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ORIGINAL ARTICLE

A SURVEY OF DIETARY INTAKE HABITS AND NUTRITIONAL STATUS IN WOMEN AGED 60-90 YEARS SUFFERING FROM SLEEP DISORDERS

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ABSTRACT

Background. Disturbances to the rhythms of the sleep-wake cycle adversely impact the quality of everyday living. Amongst those factors predisposing, causing and consolidating sleeping disorders are inappropriate nutrition and its effect on nutritional status.

Objective. To survey by questionnaire the nutritional status and habits in women aged 60-90 years suffering from sleeping disorders.

Materials and methods. Subjects were 141 women aged 60-90 years, attending lectures at the Szczecin Humanistic University for Seniors, of whom 110 (78%) were selected as having declared sleep disorders. Three age groups were established, of 60-65 years (n=39), 65-75 years (n=52) and above 75 years (n=19). Anthropometric measurements were performed (body mass and height) and the BMI (Body Mass Index) calculated. Calorific/energy and nutritional values of the daily dietary intakes were assessed in 330 meals using the PDCAAS calculation (Protein Digestibility-Corrected Amino Acid Score). Subjects had previously undergone a two-month pro-health nutrition course.

Results. Daily sleeping disorders were declared by 24.5% women, whilst 45.4% demonstrated inappropriate nutrition. Daily dietary intakes showed insufficiencies in the following: calories, consuming assimilative carbohydrates, cellulose, potassium, calcium, vitamin D_3 and water. Simultaneously, excessive intake of Na, P, Fe, Zn, Cu and vitamins: A, B_2, B_6, B_{12}, niacin and C were found. The smallest quantity of nutritious foodstuffs were consumed by the eldest women (significance of $p \leq 0.05$). The share of protein-derived calories was significantly the highest in the 66-75 age group ($p \leq 0.01$). Leucine was the amino acid that limited the biological value of consumed protein. Such dietary faults/errors were due to an inappropriate structure of foodstuff consumption.

Conclusion. The dietary intake habits of women in all the age groups were found to be unbalanced in terms of calories and nutritional value, which may affect neurotransmitter synthesis that regulates the sleep and wake cycle along with melatonin homeostasis. It is essential that elderly women are provided with pro-health education covering their nutrition as well as sleeping hygiene.

Key words: *elderly women, nutritional status, dietary intake habits, sleeping disorders*

STRESZCZENIE

Wprowadzenie. Zaburzenia w rytmie sen-czuwanie u kobiet wpływają na pogorszenie jakości codziennego życia. Do czynników predysponujących, wywołujących i utrwalających zaburzenia snu należy m.in. nieprawidłowy sposób odżywiania, warunkujący stan odżywienia.

Cel. Ocena stanu odżywienia i sposobu żywienia kobiet w wieku 60-90 lat z zadeklarowanymi zaburzeniami snu.

Materiał i metody. Badaniem ankietowym objęto 141 słuchaczek (w wieku 60-90 lat) Szczecińskiego Humanistycznego Uniwersytetu Seniora i wytypowano 110 kobiet (78% ogółu) z zadeklarowanymi zaburzeniami snu, które podzielono na trzy grupy wiekowe: 60-65 lat (n=39), 65-75 lat (n=52) oraz >75 lat (n=19). Wykonano pomiary antropometryczne (masa i wysokość ciała) i wyliczono wskaźnik stanu odżywienia BMI (Body Mass Index). Dokonano oceny wartości energetycznej i odżywczej 330 całodziennych racji pokarmowych, uzyskanych metodą bieżącego notowania. Obliczono wskaźnik PDCAAS (*Protein Digestibility-Coreected Amino Acid Score*). Kobiety poddano dwumiesięcznej prozdrowotnej edukacji żywieniowej.

Wyniki. Występowanie codziennych zaburzeń snu zadeklarowało 24,5% kobiet. Nieprawidłowym stanem odżywienia charakteryzowało się 45,4% kobiet. Całodzienne racje pokarmowe kobiet charakteryzowały się niewystarczającą wartością energetyczną, spożyciem węglowodanów przyswajalnych, błonnika, K, Ca, witaminy D_3 oraz wody, przy równocześnie

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nadmiernym spożyciu Na, P, Fe, Zn, Cu oraz witamin: A, B_2, B_6, B_{12}, niacyny i C. Istotnie ($p \leq 0.05$) najmniej składników odżywczych spożywały kobiety najstarsze. Udział energii pochodzącej z białek był istotnie ($p \leq 0.01$) najwyższy w grupie 66-75 lat. Aminokwasem ograniczającym wartość biologiczną spożytego białka była leucyna. Powyższe nieprawidłowości wynikały z niewłaściwej struktury spożycia produktów spożywczych.

