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Impact of Serum Vitamin D, B6, and B12 and Cognitive Functions on Quality of Life in Peri- and Postmenopausal Polish Women

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Background: Menopause initiates or accelerates health problems in a woman's life, and affects cognitive processes and quality of life. We aimed to assess the quality of life, cognitive functions, and serum vitamin D, B6, and B12 concentrations in perimenopausal and postmenopausal Polish women. Also, we correlated the assessment of the quality of life with these vitamin concentrations and cognitive functions.

Material/Methods: The study was conducted in 287 perimenopausal and postmenopausal women. Serum levels of vitamin D, B6, and B12, cognitive functions using CNS Vital Signs software, and quality of life using WHO Quality of Life Brief were tested.

Results: Almost all of the perimenopausal and postmenopausal women had normal concentrations of serum vitamin B12 (96%), 80% of them had normal B6 concentration, while only 9% had optimal serum vitamin D concentration. Postmenopausal women had lower Neurocognitive Index, psychomotor speed, motor speed, reaction time, and lower assessment of overall quality of life, physical health, and social relationships compared to perimenopausal women. In comparison to postmenopausal women, perimenopausal women had a lower serum vitamin B6 concentration, and the lower the concentration of this vitamin in serum they had, the lower they assessed their environment. Perimenopausal women assessed their social relationships the better, the better the visual memory, and the lower the processing speed they had. Postmenopausal women assessed the environment the better, the higher their Neurocognition Index was, and the better the reaction time they had.

Conclusions: Assessment of quality of life was associated with some cognitive functions in both perimenopausal and postmenopausal women.

Keywords: Cognitive Dysfunction • Menopause • Perimenopause • Postmenopause • Quality of Life • Vitamins

Abbreviations: **MoCA** – Montreal Cognitive Assessment Scale; **NCI** – Neurocognitive Index; **WHOQoL-Brief** – World Health Organization Quality of Life Brief Questionnaire

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Introduction

The average age of onset of menopause in the urban population in Poland is 52 years [1]. Thanks to advances in medicine and health care, the life expectancy of women in Poland has increased to over 80 years [2]. This means that as much as a third of the average woman's life is spent in the perimenopausal and postmenopausal periods. The menopause process initiates the emergence or acceleration of health problems in a woman's life, such as cardiovascular diseases, osteoporosis, and, according to recent reports, a decline in cognitive processes [3-5]. Epidemiological data show that problems with memory and concentration begin in this period of life, as well as the occurrence of depression increases [6]. It is observed that women in the perimenopausal and postmenopausal periods cope worse with stress at work and, therefore, cope with failures at work less easily [7]. It is also more difficult for them to make health decisions [8].

Vitamins play a vital role in the proper functioning of the body, including the etiology and development of cognitive disorders in the population of perimenopausal and postmenopausal women [9]. The mechanism of action of folic acid and other B vitamins is directly related to the proper functioning of the nervous system, including the correct cognitive functions [10]. Deficiencies of any of the B vitamins may cause a reduced methylation status in appropriate tissues, and hyperhomocysteinemia, which leads to adverse health effects in menopausal women [11,12]. Women using oral contraceptives, cigarette smokers and the elderly are at risk of folic acid deficiency [13,14]. An earlier study by Ma et al [15] demonstrated that oral supplementation with the combination of folic acid and vitamin B12 in elderly people with mild cognitive impairment for 6 months can significantly improve cognitive performance. In addition, this combination of vitamins was able to reduce the levels of inflammatory cytokines in the peripheral blood. Folic acid, together with other B vitamins, reduces the level of homocysteine, high levels of which increase the risk of dementia [16].

