ORIGINAL ARTICLE

Annals of Agricultural and Environmental Medicine 2019, Vol 26, No 3, 489–495
www.aaem.pl

Level of vitamin 25 (OH) D and B group vitamins and functional efficiency among the chronically ill elderly in domiciliary care – a pilot study

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Kocka KH, Ślusarska BJ, Nowicki GJ, Bartoszek AB, Rudnicka-Drożak EA, Panasiuk L, Kocki T. Level of vitamin 25 (OH) D and B group vitamins and functional efficiency among the chronically ill elderly in domiciliary care – a pilot study. Ann Agric Environ Med. 2019; 26(3): 489–495. doi: 10.26444/aaem/105801

Abstract

Introduction and objective. Deficits of vitamin resources constitute a significant public health problem, especially among the elderly population. The aim of the research was to determine the level of vitamin 25 (OH) D and vitamins from group B in the chronically ill elderly in domiciliary care, depending on functional capacity and coexisting diseases.

Materials and method. The pilot study included 137 patients staying in long-term domiciliary care. Samples of the participants' venous blood was obtained for laboratory tests. Centrifuged serum was used to determine the level of the following biochemical parameters: vitamin 25 (OH)D, B12, folic acid and total protein, albumin, triglycerides, total cholesterol and HDL cholesterol. Assessment of the functional status of patients was made by using the Barthel scale.

Results. More than ¾ of the patients with functional deficit (according to Barthel's score 0–85 points) were deficient in vitamin 25 (OH)D, while folic acid values were below the reference values in more than half of the patients. Respondents with lower functional efficiency were characterised by a reduced average value of vitamin 25 (OH)D and folic acid.

Conclusions. The studied group of the chronically ill elderly was characterised by a deficiency of vitamin D3 and folic acid. Subjects with a functional impairment deficit show a reduced mean value of vitamin 25 (OH)D and folic acid in the blood serum, compared to the group of patients with higher mobility.

Key words

vitamin D3, vitamin B12, folic acid, elderly, long-term home care

INTRODUCTION

Deficits of vitamin resources constitute a significant public health problem, especially among the elderly population, in whom multi-morbidity and limited functional capacity are often diagnosed. The term 'vitamin deficiency' refers to a state in which the deficiency of specific groups of vitamins has a negative effect on the functioning of the body. The most common deficiencies observed in chronically ill elderly patients concern vitamins B12, B1, B6 and D [1].

The prevalence of vitamin D deficiency (cholecalciferol) in the elderly ranges from 5%-25% of those living alone and from 60%-80% of people living in nursing homes. Scientific research implemented in recent years has shown the pleiotropic effect of vitamin D3. Among the numerous effects regarding active metabolites of cholecalciferol, the following are particularly important: the relationship between vitamin D3 deficiency and heart disease, type 1 diabetes, mental and neoplastic diseases, and even increased mortality with long-term vitamin deficits [2, 3, 4]. The relationship between cholecalciferol deficiency and changes in the skeletal system in people over 65 is significant, due to the direct relationship between these factors and mobility, which is one of the most important elements determining the independence of elderly people [5].

The second, clinically significant vitamin deficiency in the elderly is avitaminosis B12 (cobalamin) [6]. It is estimated that vitamin B12 deficiency affects about 10–40% of the elderly population. Studies clearly show an increased risk of cobalamin deficiency with age [7, 8, 9]. The avitaminosis B12 is often accompanied by a deficiency of folic acid (vitamin B9), which is caused by reduced retention of folic acid by the cells in a situation of cobalamin deficiency [10]. The deficiency of cobalamin and folic acid is a frequent cause of neuropsychiatric symptoms in the elderly and is associated with the occurrence of neurological, cognitive, psychotic and mood disorders [7]. It is believed that a deficiency of vitamin B12 is a risk factor for the development of Alzheimer's disease. It is also one of the causes of the development of dementia, resulting in psychomotor slowing, apathy, and lack of concentration [11, 12].

The occurrence of vitamin deficiencies in the chronically ill elderly is especially worrying due to the clinical consequences caused by these deficiencies. Research indicates a correlation

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Received: 13.09.2018; accepted: 20.02.2019; *first published: 18.03.2019*

between vitamin deficiencies and the functional state of chronically ill elderly people [5,6]. However, there is a lack of a Polish population-wide research of people over 65 in the field of vitamin and micronutrient assessment in the body. In representative German studies, the KORA-Age-Study conducted in a group of people over 65 (n = 1,079, aged 65-93), deficiencies of vitamin 25 (OH) D (<50 nmol / l) were found in 52% of respondents and vitamin B12 (<221 pmol / l) in 27.3% of subjects [13].