Wnioski. Sposób żywienia kobiet we wszystkich grupach wiekowych charakteryzował się niezbilansowaniem pod względem wartości energetycznej i wartości odżywczej, co mogło wpłynąć na syntezę w ustroju neuroprzekaźników regulujących proces snu i czuwania oraz hormonu melatoniny. Zasadne jest poddawanie kobiet w starszym wieku edukacji prozdrowotnej uwzględniającej zarówno sposób żywienia, jak i higienę snu.

Słowa kluczowe: *kobiety w wieku starszym, stan odżywienia, sposób żywienia, sen*

INTRODUCTION

During the period of aging, which according WHO starts at the age of 60 years, the general state of women's health, well-being and sleep patterns deteriorate, which has an impact on their quality of everyday life [12].

Among the elderly, the deterioration of sleep-wake cycle has generally been caused by a physiological decrease of melatonin synthesis in pineal gland, but also other factors, such as coexisting disorders or medications. Epidemiological research conducted among the elderly has shown that difficulties with falling asleep were declared by 15-45% of respondents, while 20-45% declared sleep discontinuity and impaired sleep continuity, and 15-54% of respondents wake up too early. The fact that sleeping disorders among the elderly are so common results from disturbances of sleep-wake cycle [21]. Moreover, it has been evidenced that there is a correlation between sleeping disorders and a higher risk of collapse, deterioration of physical and mental fitness (slow reaction time, tendency to make more mistakes and impairment of attention and logical thinking), disturbance of cognitive functions (memory, decision making and problem solving) and higher mortality [3, 9, 12].

Incorrect dietary intake habits (affecting the state of nutrition) are perceived to be one of the factors predisposing, causing and consolidating sleeping disorders [1, 16]. Their improvement might complement the pharmacological therapy applied to people with sleeping disorders, thus significantly improving their life quality. The main role in regulating the sleep-wake cycle is played by neurotransmitters: both serotonin from which melatonin is synthetized, as well as acetylcholine, dopamine, and *gamma*-aminobutyric (GABA) acid.

One would presume that, since the elderly have more free time at their disposal, they would pay more careful attention to the kind and quantity of foodstuffs consumed. However, the choice of foods consumed might depend on nutritional awareness, dietary habits obtained throughout life, as well as financial status, which most often changes during retirement [7].

Therefore, the objective of this research is to survey the nutritional status and habits in women aged 60-90 years with declared sleeping disorders.

MATERIAL AND METHODS

The presented survey is an excerpt of the results of a completed project, titled "Education Risen to Senior Power," conducted within the Government Programme for Social Participation of Senior Citizens (ASOS) in the years 2014 – 2020 aiming at, among others, improvement of the quality and standard of life of the elderly.

The initial questionnaire survey covered 141 students (aged 60 – 90) of Szczecin Humanities University for Senior Citizens at the University of Szczecin in May 2015. Information regarding socio-demographic data, sleep disorders, selected aspects of lifestyle, coexisting disorders and medications were obtained from the female respondents. On this basis, only 110 women (78% of all) with declared sleep disorders were selected for further survey. Subsequently, the subjects were divided into three age groups: 60-65 years of age (39 women), 65-75 years of age (52 women) and over 75 years (women).

Anthropometric measurements were performed using Martin's classical measuring technique, and they included body height, measured with SECA 215 stadiometer in the vertical (standing) position, with head placed in Frankfurt position; and body weight, measured with legalized and standardized medical weigh RADWAG WPT-200.0, without shoes and in light clothes. From the obtained anthropometric data, BMI (*Body Mass Index*) was calculated according to the formula: body mass in (kg) /height(m^2) [17].

Moreover, after having been instructed, the subjects noted time, type and quantity of consumed foodstuffs during three, randomly chosen days (24 hours) of the week (including one weekend day), on a regular basis. They would assess the size of consumed portions on the basis of *The Register of portions, products and dishes* they had been provided [23]. Thereby, the regular notes provided 330 daily dietary intake reports (110 women provided 3 daily menus each),

which subsequently were assessed with the use of a computer program "*Diet 5.D*" from the Institute of Nutrition and Food. The program assessed the energy and nutrition values of the meals. The results for each subject were individually contrasted with nutrition standards: energy to estimated energy requirement (EER), vitamins and mineral elements (A, B_1, B_2, B_6, B_{12}, niacin, C, Ca, P, Mg, Fe, Zn, Cu) to the estimated average requirements (EAR) and (B_3, E, Na, K, water) to the adequate intake (AI), according to age and sex [14]. Fiber and cholesterol consumption was referred to the recommended values which enable prevention of obesity and other noncontagious diseases (25g/24h and <300mg/24h respectively). The limiting amino acid *Chemical Score* (CS) index was also calculated and next, after taking into consideration digestibility of protein of food rations at the level of 0.9, the index of *Protein Digestibility Corrected Amino Acid Score* (PDCAAS) was calculated.