Older women (perimenopausal and postmenopausal) have thinner skin and their ability to produce vitamin D is lower. Moreover, their absorption of vitamin D in the intestines and hydroxylation of vitamin D in the liver and kidneys are reduced [17]. A deficiency of vitamin D is an established risk factor for osteoporosis [18] and thus may be also associated with a lower quality of life. Several studies have analyzed the level of vitamin D and quality of life [19,20]. The physical score and mental score components of quality of life were lower in premenopausal women with vitamin D deficiency and vitamin D insufficiency [19]. However, a Brazilian study did not prove the association between serum vitamin D levels and quality of life [20]. Grimnes et al [21] demonstrated that treatment with high doses of vitamin D for 1 year had no effect on the quality of life in postmenopausal women with osteopenia or osteoporosis compared to standard-dose vitamin D administration. Vitamin D supplementation at different doses may have different effects on cognitive functions. In a study based on a group of postmenopausal women from the USA, Castle et al [22] demonstrated that women who took vitamin D supplementation at a dose of 2000 IU/day achieved better results in learning and memory tests than other groups of women taking 4000IU/day and 600 IU/day. In turn, women taking 4000 IU/day had a slower reaction time than women taking 600 IU/day of vitamin D [22].

The present study aimed to assess the quality of life, cognitive functions, and serum vitamins D, B6, and B12 concentrations in 287 perimenopausal and postmenopausal Polish women. We also examined the correlation of the assessment of the quality of life with cognitive functions, and serum vitamins D, B6, and B12 concentrations.

Material and Methods

Ethics Statement

The study complied with the Declaration of Helsinki and was approved by the Ethics Committee of the Institute of Rural Medicine in Lublin (consent number 07/2015 issued on September 15, 2015). All subjects involved in the study gave their informed consent.

Study Group

The study was conducted during 2021-2022 at the Institute of Rural Health in Lublin (Poland). Since the tests (blood collection, computer neurocognitive tests) were to be carried out at the Institute of Rural Medicine in Lublin, it was decided to recruit the study group among women from south-east Poland. The women voluntarily answered an advertisement for health promotion titled "Selected physical and psychological determinants of the quality of life of women in perimenopausal and postmenopausal periods" in social media. Information about the project was also posted on the Institute's website. Women volunteered to participate in the project. The inclusion criterion was age 45-60 years old. The exclusion criteria were: severe menopausal symptoms, use of hormone replacement therapy, chronic illnesses or cancer in the last 5 years, drug and alcohol addiction, psychological illnesses, and cognitive impairment. During qualification for the study, the women were given the Montreal Cognitive Assessment test to exclude those with cognitive impairment.

A medical examination was conducted and blood samples were taken from the women to assess serum vitamin D, B6, B12,

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and FSH concentrations. Blood samples were immediately delivered to the laboratory.

The examined women were divided into 2 groups – perimenopausal and postmenopausal – according to their reproductive status based on the Stages of Reproductive Aging Workshop 2012 [23,24]. The STRAW staging system is based on the assessment of the reproductive cycle (regularity and length of the cycle) and on assessment of endocrine markers (FSH assessment in the early follicular phase), which ensured comparability with the studies of other authors. Women who did not meet the STRAW criteria qualifying for the perimenopausal and postmenopausal groups were not qualified for further analyses.

For the study, 287 women from south-east Poland were recruited by a qualified gynecologist, including 141 women of perimenopausal age (49.13%) and 146 women of postmenopausal age (50.87%).

Survey Questionnaire

The survey questionnaire consisted of 3 parts: social-demographic data (age, level of education, place of residence, marital status), cognitive functions, and quality of life.

Montreal Cognitive Assessment Test

The Montreal Cognitive Assessment Scale (MoCA) test was designed as a quick screening tool for the assessment of mild cognitive impairment and has a Polish adaptation by Magierska et al. [25]. It allows to assess various cognitive areas: attention and concentration, executive functions, memory, language functions, visual-spatial functions, conceptual thinking, calculation skills, and orientation. The maximum number of points in this test is 30, and a score of 26 or more is considered correct. Tested women who are included in further stages of the study must score 26 or more on the MoCA test.

Assessment of Cognitive Functions

Cognitive functions were assessed using CNS Vital Signs software (CNS Vital Signs, 1829 East Franklin Street, Bldg 500, Chapel Hill NC 27514, USA). This tool is standardized and underwent full validation [26]. It has many cultural and linguistic adaptations, including Polish. The procedure was conducted on a computer in Polish. It contains 11 cognitive functions: Composite Memory, Verbal Memory, Visual Memory, Psychomotor Speed, Reaction Time, Complex Attention, Cognitive Flexibility, Processing Speed, Executive Function, Simple Attention, and Motor Speed. Based on these 11 cognitive functions, the Neurocognitive Index (NCI) is calculated. The test report is printed in English.

