)	58 (19.33)	20 (20.00)	8 (18.60)	30 (19.11)		
Very high, n (%)	64 (21.33)	22 (22.00)	11 (25.58)	31 (19.75)		

Table 5. Serum vitamin D concentration in the examined women.

Parameter	Total women	Early peri-menopausal women	Late peri-menopausal women	Post-menopausal women	Comparisons between groups	
					F	p
Vitamin D concentration (ng/mL), M ±SD	16.83±8.74	17.09±9.37	14.47±6.54	17.31±8.79	1.860	0.157
Severe deficiency, n (%)	68 (22.67)	26 (26.00)	10 (23.26)	32 (20.38)		
Moderate deficiency, n (%)	143 (47.67)	42 (42.00)	24 (55.81)	77 (49.04)		
Mild deficiency, n (%)	61 (20.33)	22 (22.00)	7 (16.28)	32 (20.38)		
Optimal, n (%)	28 (9.33)	10 (10.00)	2 (4.65)	16 (10.19)		

study groups (p>0.05) (Table 4). Based on the BMI, 44% of the women had a normal body weight, 39% were overweight, 17% were obese, and one woman was underweight. The WHR ratio was normal in 71% of the women studied, and in 29% it was above normal. The percentage of body fat was normal in about half of the women studied (51%); high in 19%; very high in 21%; low in 6%; and very low in 2%.

Serum vitamin D levels: severe deficiency, moderate deficiency, mild deficiency, and optimal

The mean serum vitamin D in all 300 women studied was 17 ng/mL and did not differ significantly among the three study groups (p=0.157) (Table 5). The concentration of serum vitamin D at the optimal level was found in 9.33%; mild deficiency of vitamin D occurred in 20.33%; 50% had moderate deficiency; and 22.67% had severe deficiency.

Interdependencies of the lipid profile and obesity *vs.* serum vitamin D concentration

In the total number of 300 women studied, with varied serum vitamin D levels, there were significant differences in terms of serum HDL cholesterol concentration (p=0.013); the two lipid ratios CHOL/HDL (0.050) and LDL/HDL (0.048); BMI (0.050); and the percentage of body fat (p<0.001) (Tables 6, 7).

Women with severe or moderate deficiency of serum vitamin D had the lowest HDL cholesterol; those with vitamin D mild deficiency had a higher HDL cholesterol, and those with optimal vitamin D levels had the highest HDL cholesterol. The women with optimal serum vitamin D levels had significantly lower LDL/HDL and CHOL/HDL ratios compared to those with lower serum vitamin D levels.

Women with severe or moderate deficiency of serum vitamin D had a significantly higher BMI compared with those with vitamin D mild deficiency or optimal serum concentrations of

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Table 6. Lipid profile and obesity according to intervals of serum vitamin D concentration in the examined women.

Parameter	Vitamin D concentration				Comparisons between groups	
	Severe deficiency	Moderate deficiency	Mild deficiency	Optimal		
	M ±SD				F	p
CHOL (mg/dL)	214.82±38.63	215.29±38.94	218.72±33.92	214.39±41.53	0.155	0.926
HDL (mg/dL)	64.40±12.92	64.14±14.09	68.84±16.03	72.39±16.69	3.646	0.013
LDL (mg/dL)	128.79±32.07	129.29±34.76	130.83±30.43	120.80±33.74	0.626	0.599
TG (mg/dL)	108.19±52.14	109.31±55.45	95.26±47.30	106.00±49.68	1.074	0.360
LDL/HDL	2.07±0.62	2.11±0.74	2.03±0.75	1.71±0.49	2.665	0.048
CHOL/HDL	3.44±0.77	3.49±0.90	3.33±0.90	3.04±0.58	2.535	0.050
TG/HDL	1.82±1.17	1.86±1.26	1.53±1.05	1.64±1.25	1.240	0.295
BMI (kg/m^2)	27.11±5.66	26.44±4.68	25.30±3.35	25.17±3.32	2.625	0.050
W/H ratio (%)	82.35±6.57	81.72±5.61	82.44±5.89	80.54±6.68	0.813	0.487
Body fat accumulation (%)	32.35±6.83	30.12±5.91	28.00±5.09	28.64±5.46	6.361	<0.001

Table 7. p Values for multiple comparison tests of lipid profile and obesity between intervals of serum vitamin D concentration in the examined women.