The female subjects completed two-month pro-health nutrition education in the form of lectures and nutrition workshops, in the course of which attention was paid to the importance of nutritional status and nutrition habits for the sleep-wake cycle regulation.

After their normality of decomposition was tested with *Shapiro-Wilk* test, and their homogeneity of fluctuation was tested with *Laven* test, a logarithm was found in the results of the survey, and they were subjected to statistical calculation. Single factor analysis of variance (ANOVA) was applied, and *Tukey* test was used to estimate the difference between the survey groups, at the level of significance of $p \leq 0.05$ and $p \leq 0.01$, using the statistical program Statistica ®10.0 (Statsoft, Tulsa, OK, USA).

RESULTS

The studied group consisted mainly of married women aged 60-65 years and 66-75 years, and of unmarried women in the age group of 75 years or more (Table 1). Only half of the women described their financial status as sufficient. Over 70% of women had chronical diseases such as: high blood pressure, hypothyroidism, type 2 diabetes and arthrosis, for which they were being medicated (Table1).

The respondents aged 60-65 and 66-75 predominantly reported problems with falling asleep in the evening, while the oldest subjects had problems with falling back asleep after waking up at night. Those sleeping disorders occurred daily in every fourth subject. In the groups of the youngest and the oldest women, sleeping disorders occurred most often several times a week, while in the group aged 66-75 years they occurred once a week. And yet, only 37.3% of the subjects had consulted a physician and received help in the form of sleep medication, such as: Melatonin, Neospasmin, Forsen and Valerian. However, every fifth subject used herbal remedies, such as: herbal teas, a hop cone, Melissa and Persen.

A small percentage of respondents had more than 3 hours of uninterrupted sleep. More than a half of the subjects reported problems with everyday functioning after a night of bad sleep; they reported irritation, problems with concentration and nervousness. Nearly half of the women declared having a nap during the day. The same number habitually consumed supper about 3-4 hours before going to bed. About 2/3 of the respondents habitually drank 1-2 cups of coffee a day.

The analysis of the data obtained from anthropometric measurements (Table 2) did not show significant differences in body mass between the surveyed groups of women. The only significant ($p \leq 0.05$) variation was the lowest body height of the subjects in the group of the oldest women. The average value of BMI in all age groups of surveyed women did not differ statistically significantly and pointed to a proper state of nutrition. However, a thorough analysis of the value of BMI showed that only every third subject could be described as being in the proper state of nutrition, the most of whom were found in the group aged 66-75 years. The highest percentage of underweight and overweight women and those under the risk of being underweight was found among the oldest women. Obesity was most often found among the subjects aged 66-75 years.

The conducted qualitative dfr analysis of the subjects (Table3) showed that recommended 4-5 meals a day were most often consumed by the youngest women and most rarely by subjects aged 66 -75 years. In this age group the highest number of additional meals were consumed. It was ascertained that the lowest percentage of main meals during the day (24 hours) (breakfast, lunch, afternoon tea, and supper) were consumed in the group of the youngest women. However, the smallest number of dinners was consumed among the oldest respondents, and in the same group most women snacked.

The quantitative dfr analysis of surveyed women showed insufficient energy value, insufficient intake of assimilative carbohydrates, cellulose, K, Ca, D_3 vitamin and water with simultaneous excessive intake of Na, P, Fe, Zn, Cu and vitamins: A, B_2 ,B_6, B_{12}, PP, and C (Table 4).

Systematically significantly ($p \leq 0.05$) the smallest quantity of energy, mineral ingredients (K, P, Mg, Fe, Zn, Cu), vitamins (D_3, B_1, B_2, B_6, niacin) and water were consumed by the oldest women. It was ascertained that, despite the insufficient energy value of the subjects' diets, too much energy came from proteins, which was significantly ($p \leq 0.01$) the highest quantity consumed in the group aged 66-75 years, in comparison to the other groups (Table 4).