In Poland, elderly patients with a large functional deficit, requiring long-term care, constitute a small percentage of seniors. In the PolSenior study among the Polish population (n = 4,913) aged over 65 (mean age 79.3 ± 8.7, age range 65–104 years), in the assessment of their functional status in terms of basic vital signs according to the Katza scale (ADL), 5.3% of respondentswere functionally dependent (partially efficient 3–4 points, and inefficient 1–2 points on the scale) [14]. In cross-sectional studies evaluating vitamin resources in the body of adults or elderly people, patients with low functional efficiency in domiciliary care are often excluded or overlooked, hence the inclusion of such a specific group in the current study seems to be necessary and justified.

OBJECTIVE

Presented results constitute an initial stage of a larger study aimed at determining the level of vitamin 25 (OH) D and B vitamins in the chronically ill elderly receiving domiciliary care, depending on functional capacity and coexisting diseases.

MATERIALS AND METHOD

The study pilot included 137 patients staying in long-term domiciliary care. The research was conducted between September 2016 – February 2017. Information was collected through a direct interview, by nurses (n=18) working in long-term domiciliary care. The nurses were employees of 5 facilities of primary health care. Additionally, the nurses providing the domiciliary care had been familiarised with the study protocol and were prepared to collect data, take measurements and collect materials for laboratory tests prior to home visits, in accordance with the adopted study procedure.

Patients were informed concerning preparation for the laboratory test on the following day (recommendation concerning blood collection: morning on an empty stomach, after about 8–12 hours without eating). In the morning, each patient had venous blood drawn to determine biochemical parameters. The blood was transported in specially prepared containers to the laboratory within no more than 30–60 minutes from the time of collection. The inclusion criteria were as follow: a normal diet consistent with dietary recommendations for seniors, without limiting the amount and quality of food intake, and not taking vitamin supplements. In addition, low risk associated with state of nutrition according to the scale NRS-2002 < 3 (the Nutrition Risk Screening 2002); functional deficit of the patient – Barthel scale 0–85 points, no co-existing neoplastic disease or renal failure, and no cognitive impairment measured by the MMSE scale ≥ 7 (Mini-Mental State Examination), receiving domiciliary care.

In total, 149 people qualified for the research. However, after a detailed analysis of the collected research materials, due to some questionnaires being incomplete, 12 respondents were excluded. Written consent was obtained from the directors of health care who employed environmental nurses to collect the research data. The research was voluntary and anonymous. At each stage of material collection, the patients had the right to resign or refuse to continue participating in the research. The research received a positive opinion from the Bioethics Committee at the Medical University in Lublin (KE-0254/13/2016) and was in accordance with the Helsinki Declaration. The research was carried out as part of the authors' own research funded by the Medical University in Lublin.

Barthel Index. The Barthel Index was used to assess basic everyday activities. In this scale, everyday activities, such as eating, moving, maintaining personal hygiene, using the toilet, bathing the whole body, moving on a flat surface, climbing stairs, dressing and controlling the excretion of stool and urine, are all taken into account. Depending on the extent of independence, the patient is assigned 0–100 points. The efficiency of the patients could be differentiated depending on the point ranges to which they were qualified: 86–100 points – the patient copes well with everyday activities, 41–85 points – the patient partly cannot cope with everyday activities, 0–40 points – the patient cannot perform most everyday activities [15]. Evaluation of the usefulness of the Barthel Index in the conditions of Polish healthcare as a reliable tool (α-Cronbach coefficient = 0.78 ÷ 0.89, test-retest correlation coefficient R = 0.93 ÷ 0.95) to measure the scope of independence in performing everyday activities by older people has been confirmed in research [16].

Demographic and clinical variables. The collected socio-demographic data describing the examined group were gender and age. The variable considered in the medical assessment was multimorbidity, i.e. the presence or absence of diseases of the circulatory, respiratory, endocrine and nervous systems, according to the ICD 10 classification.

Blood collection and biochemical analysis. Blood samples were taken from fasting respondents after an overnight rest and light supper the previous day. The blood was collected in tubes containing a clot activator and a separating agent (granulate). The plasma was separated by centrifugation at 3,000 rpm for 10 minutes. Centrifuged serum was used to determine the level of biochemical parameters. Testing for total protein concentration, albumin, total cholesterol, triglycerides and HDL cholesterol was performed using original reagents on the Advia 1800 (Siemens). LDL cholesterol was calculated from the Friedewald formula. Vitamin 25 (OH) D was determined on the Cobas E411 (Roche), using the original reagent kit via electrochemiluminescence. Vitamin B12 and folic acid were determined on an Advia Centaur apparatus (Siemens) using chemiluminescence.