Parameter	Serum vitamin D concentration					
	Severe deficiency *vs.* moderate deficiency	Severe deficiency *vs.* mild deficiency	Severe deficiency *vs.* optimal	Moderate deficiency *vs.* mild deficiency	Moderate deficiency *vs.* optimal	Mild deficiency *vs.* optimal
HDL	0.904	0.084	0.015	0.035	0.006	0.284
LDL/HDL	0.677	0.710	0.022	0.406	0.005	0.049
CHOL/HDL	0.685	0.487	0.038	0.234	0.011	0.132
BMI	0.321	0.026	0.060	0.107	0.181	0.896
Body fat accumulation	0.011	<0.001	0.006	0.020	0.230	0.636

vitamin D. The women with mild deficiency or optimal serum vitamin D level had the lowest percentage of body fat, women with moderate deficiency of vitamin D had higher percentage of body fat, and women with severe deficiency of vitamin D had the highest percentage of body fat.

Discussion

The hormonal alterations in women in the perimenopausal and postmenopausal periods may result in musculoskeletal, metabolic, and cardiovascular conditions, and may affect mental health. All these conditions may also be related to vitamin D deficiency. Also, women in the perimenopausal and postmenopausal period are more susceptible to vitamin D deficiency and its possible health consequences. It is plausible that in perimenopausal and postmenopausal women, estrogen deficiency together with vitamin D deficiency results in increased risk of metabolic and cardiovascular complications [1].

According to some authors, dyslipidemia in menopause period is characterized by an elevation of the blood low-density lipoprotein (LDL) cholesterol and triglycerides (TG), as well as the decrease in high-density lipoprotein (HDL) cholesterol concentrations [10].

In this study, women were compared in three study groups: early perimenopausal; late perimenopausal; and postmenopausal.

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The findings of this study showed that in all three groups, there were significant abnormalities in lipid profiles, with most groups having increased concentrations of total cholesterol (CHOL) and LDL cholesterol. Furthermore, CHOL, LDL cholesterol, the LDL/HDL ratio, and the total cholesterol/HDL ratio were significantly greater in postmenopausal women than in the two groups of perimenopausal women. In previous studies, a significant increase in total cholesterol and LDL cholesterol and a significant decrease in HDL cholesterol were also observed in postmenopausal women when compared with premenopausal women [11].

The relationship between vitamin D and dyslipidemia is not well understood. However, the findings of some studies have shown that lower serum vitamin D levels might be associated with a more atherogenic lipid profile [12]. It is thought that vitamin D may regulate reverse cholesterol transport, in which HDL particles carry cholesterol out of atherosclerotic plaques [9]. In our study, the average serum vitamin D concentration in the 300 women studied was 16.83±8.74 ng/mL, which represented a deficiency of vitamin D. Furthermore, only 9.33% of women studied had an optimal serum vitamin D concentration. However, in most of the 300 women studied (93%), the serum HDL cholesterol level was within normal limits. Godala et al. [13] showed that vitamin D levels were significantly lower in women diagnosed with metabolic syndrome when compared with patients without metabolic syndrome in both premenopausal and postmenopausal groups.

Chacko et al. [14] found that higher serum vitamin D levels were inversely associated with adiposity, triglycerides, TG/HDL ratio, and metabolic syndrome, but were not associated with LDL cholesterol and HDL cholesterol in postmenopausal women. The TG/HDL ratio is also regarded as a marker of the atherogenic effect of blood lipids [14]. However, the findings of this study did not show a significant correlation between serum vitamin D concentration and TG/HDL ratio in the group of women working in non-manual jobs.