Table 1. The characteristics of the studied female subjects aged >60 years, (%, *n* = 110)

	Examined women			Total
	60-65 years (n = 39)	66-75 years (n = 52)	>75 years (n = 19)	>60 years (n = 110)
Marital status				
- unmarried	2,6	5,8	0,0	3,6
- married	69,2	40,4	21,1	47,3
- widow	5,1	25,0	21,1	17,3
- single	23,1	23,1	57,9	29,1
Financial status				
- insufficient	7,7	7,7	0,0	6,4
- sufficient	43,6	51,9	68,4	51,8
- good	35,9	38,5	31,6	36,4
- very good	12,8	1,9	0,0	5,5
Occurrence of chronic illness	71,8	69,2	89,5	73,6
Medicine administered for chronic illness	59,2	72,8	68,6	67,1
Sleeping disorders				
- problems with falling asleep	48,7	40,4	21,1	40,0
- interrupted sleep	30,8	36,5	42,1	35,5
- waking up too early	20,5	17,3	42,1	22,7
- waking up often	38,5	25,0	36,8	31,8
- problem with falling asleep after waking up at night	48,8	38,4	57,9	45,4
Frequency of sleeping disorders				
- once a week	25,7	46,2	15,7	33,5
- several times a week	48,7	28,8	63,2	41,8
- everyday	25,6	25,0	21,1	24,5
Consulting sleeping disorders with a physician	38,5	38,5	31,6	37,3
Prescribing hypnagogic medicine: Melatonina, Neospasmina, Forsen, Waleriana	35,9	34,6	21,1	32,7
Usage of herbal medicine: Herbal teas, Persen, Melisa, hop cones	23,1	23,1	10,5	20,9
Number of hours of uninterrupted sleep:				
< 3	7,7	13,5	10,5	10,9
3-4	59,0	34,6	47,4	45,5
5-6	25,6	34,6	21,1	29,1
6-8	5,1	13,5	10,5	10,0
>8	5,1	3,8	15,8	6,3
Results of insufficient sleep:				
- irritation	38,5	32,7	42,1	36,4
- emotional lability	25,6	13,5	15,8	18,2
- problems with concentration	33,3	15,4	21,1	22,7
- memory disorders	17,9	17,3	21,1	18,2
- worse functioning during the day	64,1	57,7	57,9	60,0
- reduced muscle power	23,1	17,3	31,6	21,8
- nervousness	28,2	21,2	15,8	22,7
- laziness	17,9	13,5	15,8	15,5
Taking a nap during the day	48,7	36,5	73,7	47,3
Time of the last meal before going to sleep:				
- directly before sleeping	5,1	3,8	0,0	3,6
- 1 hour before sleeping	20,5	13,5	5,3	14,5
- 2 hours before sleeping	7,7	27,0	15,8	18,2
- 3 - 4 hours before sleeping	59,0	36,5	52,6	47,3
- I do not have supper before sleep	7,7	19,2	26,3	16,4
Number of cups of coffee a day:				
- do not drink coffee	15,4	13,5	10,5	13,6
- 1 - 2 cups	79,5	80,8	89,5	81,8
- 3 - 4 cups	5,1	5,8	0,0	4,5

Table 2. Values on anthropometric attributes and the BMI indicators in female subjects, (*mean* ± SD, *n* = 110)

Feature	Subjects (*n* = 110)			*p* value
	60-65 years (n = 39)	66-75 years (n = 52)	>75 years (n = 19)	
Age, years	62.4 ± 2.3	70.0 ± 2.5	79.2 ± 3.5	
Body weight, kg	70.3 ± 10.5	70.4 ± 10.9	65.1 ± 10.3	0.129
Body height, cm	161.9[a] ± 6.8	160.1 ± 5.8	156.8[b] ± 6.7	0.018
BMI, kg· m^{-2}	26.9 ± 4.3	27.5 ± 4.4	26.5 ± 4.4	0.595
BMI n (%)				Total
<22 (underweight)	10.3	5.8	15.8	9.1
22-23 (risk underweight)	20.5	13.5	21.1	17.3
24-27 (normal)	20.5	38.5	15.8	28.2
27- 32 (overweight)	35.9	26.8	36.8	31.8
>32 (obesity)	12.8	15.4	10.5	13.6

BMI - body mass index;
a, b – means denoted with the different letters are statistically significant difference $p \leq 0.05$;

The analysis of CS indicator and PDCAAS calculated on the basis of this indicator (Table 5) showed that leucine was the amino acid which limited the biological worth of consumed protein in dfr of all the age groups. It was ascertained that the significantly ($p \leq 0.05$) lowest intake of all exogenous amino acids took place in the oldest group, in comparison to the youngest group.