In the analysis, the standard scores of NCI and the 11 cognitive functions obtained from the tests were used. The scoring has a positive direction, i.e. the higher the number of points, the higher the cognitive function. Based on standard scores, the test report of the CNS Vital Signs classifies the NCI and 11 cognitive functions into 5 ranges described as follows: 5. above average (>109 standard score), 4. average (90-109 standard score), 3. below average (80-89 standard score), 2. poor (70-79 standard score) 1. very poor (<70 standard score).

Assessment of Quality of Life

The quality of life of the perimenopausal and postmenopausal women was assessed using the World Health Organization Quality of Life Brief questionnaire (WHOQoL-Brief) [27]. It is used for both healthy and ill people. It is a shortened version of the World Health Organization Quality of Life questionnaire and it contains 26 questions. The answer to every question is scored as follows: 1=very poor, 2=poor, 3=neither poor nor good, 4=good, 5=very good. However, 2 questions are reversed. The first 2 questions are general and concern the overall quality of life and general health, while the other questions are detailed and concern the quality of life in the 4 specific domains: physical health, psychological health, social relationships, and environment. The scoring of questions has a positive direction, i.e. the higher the number of points, the higher the quality of life. The exceptions are 2 questions: 3 and 4, whose higher scores indicate a lower quality of life. Therefore, they are transformed into positive ones by reverse. The scores for the 4 specific domains are calculated as an arithmetic mean of the scores obtained for the answers to the questions belonging to a particular domain. The more scores a respondent obtains, the higher their quality of life is. The scores on a scale from 1 to 5 can be recalculated on a scale from 4 to 20 by multiplying the scores by 4. Then, they are on the same scale as the full version of the WHOQoL questionnaire. These results could be recalculated on a scale from 0 to 100 using a formula:

$$(0 \text{ to } 100 \text{ scale}) = \left[\frac{(4 \text{ to } 20 \text{ scale}) - 4}{16}\right] \times 100$$

Statistical Methods

The data were analyzed using STATISTICA 13.3 software (StatSoft Polska Sp. z o.o. Cracow, Poland).

All analyses were performed separately in 2 groups of women: perimenopausal and postmenopausal.

Absolute numbers (n) and percentages (%) of the occurrence of categories were estimated for categorical variables: level of education, place of residence, marital status, and intervals

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Table 1. Characteristics of the study groups.

Variable, parameter	Unit or category	Peri-menopausal women (N=141)	Post-menopausal women (N=146)	p
Age, Min-Max, M±SD	Years	45-60, 50.0±3.1	46-60, 56.0±3.1	<0.001
Level of education, n (%)	Primary	0 (0.00)	1 (0.68)	<0.001
	Basic vocational	6 (4.26)	5 (3.42)	
	Secondary	28 (19.86)	62 (42.47)	
	University	107 (75.89)	78 (53.42)	
Place of residence, n (%)	City	90 (63.83)	92 (63.01)	0.867
	Town	29 (20.57)	28 (19.18)	
	Village	22 (15.60)	26 (17.81)	
Marital status, n (%)	Married	102 (72.34)	118 (80.82)	0.187
	Never married	15 (10.64)	6 (4.11)	
	Divorced	16 (11.35)	12 (8.22)	
	Widowed	6 (4.26)	6 (4.11)	
	Separated	2 (1.42)	4 (2.74)	

of serum vitamin concentrations. Arithmetic means (M) and standard deviations (SD) were estimated for numerical variables: age, serum vitamin concentrations in numbers, cognitive functions (standard scores, in numbers), and 6 domains of quality of life in numbers from 1 to 5.

The following statistical tests were used:

- Chi-square test to compare categorical patients' characteristics (level of education, place of residence, marital status) and intervals of serum vitamin concentrations between perimenopausal and postmenopausal women;
- Student t-test test to compare numerical patients' characteristics (age), numerical serum vitamin concentrations, cognitive functions, and quality of life assessments between perimenopausal and postmenopausal women;
- Pearson correlation coefficient to correlate quality of life assessments with numerical serum vitamin concentrations and with cognitive functions.