The findings of this study showed that an optimal serum vitamin D concentration was associated with a statistically significant decrease in the LDL/HDL ratio, percentages of body fat, and increase in HDL cholesterol. Chon et al. [7], in a study in a group of Korean postmenopausal women, showed that adequate serum vitamin D levels were significantly associated with the normalization of triglycerides and HDL cholesterol levels. However, studies on the association between vitamin D supplementation and beneficial changes in lipids are inconclusive [2,15,16]. Schnatz et al. [15], in a randomized trial, found that postmenopausal women with higher serum vitamin D levels had improved lipid profiles, including increased HDL cholesterol and lower LDL cholesterol and triglycerides, and that supplementation with vitamin D decreased their LDL cholesterol levels.

Menopause is associated with weight gain and changes in body fat distribution, with visceral fat accumulation (central adiposity). The typical gynoid distribution of body fat of premenopausal women gradually turns into the android type distribution, characterized by fat accumulation in the abdomen [1]. In this study, more than 50% of women working in non-manual jobs were overweight or obese, and both BMI and the percentage of body fat did not differ significantly between the three groups studied. However, an increased waist-hip ratio (WHR) was more common in early perimenopausal and postmenopausal women compared with late perimenopausal women.

Previous studies have shown that obesity may be associated with lower serum vitamin D levels, although the underlying mechanism is not clear [17,18]. One of the possible explanations could be reduced bioavailability of vitamin D due to sequestration in excess adipose tissue [1]. However, Andreozzi et al. [19] concluded that vitamin D fat sequestration applied only to individuals with very large amounts of adipose tissue.

The accumulation of visceral fat results in an increased risk of metabolic and cardiovascular complications [20]. Arunabh et al. [21], studied a group of women between 20–80 years old and showed that serum vitamin D levels decreased with an increase in the amount of adipose tissue. Recent studies have shown that vitamin D may play an active role within the adipose tissue by modulating inflammation, adipogenesis, and adipocyte secretion [22]. Chacko et al. [14], in a study of postmenopausal women, showed a negative association between serum vitamin D levels and BMI, as well as waist circumference. In our study, we have found a negative correlation between serum vitamin D levels and BMI, as well as body fat, but not with the WHR. Andreozzi et al. [19] showed a negative correlation between serum vitamin D levels and waist circumference, as well as the android fat to gynoid fat (A/G) ratio, but not with BMI. The authors suggested that the android disposition of body fat is more closely associated with the onset of metabolic syndrome [19].

A possible link between supplementation with vitamin D and weight loss is not fully understood. Previously reported *in vitro* studies have shown that 1,25-dihydroxy vitamin D3 may inhibit adipogenesis in T3-L1 cells [23], and may also stimulate lipogenesis and inhibit lipolysis by interacting with mouse vitamin D receptor (mVDR) [24]. The meta-analysis of Pereira-Santos et al. [25] showed that the prevalence of vitamin D deficiency was 35% greater in obese subjects when compared with overweight groups. Vitamin D may also influence leptin levels [24], which are important in the control of appetite and the occurrence of obesity.

The production of active vitamin D in the skin decreases with age, and a similar exposure to the sunlight in elderly people produces up to 75% less vitamin D when compared with young adults [26].

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The findings of this study showed that vitamin D status was not significantly different in the three study groups. Similarly, Godala et al. [13] demonstrated that the mean concentration of vitamin D was not significantly different in the premenopausal and postmenopausal periods. The low serum vitamin D concentration in all three groups of women working in non-manual jobs could be partially explained by increased indoor activity and limited physical activity during the working hours, as well as limited sun exposure and a sedentary lifestyle. Ardawi et al. [27] showed that vitamin D deficiency (<20 ng/mL) was common among premenopausal (72.4%) and postmenopausal (85.0%) Saudi women [28].