Statistical analysis. The obtained results were subjected to statistical analysis using the STATISTICA 10 software (StatSoft, 2011). The value of $p < 0.05$ was considered statistically significant. Due to the fact that the distribution of variables deviated from the normal distribution, non-parametric statistical tests were used. To examine the differences between 2 groups, U Mann-Whitney non-parametric test was used, and for more than 2 groups, the Kruskal-Wallis test with the *post-hoc* NIR test was used.

RESULTS

Characteristics of the study group. The research included a total of 137 patients living in their own homes, receiving long-term domiciliary care on an average for 3.91 years (± 2.61). Functional efficiency according to the Barthel Index score was: in 37 (27%) patients 0–20 points, in 76 (55.5%) subjects 21–40 points, while in the remaining 24 (17.5%) respondents the value reached the range between 41–85 points. Of the respondents, 78.1% were women and 21.9% were men. The average age of the study group was 79.6 years (± 9.1); the youngest patient was 58 years old and the oldest 104. In the assessment of the nutritional status of the examined patients, due to the difficulty in assessing the body weight in the home conditions in bedridden patients, biochemical tests of the serum albumin concentration in blood were used, according to De Chicco et al. [17]. The mean serum albumin concentration in the study group was 4.11 g / dl (± 0.42). Analysis of the medical records of the respondents, taking into account the ICD classification, revealed the occurrence of specific disease entities (Tab. 1).

Table 1. Characteristics of the respondents

Variables	N	%	M	Me	SD
Gender					
Male	30	21.9	-	-	-
Female	107	78.1	-	-	-
Age (years)	-	-	79.6	79.4	9.1
Functional capacity according to Barthel index					
0 – 20 points	37	27	-	-	-
21 – 40 points	76	55.5	-	-	-
41 – 85 points	24	17.5	-	-	-
Multimorbidities (according to ICD)#					
Hypertension (I10)	84	61.3	-	-	-
Ischemic heart disease (I25)	23	16.8	-	-	-
Atherosclerosis (I70)	96	70.1	-	-	-
Diabetes (E10)	31	22.6	-	-	-
Cerebrovascular disease (I64)	15	10.9	-	-	-
Degenerative polyarthritis (M15)	58	42.3	-	-	-
Laboratory test results					
Total protein (g/dl)	-	-	6.99	7.12	0.48
Serum albumin (g/dl)	-	-	4.11	4.18	0.42
Total cholesterol (mg/dl)	-	-	192.2	180	50.28
HDL Cholesterol (mg/dl)	-	-	57.5	51.3	16.55
LDL Cholesterol (mg/dl)	-	-	110.45	150	38.55
Triglycerides (mg/dl)	-	-	122.25	119	49.21

#values do not add up due to the possibility of multiple choice of answers

Vitamin levels in the study group. Table 2 shows the average levels of vitamin 25 (OH) D, B12 and folic acid in the study group. More than ¾ of the studied population (N = 115, 83.9%) were deficient in vitamin D3, the average value of vitamin 25 (OH) D in the studied patients being 17.27 ng/ml (± 14.73). The level of vitamin B12 was consistent with the reference range in almost all subjects (93.4%, N = 128). Only in a small group of patients (6.6%, N = 9) the level of marked vitamin B12 was below the laboratory standard. The average level of vitamin B12 was 386.54 pg/ml (±131.77). The marked values of folic acid were below the reference values in more than half of the respondents (51.1%, N = 70), while the average value of folic acid was 7.36 ng/ml (±5.26).

Table 2. Levels of vitamin 25(OH)D, B12, folic acid among respondents

Variable	Norm N (%)	Deficit N (%)	M	Me	SD
25(OH)D*	22 (16.1)	115 (83.9)	17.24	11.88	14.73
Vitamin B12**	128 (93.4)	9 (6.6)	386.5	362	131.7
Folic Acid***	67 (48.9)	70 (51.1)	7.36	5.38	5.26

* normal result – 25(OH)D: 30–80 ng/ml
** normal result ofthe vitamin B12: 211–911pg/ml
*** normal result of folic acid: 5–20 ng/ml

Functional efficiency, coexisting diseases and vitamin reserves in patients. Table 3 presents the relationship between the assessment of the functional efficiency of the subjects and the level of analysed vitamins.Statistical analysis showed a significant difference between the level of vitamin 25 (OH) D and functional fitness assessed by the Barthel Index ($p = 0.0002$). Patients who scored 0–20 points and from 21–40 points on the Barthel Index had significantly lower levels of vitamin 25 (OH) D, compared to patients who scored 41–85 points. A similar relationship was observed for the level of folic acid and the Barthel Index performance rating ($p = 0.02$). Patients who scored 21–40 points on the Barthel Index had significantly lower folic acid levels, compared to patients who scored between 40–85 points on the Barthel Index. In the case of vitamin B12 level, no significant differences in groups were observed ($p = 0.08$).