Table 3. Number and type of meals consumed daily by the subjects during the period of the survey, n = 330 menus

Number and type of meals	Female subjects		
	60-65 years (n = 117)	66-75 years (n = 156)	>75 years (n = 57)
Number of meals (%)			
1 – 2	0	6.4	5.3
3	7.8	7.7	14.0
4	43.6	34.0	33.3
5	35.8	35.9	36.9
6 and more	12.8	16.0	10.5
Type of meals (%)			
Breakfast	64.1	82.1	86.0
Lunch	49.6	67.9	54.4
Dinner	61.5	80.1	54.4
Afternoon tea	35.0	46.8	47.4
Supper	51.3	66.7	66.7
Get	18.8	22.4	28.1

The observed irregularities in energy and nutritious value of subjects' diets resulted from an inappropriate foodstuffs consumption (Table 6). It was ascertained that the quantity of certain products was insufficient in relation to a model food ratio; this concerns the consumption of bakery products, flour and pasta, potatoes, vegetables, leguminous seeds and nuts, fruit, dairy products, fish, plant oils and mixed fats. However, an excessive consumption of groats, meat and poultry, eggs, animal fats and sugar and sweets was noticed. Significantly the smallest quantity of vegetables ($p \leq 0.05$), rennet cheese ($p \leq 0.05$), meat and poultry ($p \leq 0.01$), plant fats, ($p \leq 0.05$) and mixed fats ($p \leq 0.01$) were consumed by the oldest woman.

DISCUSSION

Sleep is a physiological period of rest and regeneration of the body which is subjected to synchronization in the 24-hour cycle, depending on the environmental changes. It was shown that sleep which is habitually shorter than 5-6 hours or longer than 8-9 hours during a 24-hour cycle increases the risk of diabetes type 2, cardiovascular diseases (cerebral ischemia stroke, myocardial infarction) and breast carcinoma development [4, 19]. In this research, more than a half of subjects reported sleep shorter than 5-6 hours, as well as chronic diseases and medication. What is more, in the period of aging an inappropriate state of nutrition is conductive to chronic diseases, which might result in sleeping disorders [3, 13]. In this research two thirds of the subjects were characterized by an inappropriate state of nutrition, which could have been the result of non-normative nutritional status in their previous stages of life, changes in their hormonal status after menopause, as well as sleep deprivation that had been declared by the subjects in the questionnaire. Similar inappropriate nutritional status of women over 60 was indicated by other authors [6, 7].

The factor regulating the state of nutrition is a diverse and balanced diet, metabolically adjusted to the age. Despite the free time which the respondents have (due to their retirement) and the ability to pay more attention to composing their meals, it was their economic status and affordability of various groups of foodstuffs that was the key factor influencing the subjects' nutritional choices. It was ascertained that in the case of half of the subjects, the assortment of consumed foodstuffs was narrow due to their low income, which was reflected in the qualitative and quantitative analysis of their diets.

Table 4. Energy value and basic nutrient levels in daily food rations consumed by the female subjects during the period of the survey (Mean ± SD, n = 330 menus)