The significance level was assumed to be 0.05 in all the statistical tests.

Results

Characteristics of the Study Groups

The examined women were aged 40-65 years including perimenopausal ones 50.0±3.1 years on average and postmenopausal 56.0±3.1 years on average (**Table 1**). The postmenopausal women were significantly lower educated than the perimenopausal ones (p<0.001). Most of the examined women lived in cities (63%) and were married.

Serum Vitamins D, B6, B12 Concentrations in Perimenopausal and Postmenopausal Women

Table 2 presents serum vitamins D, B6, and B12 concentrations in perimenopausal and postmenopausal women. Serum vitamins D and B12 concentrations did not differ significantly between the perimenopausal and postmenopausal women (p=0.271 and 0.355, respectively). Only 8% of the perimenopausal women and 10% of the postmenopausal women had serum vitamin D at an optimal level, while approximately 20% of all the women had a low deficiency, almost half – had a moderate deficiency, and every 4th of the perimenopausal and every 5th of the postmenopausal women had a high deficiency. No woman had an elevated or toxic level of vitamin D. Almost all the examined women (96%) had serum vitamin B12 at a normal level.

However, the postmenopausal women had significantly higher serum vitamin B6 concentrations than the perimenopausal women (*P*=0.013). Serum vitamin B6 concentration at a normal level was found in 86.5% of the perimenopausal women and in a lower percentage of postmenopausal women (79%), while above the normal level of this vitamin was found in 11% of the perimenopausal women and in a higher percentage of postmenopausal women (21%).

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Table 2. Serum vitamins D, B6, B12 concentrations in perimenopausal and postmenopausal women.

Variable, parameter	Unit or category	Peri-menopausal women (N=141)	Post-menopausal women (N=146)	p
Vitamin D, Min-Max, M±SD	ng/mL	3.0-49.3, 16.3±8.7	3.0-49.4, 17.4±8.8	0.271
Vitamin D, n (%)	High deficiency <10	36 (25.53)	30 (20.55)	
	Moderate deficiency 10-20	65 (46.10)	71 (48.63)	
	Low deficiency 20-30	28 (19.86)	30 (20.55)	
	Optimal 30-80	12 (8.51)	15 (10.27)	
	Elevated 80-100	0 (0.00)	0 (0.00)	
	Toxic >100	0 (0.00)	0 (0.00)	
Vitamin B6, Min-Max, M±SD	µg/L	3-79, 17.3±13.4	4.4-97, 22.2±19.0	0.013
Vitamin B6, n (%)	Below normal <5.0	4 (2.84)	1 (0.68)	
	Normal 5.0-30.0	122 (86.52)	115 (78.77)	
	Above normal >30.0	15 (10.64)	30 (20.55)	
Wit. B12, Min-Max, M±SD	pg/mL	153-744, 364.9±109.4	159-749, 377.7±125.5	0.355
Vitamin B12, n (%)	Below normal <211	5 (3.55)	5 (3.42)	
	Normal 211-911	136 (96.45)	141 (96.58)	
	Above normal >911	0 (0.00)	0 (0.00)	

Table 3. Cognitive functions in perimenopausal and postmenopausal women.

Cognitive function	Peri-menopausal women (N=141)	Post-menopausal women (N=146)	p
Neurocognitive Index	94.1±12.1	90.6±14.0	0.023
Composite memory	96.3±14.9	94.3±15.6	0.274
Verbal memory	97.7±14.0	94.9±15.4	0.107
Visual memory	96.6±15.2	96.3±14.4	0.832
Psychomotor speed	94.4±14.9	90.9±14.5	0.047
Reaction time	91.0±15.5	86.3±18.5	0.020
Complex attention	95.0±20.8	92.3±23.2	0.291
Cognitive flexibility	93.8±20.1	90.3±21.8	0.157
Processing speed	92.9±13.0	90.1±15.8	0.111
Executive functioning	94.2±20.0	91.2±21.4	0.221
Simple attention	101.3±10.6	100.0±13.2	0.361
Motor speed	97.6±14.6	93.9±15.0	0.035

Scale: <70 – very low, 70-79 – low, 80-89 – low average, 90-109 – average, >109 – above average.