A relationship was discovered between the occurrence of degenerative joint disease and the level of vitamin B12 ($p = 0.01$). The patients had a higher average level of vitamin B12 (M (mean) = 424.1 ± 139.8), compared to the group of people with undiagnosed degenerative joint disease (M = 358.9 ± 119.0) (Tab. 4).

Level of vitamins and selected blood chemistry parameters. People with vitamin 25 (OH)D deficiency had lower levels of folic acid ($p = 0.01$), total protein ($p = 0.008$), HDL cholesterol ($p = 0.003$) and triglycerides ($p = 0.05$) simultaneously, compared to the group of patients with vitamin 25 (OH)D level in the standard results, in accordance with the reference range (Tab. 5).

Patients characterised by lower levels of folic acid in serum biochemical tests possessed a lower value of vitamin 25 (OH) D ($p = 0.003$) and vitamin B12 ($p = 0.002$).

Table 3. Functional capacity of respondents according to the Barthel Index and level of vitamin 25(OH)D, B12, folic acid in respondents

Variable	Categories	25(OH)D				Vitamin B12			Folic acid		
		N	M	Me	SD	M	Me	SD	M	Me	SD
Barthel index	0–20 points	37	17.1	11.3	21.7	375.4	340	124.9	7.4	5.4	5.5
	20–40 points	76	15.1	10.0	10.9	373.7	362	128.2	6.6	5.1	4.7
	41–85 points	24	24.2	24.3	9.5	444.4	432	142.7	9.7	7.4	6.1
Kruskal Wallis test			16.82				5.02			7.50	
p			0.0002				0.08			0.02	

Table 4. Multimorbidities and level of vitamin 25(OH)D, B12, folic acid in respondents

Multimorbidities	Categories	25(OH)D			Vitamin B12			Folic acid		
		M	Me	SD	M	Me	SD	M	Me	SD
I10	Yes	16.5	12.3	10.4	386,6	362	134,9	7.2	5.3	5.2
	No	18.4	11.4	19.8	386.5	362	127,7	7.6	5.7	5.3
Mann-Whitney U test			0.26			0,01			-0.16	
p			0.78			0,98			0.86	
I25	Yes	19.3	20.3	11.3	350.8	342	112.9	8.2	5.3	7.2
	No	16.8	11.5	15.3	393.8	363.5	134.5	7.2	5.4	5.2
Mann-Whitney U test			-1.42			1,05			-0.84	
p			0.15			0,29			0.39	
I70	Yes	16.3	11.9	11.2	393.1	365.5	133.5	7.4	5.4	5.4
	No	19.4	11.7	20.8	371.2	342	127.9	7.3	5.3	5.0
Mann-Whitney U test			-0.92			1,0			-0.22	
p			0.35			0,31			0.82	
E10	Yes	17.1	14.1	20.2	399.3	353	137.4	7.8	5.9	5.6
	No	17.3	11.3	15.8	382.8	362	130.5	7.2	5.3	5.2
Mann-Whitney U test			-0.45			-0.24			-0.8	
p			0.65			0.8			0.42	
I64	Yes	16.1	10.2	17.4	365.1	379	86.2	7.2	4.9	5.8
	No	17.4	11.9	15.1	389.2	362	136.3	7.4	5.5	5.2
Mann-Whitney U test			0.44			0.31			0.47	
p			0.65			0.75			0.63	
M15	Yes	18.1	14.9	11.3	424.2	376	358.9	7.8	5.3	5.8
	No	16.6	11.05	16.8	358.9	342	119	7.1	5.4	4.9
Mann-Whitney U test			1.5			2.45			0.36	
p			0.13			0.01			0.71	

I10 – hypertension; I25 – ischemic heart disease; I70 – arteriosclerosis; E10 – diabetes; I64 – cerebrovascular disease; M15 – degenerative polyarthritis

Table 5. Vitamin 25(OH)D and level of vitamin B12, folic acid, total protein and lipoprotein