Components	Female subjects						*p*
	Mean ± SD			% of daily allowance EAR			
	60-65 years (n = 117)	66-75 years (n = 156)	>75 years (n = 57)	60-65 years (n = 117)	66-75 years (n = 156)	>75 years (n = 57)	
Energy, kcal	1867.1± 583.4	1709.6± 500.3	1361.5± 409.7	88.9^{a} ± 27.8	85.5 ± 25.0	71.7^{b} ± 21.6	0.047
Total protein, g	76.4 ± 22.0	73.0 ± 20.0	58.8 ± 18.3	97.0 ± 27.9	97.3 ± 27.9	82.5 ± 25.6	0.063
Animal protein, g	49.9 ± 16.6	48. ± 16.8	39.1 ± 15.0	95.0 ± 31.6	96.1 ± 33.6	82.3 ± 31.7	0.212
Assimilable carbohydrates, g	260.0 ± 88.6	237.9 ± 75.2	186.2 ± 48.7	90.0 ± 30.7	86.5 ± 27.4	71.3 ± 18.6	0.059
Dietary fibre, g	21.6 ± 8.3	21.6 ± 7.1	17.9 ± 4.1	72.1 ± 27.5	71.9 ± 23.8	59.8 ± 13.7	0.225
Total fat, g	65.4 ± 23.6	61.3 ± 22.7	49.7 ± 21.9	93.4 ± 33.7	91.9 ± 34.0	78.5 ± 34.5	0.210
Cholesterol, mg	298.2 ± 116.0	262.6 ± 128.4	231.5 ± 98.4	99.4 ± 38.7	87.5 ± 42.8	77.2 ± 32.8	0.066
Sodium, mg	1867.4 ± 908.9	1621.9 ± 772.1	1270.0± 872.1	133.4 ± 64.9	124.8 ± 59.4	105.8 ± 72.7	0.136
Potassium, mg	3379.3 ± 989.8	3408.8±1109.6	2689.3± 704.9	71.9^{a} ± 21.1	72.5^{a} ± 23.6	57.2^{b} ± 15.0	0.017
Calcium, mg	546.8 ± 226.8	547.9 ± 288.7	441.8 ± 171.1	54.7 ± 22.7	53.8 ± 26.2	44.2 ± 17.1	0.377
Phosphorus, mg	1226.0± 344.1	1213.7 ± 399.9	985.8 ± 276.6	211.4^{a} ±59.3	206.1 ± 62.4	170.0^{b} ± 47.7	0.024
Magnesium, mg	311.9 ± 97.0	301.5 ± 102.7	242.3 ± 70.1	117.7^{a} ± 36.6	112.1 ± 36.4	91.4^{b}± 26.4	0.021
Ferrum, mg	12.2 ± 4.2	10.7 ± 3.7	9.1 ± 4.1	203.2^{a} ±69.7	173.1 ± 57.7	152.3^{b} ± 68.7	0.005
Zinc, mg	9.8± 3.0	9.3 ± 2.6	7.5 ± 2.1	143.6^{a} ±43.4	135.0 ± 36.6	109.6^{b} ± 30.7	0.005
Copper, mg	1.27 ± 0.4	1.20 ± 0.4	0.98 ± 2.7	182.1^{a} ±56.7	168.2 ± 54.7	139.4^{b} ± 38.4	0.019
Retinol Equivalent, µg	989.9 ± 654.2	981.9 ± 847.5	687.5 ± 360.0	198.0 ±130.8	192.4 ±167.6	137.5 ± 72.0	0.124
Vitamin D_3, µg	3.2 ± 2.6	3.3 ± 3.0	3.2 ± 3.1	31.8^{a} ± 26.1	21.9 ± 20.1	21.6^{b} ± 20.8	0.019
Vitamin E, mg	8.9 ± 3.4	8.6 ± 3.2	7.3 ± 3.0	111.8 ± 43.1	107.9 ± 39.5	91.5 ± 37.0	0.167
Vitamin B_1, mg	1.1 ± 0.4	0.9 ± 0.3	0.8 ± 0.2	119.3^{a} ± 49.9	102.1 ± 35.1	87.3^{b} ± 25.3	0.034
Vitamin B_2, mg	1.5 ± 0.5	1.5 ± 0.6	1.2 ± 0.3	164.5^{A} ±50.4	160.7^{A} ±58.2	105.0^{B} ± 31.2	<0.001
Vitamin B_6, mg	1.9 ± 0.6	1.9 ± 0.7	1.5 ± 0.4	143.6^{a} ±46.1	139.1 ± 44.2	112.8^{b} ± 30.1	0.020
Vitamin B_{12}, µg	3.8 ± 2.4	4.1 ± 4.0	3.3 ± 2.3	189.2± 121.5	203.4± 195.3	167.1± 113.0	0.718
Folate, µg	291.9 ±101.1	291,5 ± 109.7	223.9 ± 86.1	88.1 ± 31.6	91.1^{a} ± 34.3	70.0^{b}± 26.9	0.027
Vitamin PP, mg	18.1 ± 6.0	17.4 ± 5.1	12.6 ± 4.2	163.0^{A} ±55.5	155.7^{A} ±45.4	114.7^{B} ± 37.8	0.005
Vitamin C, mg	79.9 ± 64.5	96.1 ± 71.1	68.8 ± 43.4	133.1± 107.4	153.8± 109.3	114.7 ± 72.9	0.501
Water, ml	1593.3 ±462.5	1599.6 ± 619.7	1224.4 ±332.7	79.7^{a} ± 23.1	80.0^{a} ± 31.0	61.2^{b} ± 16.6	0.021
Protein, % energy	17.0 ± 3.6	17.6 ± 3.1	17.5 ± 2.9	113.5^{B} ±24.1	181.3^{A} ±55.4	116.9^{B} ± 19.0	<0.001
Fat, % energy	31.2 ± 5.2	31.5 ± 6.3	32.1 ± 5.9	104.1 ± 17.3	104.9 ± 20.9	107.0 ± 19.9	0.986
Carbohydrates, % energy	51.8 ± 5.4	51.0 ± 5.8	50.4 ± 6.8	94.1 ± 9.8	92.7 ± 10.6	91.6 ± 12.4	0.616
Sucrose, % energy	10.9 ± 5.0	10.2 ± 4.1	8.1 ± 4.3	109.2 ± 50.3	101.9 ± 40.6	80.9 ± 43.4	0.124