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Table 4. Assessment of quality of life in perimenopausal and postmenopausal women.

Domains	Peri-menopausal women (N=141)	Post-menopausal women (N=146)	p
Overall quality of life	3.6±0.6	3.4±0.8	0.019
General health	3.4±0.9	3.3±0.9	0.477
Physical health	3.9±0.6	3.7±0.6	0.014
Psychological health	3.1±0.5	3.1±0.5	0.183
Social relationships	3.7±0.6	3.5±0.7	0.007
Environment	3.5±0.5	3.3±0.5	0.086

Scale 1-5, where: 1=very poor, 2=poor, 3=neither poor nor good, 4=good, 5=very good.

Cognitive Functions in Peri- and Postmenopausal Women

CNS Vital Signs software was used to assess cognitive functions in perimenopausal and postmenopausal women. We used standardized scores expressed as numbers and we calculated arithmetic means and standard deviations for the Neurocognitive Index and 11 particular cognitive functions separately in 2 groups. The results are presented in **Table 3**. The mean Neurocognitive Index was 94.1±12.1, which means an average level in the perimenopausal women, and it was significantly lower in the postmenopausal women (90.6±14.0, which means between "average" and "low average" level) (*P*=0.023). Psychomotor and motor speed, as well as reaction time, were worse in the postmenopausal women in comparison to the perimenopausal ones (*P*=0.047, 0.035, and 0.020, respectively). The other cognitive functions did not differ significantly between the 2 groups of women.

Assessment of Quality of Life in Perimenopausal and Postmenopausal Women

WHO Quality of Life Brief questionnaire was used to assess the quality of life separately in the 2 groups. The results are presented in **Table 4**. We calculated arithmetic means and standard deviations for overall quality of life, general health, as well as 4 domains of quality of life: physical health, psychological health, social relationships, and environment. All these domains were assessed by the examined women as being between 3 and 4 (between "neither poor nor good' and "good"). The postmenopausal women assessed the overall quality of life, physical health, and social relationships significantly lower than the perimenopausal women (*P*=0.019, 0.014, and 0.007, respectively).

Correlations Between Quality of Life Assessment and serum Vitamin Concentrations

We estimated Pearson correlations between quality of life and serum D, B6, and B12 vitamin concentrations, separately in the 2 groups. We presented only significant correlations in the figure, while the others are not significant. **Figure 1** presents significant correlations of quality of life with serum vitamin concentrations. The assessment of the environment correlated positively with serum vitamin B6 concentration in the perimenopausal women (r=0.239, *P*=0.004) (ie, the higher the serum vitamin B6 concentration was, the better the assessment of the environment was on average). The other domains of quality of life did not correlate with serum D, B6, and B12 vitamin concentrations (*P*>0.05).

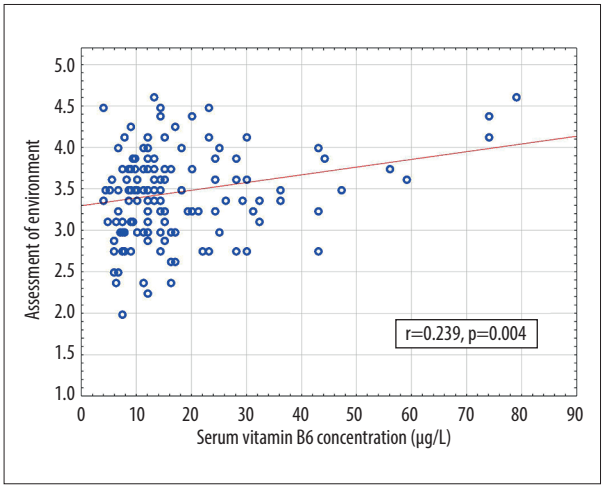

Figure 1. Significant correlations between quality of life and serum vitamin concentrations in perimenopausal women. *The figure was created in STATISTICA 13.3 software (StatSoft Polska Sp. z o.o., Cracow, Poland).*