Variable	25(OH)D	Norm (n=22)	Below the norm (n=115)	Mann-Whitney U test	p
Vitamin B12	M	428.5	379.6	-1.8	0.07
	Me	422	354		
	SD	118.2	133.5		
Folic acid	M	10.2	6.8	-2.3	0.01
	Me	9.2	5.3		
	SD	6.1	4.9		
Total protein	M	4.3	4.07	-2.6	0.008
	Me	4.4	4.1		
	SD	0.39	0.41		
Total cholesterol	M	199	185.5	-0.9	0.34
	Me	183	175		
	SD	53.5	47.07		
HDL Cholesterol	M	62.7	4.07	-2.9	0.003
	Me	4.4	4.1		
	SD	0.39	0.41		
LDL Cholesterol	M	114.3	106.6	-0.4	0.61
	Me	105	106.6		
	SD	40.6	36.5		
Triglycerides	M	109.9	134.6	1.9	0.05
	Me	99	124		
	SD	42.4	56		

DISCUSSION

Vitamin 25 (OH)D, B12 and folic acid deficiencies are the most common vitamin deficiencies in the elderly. In this study, vitamin 25 (OH)D deficiency (value below 30 ng/ml) was found in 83.9% of patients. Similar results were shown in the studies of Napiórkowska et al. [18], where levels of vitamin D3 were investigated in 274 women aged 60–90; vitamin D3 deficiency was present in 83.2% of the subjects.

Research by Cashman et al. [19], conducted among 55,844 residents of 18 European countries, showed vitamin D3 levels below 30 ng/ml in 13% of the general population, without distinction according to their age, race or place of residence. The MORE (Multiple Outcomes of Raloxifene Evaluation) international study [20] conducted in many countries around the world, showed significant differences between serum vitamin D3 levels within a group of 7,564 elderly postmenopausal women, depending on the country and region of the women studied. In the mentioned study, Poland was represented by 152 women, with an average age 64.6 years. The above group was characterised by the level of 25 (OH)D in the serum below 25 mmol/ml in 12.5% of women; the remaining 45.4% had a level of vitamin D3 in the range of 25–50 mmol/ml, indicating a deficiency of vitamin D3. Similarly, in other European countries, vitamin D3 deficiency has been found in people over 65 years of age. Among 1,282 research participants aged 65–95 in The Netherlands, a deficiency of vitamin D3 was found in nearly 39% of men and 57% of women [21]. It is surprising that there is a deficit of vitamin D3 in the inhabitants of sunny Italy, where 104 of the elderly were examined; in 99 of them the concentration of 25-hydroxycaceferol was indeterminable [22].

These epidemiological studies confirm the common occurrence of vitamin D3 deficiency within the elderly population in different countries where there is a tendency to avoid contact with natural sunlight, which results in a decrease in the synthesis of vitamin D 3 in the body [23].

Another common vitamin deficit in the elderly population is a deficiency of vitamin B12 (cobalamin) and folic acid (vitamin B9). In own studies, the deficit of cobalamin was found in only 6.6% of patients. This is something which may have been caused by several factors. First, the reference range of vitamin B12 indicated by the laboratory where the tests were conducted is quite wide and covers an interval between 211 pg/ml and 911 pg/ml. In addition, the financial constraints allocated for the implementation of our research project prevented the determination of additional, indirect indicators, such as homocysteine and methylmalonic acid (MMA), which is one of the markers of B12 in the human body and, as indicated in the literature, should be marked in order to assess the body's supply of cobalamin [24]. The previous findings have been confirmed by Suter [25], which indicates that the level of vitamin B12 determined in the blood serum does not always reflect the actual resources in the body. Studies conducted in the United Kingdom among people over 65 years of age showed a deficiency of vitamin B12 in 20% of patients [26]. A cross-sectional, population-based study of 1,048 elderly (aged 65–100 years) in Finland showed a deficiency of vitamin B12 in 6.1% of subjects [27].

As indicated in the literature, it is necessary to determine the level of folic acid in the diagnosis of vitamin B12 deficiency, because it takes part during the same metabolic processes. In research by the authors of the current study, folic acid deficiency was demonstrated in more than a half of the older patients – 51.1%. A study by Wierzbicka et al. [28] conducted among older residents of Warsaw, showed that 25% of men and 7% of women were at high risk of folic acid deficiency, meaning the concentration of folate in the blood was lower than the recommended reference range. The results of a study by Naronha et al. [29] conducted among 84 elderly people living in nursing homes in Portugal, showed a low level of folic acid and vitamin B12 in 5.9% and 42.9% of respondents, respectively.