The decreased serum vitamin D levels found in the three groups of perimenopausal and postmenopausal women working in non-manual jobs in this study may also be attributed to the dietary vitamin D intake, the extent of the sun exposure, vitamin D supplementation, and lifestyle. However, some other factors could also influence serum vitamin D levels. There is lack of clear evidence that vitamin D supplementation benefits lipid profile and weight loss. Women over 50 years old should be on a calcium- and vitamin D-rich diet, which might help to prevent osteoporosis. It is also important to remember that calcium and vitamin D supplementation are needed during weight reduction, since a restricted diet is associated with decreased estrogen levels and calcium absorption, which may lead to bone loss [1].

Further studies are needed to establish the optimal dosage of calcium and vitamin D, the duration of the treatment, and the effect of increasing serum vitamin D concentration in premenopausal and postmenopausal women working in non-manual jobs, especially those with dyslipidemia and obesity. Diagnosing vitamin D deficiency and applying supplementation appear to be important steps in the prevention of metabolic and cardiovascular complications.

Conclusions

The findings of this study have shown the following. Women in early and late perimenopause, as well those who were postmenopausal, and who were working in non-manual jobs, had a deficiency of serum vitamin D. The total cholesterol, LDL cholesterol, and LDL/HDL and CHOL/HDL ratios increased the three study groups, early perimenopausal, late perimenopausal, and postmenopausal women. One-third of menopausal women working in non-manual jobs had abdominal obesity, 41% had excessive body fat, and more than 50% were overweight or obese. Menopausal women with optimal serum vitamin D levels had increased HDL cholesterol, lower LDL/HDL, and CHOL/HDL ratios, and a lower BMI, and reduced percentages of body fat compared with those with lower serum vitamin D levels. Therefore, increased awareness of the benefits of a vitamin D-rich diet and vitamin D supplementation, as well as outdoor physical activity, should be promoted among perimenopausal and postmenopausal women to help prevent obesity and unfavorable changes in lipid profile in this population.

References:

1. Lerchbaum E: Vitamin D and menopause – a narrative review. Maturitas, 2014; 79: 3–7
2. Moghassemi S, Marjani A: The effect of short-term vitamin D supplementation on lipid profile and blood pressure in post-menopausal women: A randomized controlled trial. Iran J Nurs Midwifery Res, 2014; 19: 517–21
3. Matyjaszek-Matuszek B, Lenart-Lipińska M, Woźniakowska E: Clinical implications of vitamin D deficiency. Prz Menopauzalny, 2015; 14: 75–81
4. Dadonienė J, Čypienė A, Rinkūnienė E et al: Vitamin D and functional arterial parameters in postmenopausal women with metabolic syndrome. Adv Med Sci, 2016; 61: 224–30
5. Ford ES, Ajani UA, McGuire LC, Liu S: Concentrations of serum vitamin D and the metabolic syndrome among U.S. adults. Diabetes Care, 2005; 28: 1228–30
6. Park YW, Zhu S, Palaniappan L et al: The metabolic syndrome: prevalence and associated risk factor findings in the US population from the Third National Health and Nutrition Examination Survey, 1988–1994. Arch Intern Med, 2003; 163: 427–36
7. Chon SJ, Yun BH, Jung YS et al: Association between vitamin D status and risk of metabolic syndrome among Korean postmenopausal women. PLoS One, 2014; 9: e89721
8. Skałba P: Signs of withdrawal. In: Clinical endocrinology. Milewicz A (ed.). Polish Endocrine Society, Wroclaw, 2012
9. Jackson AS, Pollock ML, Ward A: Generalized equations for predicting body density of women. Med Sci Sports Exerc, 1980; 12: 175–81
10. Derby CA, Crawford SL, Pasternak RC et al: Lipid changes during the menopause transition in relation to age and weight: the Study of Women's Health Across the Nation. Am J Epidemiol, 2009; 169: 1352–61
11. Mascarenhas-Melo F, Sereno J, Teixeira-Lemos E et al: Markers of increased cardiovascular risk in postmenopausal women: Focus on oxidized-LDL and HDL subpopulations. Dis Markers, 2013; 35: 85–96
12. Schnatz PF, Nudy M, O'Sullivan DM et al: Identification of a mechanism for increased cardiovascular risk among individuals with low vitamin D concentrations. Menopause, 2011; 18: 994–1000
13. Godala M, Materek-Kuśmierkiewicz I, Moczulski D et al: Assessment of 25(OH)D vitamin concentration in plasma of residents of Lodz with metabolic syndrome in pre- and postmenopausal period. Prz Menopauzalny, 2014; 13: 293–97
14. Chacko SA, Song Y, Manson JE et al: Serum 25-hydroxyvitamin D concentrations in relation to cardiometabolic risk factors and metabolic syndrome in postmenopausal women. Am J Clin Nutr, 2011; 94: 209–17
15. Schnatz PF, Jiang X, Vila-Wright S et al: Calcium/vitamin D supplementation, serum 25-hydroxyvitamin D concentrations, and cholesterol profiles in the Women's Health Initiative calcium/vitamin D randomized trial. Menopause, 2014; 21: 823–33
16. Heikkinen AM, Tuppurainen MT, Niskanen L et al: Long-term vitamin D3 supplementation may have adverse effects on serum lipids during postmenopausal hormone replacement therapy. Eur J Endocrinol, 1997; 137: 495–502
17. Pelczyńska M, Grzelak T, Walczak M, Czyżewska K: Hypovitaminosis D and adipose tissue – cause and effect relationships in obesity. Ann Agric Environ Med, 2016; 23(3): 403–9
18. Wojcik M, Janus D, Kalicka-Kasperczyk A et al: The potential impact of the hypovitaminosis D on metabolic complications in obese adolescents – Preliminary results. Ann Agric Environ Med, 2017
19. Andreozzi P, Verrusio W, Viscogliosi G et al: Relationship between vitamin D and body fat distribution evaluated by DXA in postmenopausal women. Nutrition, 2016; 32: 687–92

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20. Wehr E, Pilz S, Boehm BO et al: The lipid accumulation product is associated with increased mortality in normal weight postmenopausal women. Obesity (Silver Spring), 2011; 19: 1873–80
21. Arunabh S, Pollack S, Yeh J, Aloia JF: Body fat content and 25-hydroxyvitamin D levels in healthy women. J Clin Endocrinol Metab, 2003; 88: 157–61
22. Mutt SJ, Hyppönen E, Saarnio J et al: Vitamin D and adipose tissue-more than storage. Front Physiol, 2014; 5: 228
23. Kong J, Li YC: Molecular mechanism of 1,25-dihydroxyvitamin D3 inhibition of adipogenesis in 3T3-L1 cells. Am J Physiol Endocrinol Metab, 2006; 290(5): E916–24
24. Abbas MA: Physiological functions of Vitamin D in adipose tissue. J Steroid Biochem Mol Biol, 2017; 165(Pt B): 369–81
25. Pereira-Santos M, Costa PR, Assis AM et al: Obesity and vitamin D deficiency: A systematic review and meta-analysis. Obes Rev, 2015; 16(4): 341–49
26. Hagenau T, Vest R, Gissel TN et al: Global vitamin D levels in relation to age, gender, skin pigmentation and latitude: An ecologic meta-regression analysis. Osteoporos Int, 2009; 20: 133–40
27. Ardawi MS, Qari MH, Rouzi AA et al: Vitamin D status in relation to obesity, bone mineral density, bone turnover markers and vitamin D receptor genotypes in healthy Saudi pre- and postmenopausal women. Osteoporos Int, 2011; 22: 463–75
28. Fuleihan GE, Deeb M: Hypovitaminosis D in a sunny country. N Engl J Med, 1999; 340: 1840–41

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