Correlations of Quality of Life Assessment with Cognitive Functions

We estimated Pearson correlations between quality of life and cognitive functions separately in the 2 groups. We presented only significant correlations in the figure, while the others are not significant. **Figure 2** presents significant correlations

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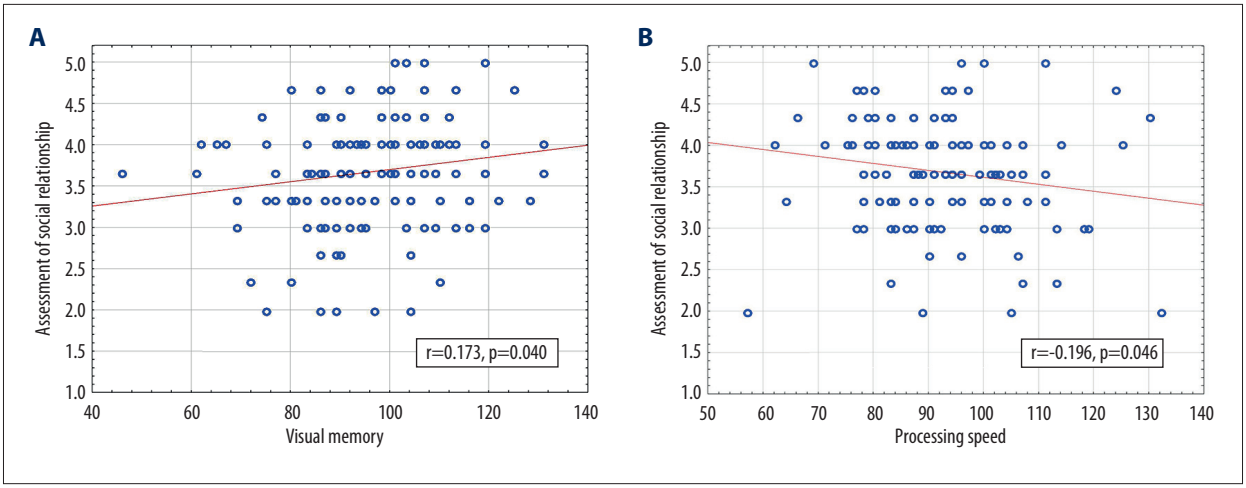

Figure 2. Significant correlations between quality of life and cognitive functions in perimenopausal women. (**A**) Correlation between assessment of social relationships and visual memory. (**B**) Correlation between assessment of social relationships and processing speed. *The figure was created in STATISTICA 13.3 software (StatSoft Polska Sp. z o.o., Cracow, Poland).*