a, b –means denoted with the different letters are statistically significant difference $p \leq 0.05$; A, B – means denoted with the different letters are statistically significant difference $p \leq 0.01$

The qualitative dfr analysis of the subjects has shown that only 2/3 of them consumed the recommended number of meals, while the appropriate glycaemia of the organism, ensured by 4-5 meals consumed in a day, in intervals of 3 to 3,5 hours, is one of the conditions of uninterrupted sleep at night. Skipping main meals (lunch, afternoon tea and supper) is the reason why the respondents snacked, even in the evening and at night. It has been indicated [2] that such snacking is less satisfying, results in hyperglycemia which leads to sleep deprivation, and in the next morning it results in a higher energy intake, which promotes fat tissue accumulation. Moreover, snacking, especially in the form of sweets and bakery products, may cause a lack of appetite for main meals, thus supplying the body with a smaller quantity of nutrients.

What is worrying is the fact that only 64-86% of the subjects consumed breakfast, which should take the form of light protein and vegetables. It is subsequent to the fact that vitamin B12, folic acid and magnesium are necessary for biosynthesis of dopamine and noradrenalin neuro hormones (from tyrosine amino acid). Particularly in the elderly, these neuro hormones influence muscular tone and thinking processes, thus increasing mental efficiency and wakefulness. In the analyzed dfr of the subjects, despite the sufficient supply of tyrosine and vitamin B_{12}, a low intake of

foliates and magnesium was ascertained, which could have influenced the biosynthesis of neuro hormones, thus disrupting the state of wakefulness and leading to napping.

should be eaten 3-4 hours before going to bed at the latest, so that it does not lead to late emptying of the stomach and not to cause lowered glucose tolerance and disturbance in lipedema. A supper also should

Table 5. Content of amino acids and value of PDCAAS indicator in daily food rations of examined women (Mean ± SD, n = 330 menus)

Essential amino acids, g×100 g	Mean ± SD			Amino acid in a protein standard, g×100 g (FAO/WHO 2013)	PDCAAS (CS x 0.9)			*p*
	60-65 years (n = 117)	66-75 years (n = 156)	>75 years (n = 57)		60-65 years (n = 117)	66-75 years (n = 156)	>75 years (n = 57)	
Isoleucine	3.7 ± 1.1	3.6 ± 1.1	2.9 ± 0.9	3.0	111.1^{a}± 33.2	108.2 ± 33.3	86.5^{b} ± 26.5	0.007
Leucine	5.9 ± 1.8	5.7 ± 1.8	4.6 ± 1.5	5.9	90.1^{a} ± 27.0	86.2 ± 27.6	69.9^{b} ± 23.4	0.009
Lysine	5.2 ± 1.6	5.1 ± 1.7	4.1 ± 1.4	4.5	104.0^{a} ± 31.3	102.5 ± 33.0	82.4^{b} ± 28.0	0.014
Methionine+ Cysteine	3.0 ± 0.9	2.9± 0.9	2.3 ± 0.7	2.2	123.4^{a} ± 36.9	117.4 ± 35.7	94.9^{b} ± 29.3	0.006
Phenylalanine + Tyrosine	6.1 ± 1.8	5.8 ± 1.9	4.8 ± 1.6	3.8	145.5^{a}± 43.7	139.9 ± 45.2	113.1^{b} ± 37.5	0.012
Threonine	3.1 ± 0.9	3.1 ± 0.9	2.5 ± 0.8	2.3	122.9^{a} ± 35.3	119.8 ± 37.5	97.3^{b} ± 32.5	0.011
Tryptophan	1.0 ± 0.3	1.0 ± 0.3	0.8 ± 0.2	0.6	148.5^{a} ± 42.6	145.8 ± 43.6	119.4^{b} ± 36.5	0.017
Valine	4.4 ± 1.3	4.3 ± 1.3	3.5 ± 1.1	3.9	101.5^{a} ± 29.5	99.1 ± 30.5	81.1^{b}± 25.0	0.017