In the presented study, an attempt has been made to assess the impact of functional capacity on the levels of vitamin D3, B12 and folic acid. Subjects with a functional deficit were characterised by a reduced mean value of folic acid and vitamin D3 in the blood serum, compared to the group of patients with good mobility.This correlation has been confirmed by the studies of Van Pottelbergh et al. [30], who examined 325 people aged 80 and above residing in Belgium, proving that the higher level of vitamin D3 was correlated with the activity and physical fitness of the subjects. Similar conclusions were formulated by Rafiq et al. [31], studying the effect of vitamin D3 supplementation on the physical fitness of patients with COPD. Individuals receiving vitamin D3 had significantly greater inspiratory muscle strength and peak exercise tolerance. The above results justified the effect of vitamin D supplementation on muscle strength and physical performance.

According to the literature, B vitamins do not directly impact physical fitness, but instead take part in many metabolic processes of the body. Their deficiency slows down the synthesis of DNA and cell replication, increases the homocysteine level in the blood, impairs nervous system function, overactivity, and difficulty in falling asleep, feelings of exhaustion and concentration problems, as well as states of anxiety and restlessness, depression, insomnia and memory problems [7, 10]. These disorders impact upon the emergence of pathology in the sphere of cognitive functions, which largely determine the independence and functional efficiency of older people [32]. Bronkowska and Karcz [33] conducted research among women with low physical activity, the results of which indicated a low intake of B vitamins, which may confirm the thesis concerning the effect of vitamin deficiencies on the weakening of muscle strength and increase in the impairment of physical activity.

In own studies, the authors of the current study have determined a relationship between the occurrence of diseases and the levels of vitamin D3, B12 and folic acid. The results of the conducted research have only indicated the existence of a relationship between the level of vitamin B12 and the occurrence of degenerative joint diseases. Respondents with osteoarthritis had a higher average level of vitamin B12, compared to the group of people with undiagnosed osteoarthritis. This fact might be influenced by the employed therapeutic recommendations, using the B vitamins for treatment. As the literature indicates, a deficiency of B vitamins (including vitamins B12 and B9) contributes to the demyelination of the spinal cord's nerves and the cerebral cortex, affecting the manifestation of neurological symptoms [34]. In addition, a deficiency of vitamin B12 and folic acid is recognised in a significant number of older patients who develop neuropsychiatric symptoms.

Deficiency of B vitamins can also lead to disturbances in the homocysteine metabolic process and increase its concentration in the blood. The above disorders result in damage to the vascular endothelium and the development of atherosclerotic lesions. In our own studies, there was no correlation between the level of vitamin B12 and folic acid and the occurrence of atherosclerosis. However, scientific reports indicate the existence of the above dependence [35]. Similarly, in own studies, the authors have not found any correlation between the level of vitamin D3 and the occurrence of cardiovascular system diseases. However, in the last decade, evidence has been provided of the relationship between low levels of vitamin D and an increased risk of hypertensive disease, stroke or cardiovascular events [36].

Study limitations. The presented results of the pilot study focused on determining the level of vitamin D3 and B group vitamins, due to their significant impact on the functional efficiency of the chronically ill elderly in domiciliary care. However, the study is characterized by some limitations. Firstly, the obtained results are only preliminary, a not too numerous group did not allow the drawing of conclusions representative for a larger population. Secondly, the number of women was more than 3 times higher (78.1%) in relation to the number of men (21.9%) due to the longer life span of elderly females (7.4 years, on average). Thirdly, there is a lack of a full analysis concerning the diet of ill elderly in domiciliary care. The diet and content of particular nutrients in the diet were not evaluated among patients; however, the food intake among the respondents was consistent with the nutritional recommendations of seniors, without introducing vitamin supplementation and without limiting the amount and quality of food intake.. Fourthly, the subjects were characterized by low and average values on the Barthel Index. The group of patients with higher functional efficiency (Barthel >40 points) was less numerous (N = 24) due to the frequent lack of nursing care in the home environment, which made it difficult to collect research material. This situation results from the Polish reality concerning the functioning of health care, in which nursing home care is exercised continuously only in the situation where the patient scored <40 points on the Barthel Index.

Given the above limitations, formulating definite conclusions requires further study of a representative sample of chronically ill patients in domiciliary care. A large population study is recommended which includes patients with varying degrees of functional capacity dysfunction (determined by the Barthel Index). Such a study should also have a multi-stage and time-staged character, so that, depending on the functional capacity, the vitamin status of the subjects can be assessed.