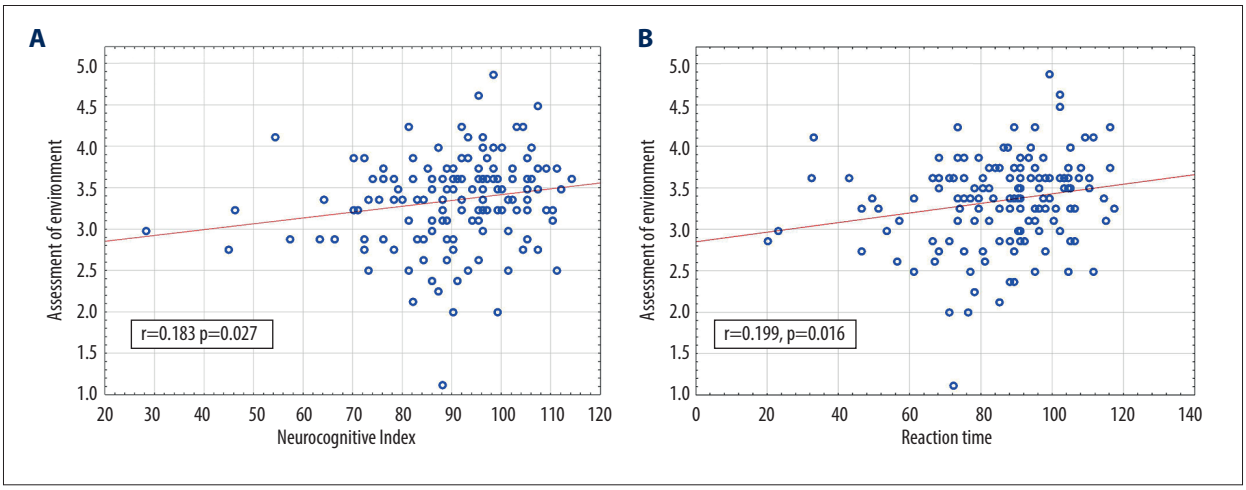

Figure 3. Significant correlations between quality of life and cognitive functions in postmenopausal women. (**A**) Correlation between assessment of environment and the Neurocognitive Index. (**B**) Correlation between assessment of environment and reaction time. *The figure was created in STATISTICA 13.3 software (StatSoft Polska Sp. z o.o., Cracow, Poland).*

of quality of life with cognitive functions in perimenopausal women, whose assessment of social relationships correlated positively with visual memory (r=0.173, *P*=0.040) and negatively with processing speed (r=0.169, *P*=0.046) (ie, the better the visual memory and the lower the processing speed was, the better the assessment of social relationships was on average) (**Figure 2A, 2B**, respectively).

Figure 3 presents significant correlations of quality of life with cognitive functions in postmenopausal women, whose assessment of environment correlated positively with the Neurocognitive Index (r=0.183, *P*=0.027) and reaction time (r=0.199, *P*=0.016) (ie, the higher the Neurocognitive Index and the better the reaction time were, the better the assessment of environment was on average) (**Figure 3A, 3B**, respectively).

The other domains of quality of life did not correlate with other cognitive functions (*P*>0.05).

Discussion

Our study aimed to analyze the quality of life, cognitive functions, and serum levels of selected vitamins in Polish women of perimenopausal and postmenopausal age. We used the WHO Quality of Life Brief questionnaire separately in 2 groups – perimenopausal women and postmenopausal women, – and found that the overall quality of life and general health, as well as 4 of the domains of quality of life (ie, physical health, psychological health, social relationships, and environment), were assessed by the women as being between "neither poor

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nor good' and "good". We observed that quality of life, physical health, and social relationships were assessed significantly lower by the postmenopausal women than the perimenopausal women. A study by Thapa et al [28] performed on women from Nepal found the highest mean score in the physical domain and the lowest score in the psychosocial domain (2.88 and 2.45, respectively). An earlier study based on over 550 women aged 50-60 years from southern Poland showed that physical activity levels higher than moderate intensity correlated with a better quality of life [29]. Another Polish study showed that older and married women and those with no formal education in a stable relationship had a lower quality of life during menopause [30]. As an interdisciplinary concept, quality of life (QoL) is analyzed in various areas of science, including medicine. To evaluate QoL, it is particularly important to use a proper, validated research tool to obtain plausible results. In our study, we used the WHOQoL-Brief, which can be used both for healthy people and sick people. This questionnaire has been evaluated in many studies and has proven to be an appropriate tool for assessing various areas that determine the well-being of older people [31,32].