CONCLUSIONS

The examined group of elderly people receiving long-term domiciliary care was characterised by a significant deficit of vitamin D3 and folic acid. The level of vitamins was conditioned by the low functional efficiency of patients, while the deficiency of vitamin D3, folic acid and vitamin B12 may be considered as a factor aggravating the functional impairment of the elderly patients. Due to the prevalence of vitamin deficiencies in the group of elderly people covered by long-term domiciliary care, it is advisable to undertake diagnostic measures for the actual determination of vitamin levels in the blood serum. It is also important to implement the education of patients and their caregivers in the field of vitamin supplementation, necessary in people with a diagnosed vitamin deficit.

REFERENCES

1. Duda G, Saran A. Polish recommendations concerning vitamins and minerals consumed by elderly people. FarmacjaWspółczesna. 2008; 1:16–23. (in Polish)
2. Matysiak-Luśnia K. Vitamin D in critically ill patients. AnestIntens Ter. 2016; 48(3): 209–216 (in Polish)
3. Souberbielle JC, Body JJ, Lappe JM, Plebani M, Shoenfeld Y, Wang TJ, et al. Vitamin D and musculoskeletal health, cardiovascular disease, autoimmunity and cancer: recommendations for clinical practice. Autoimmun Rev. 2010; 9(11): 709–715.
4. Płudowski P, Kraśkiewicz E, Karczmarewicz E. Vitamin D provision and supplementation standards. Post Nauk Med. 2012; 25(3): 265–272. (in Polish)
5. Szymański FM, Bomba-Opoń DA, Łęgosz P, Głogowska-Szeląg J, Baran W, Szepietowski JC, et al. Place of vitamin D in everyday clinical practice – an interdisciplinary expert opinion Forum Med Rodz. 2015; 9(6): 423–434. (in Polish)
6. Wojszel ZB. Malnutrition and nutritional therapy dilemmas in geriatrics. Post Nauk Med. 2011; 24(8): 649–657. (in Polish)
7. Lachner C, Steinle NI, Regenold WT. The neuropsychiatry of vitamin B12 deficiency in elderly patients. J Neuropsychiatry Clin Neurosci. 2012; 24(1): 5–15.
8. Andres E, Vogel T, Kaltenbach G, Lang PO. Food-cobalamin malabsorption and vitamin B12 deficiencyin adults and in elderly patiens: What is the problem? Rev Med Interne. 2016; 37(8): 511–513.
9. Andrès E, Vogel T, Federici L, Zimmer J, Ciobanu E, Kaltenbach G. Cobalamin deficiency in elderly patients: a personal view. Curr Gerontol Geriatr Res. 2008; 848267.
10. Cieślik E, Kościej A. Folic acid – occurrence and significances. Probl Hig Epidemiol. 2012; 93(1): 1–7. (in Polish)
11. Zboch M, Gwizdak-Siwkowska B, Serafin J, Śmigórski K, Tyfel P, Leszek J. Deficit of vitamin B12 as a factor affecting development of the dementive process. Med Rodz. 2010; 1:14–19. (in Polish)
12. Luchsinger JA, Tang MX, Miller J, Green R, Mayeux R. Relation of higher folate intake to lower risk of Alzheimer disease in the elderly. Arch Neurol. 2007; 64(1): 86–92.
13. Conzade R, Koenig W, Heier M, Schneider A, Grill E, Peters A, Thorand B. Prevalence and predictors of subclinical micronutrient deficiency in german older adults: results from the population-based KORA-Age study. Nutrients 2017; 9: 1276.
14. Wizner B, Skalska A, Klich-Rączka A, Piotrowicz K, Grodzicki P. Ocena stanu funkcjonalnego u osób w starszym wieku. W: Mossakowska M, Więcek A, Błędowski P. Aspekty medyczne, psychologiczne, socjologiczne i ekonomiczne starzenia się ludzi w Polsce. Poznań: Termedia Wydawnictwa Medyczne; 2012: 81–94 (in Polish)
15. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. Md State Med J. 1965; 14: 61–65.
16. Kuźmicz I, Brzostek T, Górkiewicz M. Barthel questionnaire as measurement tool for physical independence of older adults. Stud Med. 2008; 12: 17–21. (in Polish)
17. De Chicco RS, Matarase LE, Seidner D, Steiger E. Biochemical assessment and monitoring of nutritional status. In: R. Latifi, J.S. Dudrick (ed.): The biology and practice of current nutritional support. Landes Bioscience, Georgetown, Teksas 2003.
18. Napiórkowska L, Butlewski T, JakubasKwiatkowska W, Hamzy V, Gozdowski D, Franek E. Prevalence of low serum vitamin D concentration in an urban population of elderly women in Poland. Pol Arch Med Wewn. 2009; 119(11): 699–703.
19. Cashman KD, Dowling KG, Škrabáková Z, Gonzalez-Gross M, Valtueña J, Henauw S, et al. Vitamin D deficiency In Europe:pandemic? Am J Clin Nutr. 2016; 103(4): 1033–1044.
20. Lips P, Duong T, Oleksik A, Black D, Cummings S, Cox D, et al. A global study of vitamin D status and parathyroid function in postmenopausal women with osteoporosis: baseline data from the multiple outcomes of raloxifene evaluation clinical trial. J Clin Endocrinol Metab. 2001; 86(3): 1212–1221.
21. Hoogendijk JG, Lips P, Dik MG, Deeg DJ, Beekman AT, Penninx BW. Depression is associated with decreased 25-hydroxyvitamin D and increased parathyroid hormone levels in older adults. Arch Gen Psychiatr. 2008; 65(5): 508–512.
22. Passeri M, Pini G, Troiano L, Vescovini R, Sansoni P, Passeri M, et al. Low vitamin D status, high bone turnover, and bone fractures in centenarians. J Clin Endocrinol Med. 2003; 88(11): 5109–5115.
23. Jurkowlaniec E. Disorders of biological rhythms resulting from light pollution – selected physiological aspects of melatonin and vitamin d deficiency. Pol J Environ Stud. 2017; 21(2): 47–57. (in Polish)
24. Zabrocka J, Wojszel ZB. Vitamin B12 deficiency in old age – causes, consequences and therapeutic approach. Geriatria. 2013; 7: 24–32. (in Polish)
25. Suter PM. Vitamin Nutriture in Older Adults. In: Chernoff R. (ed.). Geriatric nutrition. The health professional's handbook. 4rd ed. Jones and Bartlett Publishers; 2014: 35–79.
26. Cuskelly GJ, Money KM, Young IS. Folate and vitamin B12: friendly or enemy nutrients for the elderly. Proc Nutr Soc. 2007; 66(4): 548–558.
27. Loikas S, Koskinen P, Irjala K, Löppönen M, Isoaho R, Kivelä SL, et al. Vitamin B12 deficiency in the aged: a population-based study. Age Ageing. 2007; 36(2): 177–183.
28. Wierzbicka E, Brzozowska A, Roszkowski W. Energy and nutrient intake of elderly people living in the Warsaw region, Poland. J Nutr Health Aging. 2001; 5(4): 248–252.
29. Noronha BM, Cunha AN, Araújo AD, Abrunhosa FS, Rocha NA, Amaral FT. Undernutrition, serum vitamin B12, folic acid and depressive symptoms in older adults. Nutr Hosp. 2015; 32(1): 354–361.
30. Van Pottelberg G, Mathei C, Vaes B, Adriaensen W, Gruson D, Degryse JM. The influence of renal function on vitamin D metabolism in the very elderly. J Nutr Health Aging. 2013; 17(2): 107–111.
31. Rafiq R, Prins HJ, Boersma WG, Daniels JM, den Heijer M, Lips P, et al. Effects of daily vitamin D supplementation on respiratory muscle strength and physical performance in vitamin D-deficient COPD

patients: a pilot trial. Int J Chron Obstruct Pulmon Dis. 2017; 28 (12): 2583–2592.
32. Walkiewicz KW, Dzięgielewska-Gęsia S, Fatyga E, Giętek M, Kozieł P,Muc-Wierzgoń M, et al. Cognitive impairment in elderly patients considering concentration of hemoglobin and vitamin B_{12} – preliminary report. Fam Med Primary Care Rev. 2015; 3: 225–228. (in Polish)
33. Bronkowska M, Karcz I. Assessment of vitamins contents in the food rations of low physically active women. Rocz Panstw Zakl Hig. 2007; 58(3): 533–540. (in Polish)
34. Kennedy DO. B Vitamins and the brain: mechanisms, dose and efficacy-a review. Nutrients. 2016; 8(2): 68.
35. Czeczot H. Folic acid in physiology and pathology. Postepy Hig Med Dosw. 2008; 62: 405–419. (in Polish)
36. Caccamo D, Ricca S, Currò M, Ientile R. Health risks of hypovitaminosis D: a review of new molecular insights. Int J Mol Sci. 2018; 19(3): E892.

Ministry of Science and Higher Education
Republic of Poland

Generation of the DOI (Digital Object Identifier) – task financed under the agreement No. 618/P-DUN/2019 by the Minister of Science and Higher Education