Vitamin D plays a multidirectional role in the human body. Its deficiency is a risk factor for fracture among women with osteoporosis, which is a particular problem in postmenopausal women [33]. In postmenopausal women from Sri Lanka, 44% had insufficient levels of vitamin D and 19% had vitamin D deficiency [34]. The authors observed that the symptoms related to vitamin D deficiency include paraesthesia (in 57.1% of patients), bone pain (55.2%), and proximal myopathy (40.0%). A study from Turkey on quality of life and vitamin D deficiency demonstrated that vitamin D did not affect decreased muscle strength and lowered quality of life [35]. A deficiency of vitamin D was found in almost half of the analyzed Turkish women. In our study, 25% of the perimenopausal and 20% of the postmenopausal women had an extreme deficiency of vitamin D. Levels of both vitamins D and B12 were comparable between the perimenopausal and postmenopausal women, and almost all the examined women (96%) had vitamin B12 at a normal level. Vitamin B12 is a cofactor for the transfer of methyl group from 5-methyltetrahydrofolate in the remethylation process of homocysteine, which is catalyzed by methionine synthase. This path may potentially affect among others cognition [36]. Vitamin B6 serves as a cofactor for the conversion of homocysteine into cysteine in a path of transsulfuration [36]. We observed a positive correlation between vitamin B6 level and environmental assessment, in which the higher the vitamin B6 level, the better the average environmental rating, but there were no correlations between other domains of quality of life and serum levels of analyzed vitamins. Godala et al [37] observed that postmenopausal women with vitamin D deficiency had a poorer quality of life, and women with comorbidities and bone fractures tended to have a lower quality of life [37]. Similarly, data on healthy perimenopausal women demonstrated that QoL is impaired when vitamin D status is low [38]. According to the authors, maintaining a vitamin D level above 30 ng/ml is associated with a good quality of life. In our study, the mean level of vitamin D in perimenopausal women was 16.3±8.7 ng/ml, while postmenopausal women had slightly higher (but not statistically significant mean level of vitamin D (17.4±8.8 ng/ml).

We used CNS Vital Signs software to separately assess cognitive functions in perimenopausal women and postmenopausal women. The value of the Neurocognitive Index was significantly lower in postmenopausal women than in perimenopausal women (90.6±14.0 vs 94.1±12.1, respectively). In addition, the postmenopausal women had worse psychomotor and motor speed and reaction time. In perimenopausal women, we observed that the better the visual memory and the lower the processing speed was, the better the assessment of social relationships was on average. On the other hand, in postmenopausal women, higher Neurocognitive Index and faster reaction time were associated with better the assessment of environment. Previously, it was demonstrated that even a mild decline in cognition can affect effective functioning in everyday life and health-related quality of life in older women (≥65 years) [39]. Postmenopausal women (65±10 years old) from Korea had significantly worse scores on neuropsychological performance and health-related QOL than non-menopausal women [40]. The results by Karlamangla et al [41], based on a large group of over 2100 American women (average age 54 years old) reported evidence of cognitive aging in middle-aged women. In these women, the average decline in cognitive speed was 4.9% over 10 years and the average decline in verbal episodic memory was 2% over 10 years. Australian perimenopausal women had greater problems with their memory than premenopausal and postmenopausal women [42]. In our study, composite memory, verbal memory, and visual memory were similar in perimenopausal and postmenopausal women.

To the best of our knowledge, the present study is one of the few analyzing the quality of life, cognitive functions, and levels of vitamins D, B6, and B12 in perimenopausal and postmenopausal women from Poland. The study is innovative because it used validated standardized tests to assess cognitive function and quality of life, and serum vitamin concentrations, cognitive function, and quality of life were separately assessed and compared between perimenopausal and postmenopausal women. In addition, the study indicates the practical aspect of the obtained results because adjusting the content of selected vitamins in the diet and maintaining proper cognitive functions could help maintain a good quality of life in perimenopausal and postmenopausal women.

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However, the present study has some limitations. Due to limited resources, only vitamins that can affect the quality of life according to previous reports were selected. In addition, we did not compare serum vitamin concentrations, cognitive functions, or quality of life in women who were not perimenopausal and postmenopausal or in men. Our study was not longitudinal, but such a study is planned in the future after obtaining additional funding.

Conclusions

Almost all of the perimenopausal and postmenopausal women had normal concentrations of serum vitamin B12 (96%), 80% of them had normal concentrations of B6, while only 9% had optimal concentrations of serum vitamin D.

The postmenopausal women had lower Neurocognitive Index, psychomotor speed, motor speed, reaction time, and lower assessment of overall quality of life, physical health, and social relationships in comparison to the perimenopausal women.

In comparison to the postmenopausal women, the perimenopausal women had a lower concentration of serum vitamin B6, and the lower the concentration of this vitamin in serum they had, the lower they assessed their environment.

The better perimenopausal women assessed their social relationships, the better their visual memory and the slower their processing speed.

In postmenopausal women, better assessment of the environment was associated with a higher Neurocognition Index and a faster reaction time.

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Declaration of Figures' Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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