CS – *Cheiacal Score*; PDCAAS - *Protein Digestibility-Coreected Amino Acid Score*;
a, b –means denoted with the different letters are statistically significant difference $p \leq 0.05$;

Table 6. Consumption of selected foodstuffs in daily food rations by the female subjects during the period of the survey (Mean ± SD, n = 330 menus)

Foostuffs, g	Mean ± SD			Implementation of model food rations (%)			*p* value
	60-65 years (n = 117)	66-75 years (n = 156)	>75 years (n = 57)	60-65 years (n = 117)	66-75 years (n = 156)	>75 years (n = 57)	
Wheat and rye bread	105.1±85.1	113.7±61.4	76.6±41.7	52.5±42.5	56.9±30.7	38.3±20.8	0.147
Flour, pasta	37.4±55.9	40.0±60.4	52.5±60.3	62.3±93.2	70.0±100.6	87.4±100.6	0.736
Groats, rice, breakfast cerals	48.3±48.5	43.8±59.8	37.2±40.4	108.0±191.5	175.2±239.3	93.0±161.6	0.359
Potatoes	121.4±105.4	158.6±109.5	121.3±111.4	48.5±42.2	63.4±43.8	48.5±44.6	0.154
Vegetables	188.8±97.7	239.1±131.0	173.1±149.9	37.8±19.5	47.5^{a}±26.2	34.6^{b}±30.0	0.037
Pulses seeds and nuts	7.5±15.8	6.6±15.4	5.7±18.8	75.4±158.5	65.9±153.6	57.0±187.8	0.451
Fruits	223.8±216.2	196.8±174.4	174.6±108.9	78.9±72.1	65.6±56.8	58.2±36.3	0.700
Milk and milk fermented beverages	103.4±95.3	100.9±108.8	114.2±128.5	20.7±19.1	20.2±21.8	22.8±25.7	0.555
Fresh cheeses	43.8±47.7	42.5±40.9	30.2±24.7	62.6±68.1	60.8±58.4	43.2±35.3	0.955
Ripening cheeses	15.6±29.8	9.3±13.5	2.1±5.0	104.1^{a}±198.9	61.8±90.1	14.0^{b}±33.2	0.023
Meat, poultry	116.7±102.2	126.5±66.1	62.6±45.8	155.6±136.2	168.6^{A}±88.1	83.5^{B}±61.1	< 0.00
Sausages	34.1±33.2	21.3±26.6	30.4±36.1	136.4±132.8	85.4±106.3	121.8±144.1	0.404
Fish	22.7±37.9	26.8±36.6	22.3±31.6	75.6±126.2	89.3±121.9	74.3±105.3	0.669
Eggs	29.1±34.2	18.1±26.3	22.6±19.9	174.6±203.6	108.2±157.3	135.4±119.4	0.316
Animal fats	22.9±34.3	20.4±17.5	14.5±12.3	152.4±228.5	135.7±116.9	96.7±82.2	0.222
Vegetable fats	1.7±3.7	3.0±5.6	4.3±4.7	11.1^{b}±25.0	19.9±37.3	28.4^{a}±31.6	0.039
Mixed fats	3.7±9.8	0.2±0.7	0.9±2.2	70.5^{A}±196.3	3.6^{B} ±13.3	17.4±43.1	< 0.00
Sugar and sweets	85.3±105.4	81.8±74.4	53.3±58.7	189.6±234.3	181.1±165.3	118.5±130.0	0.426

a, b –means denoted with the different letters are statistically significant difference $p \leq 0,05$; A, B –means denoted with the different letters are statistically significant difference $p \leq 0,01$;

A light and well-composed supper is one of the most significant meals which affect sleep patterns. It

not be the cause of hypoglycaemia and deterioration of muscle protein (sarcopenia), to which elderly

people are especially exposed [8]. Therefore, during the two-month nutrition education the subjects were instructed that for supper they should eat, first of all, complex carbohydrates with low glycemic index and load (groats, rice, pasta) with vegetables and protein containing tryptophan, from which serotonin, with cooperation of vitamins B_6, B_{12} and folic acid is produced in the brain as a precursor of the biosynthesis of melatonin, the sleep hormone [20]. It is on the synthesis of this hormone that the quantity and quality of our sleep depends.

The reported sleep disorders could have been influenced by the low energy value of the subjects' diets, as it has been shown that lowering the energy intake below 300 kcal a day decreases melatonin concentration in the blood even by about 20%. Moreover, a low intake of assimilative carbohydrates could have an influence on pinealocytes, which need certain minimum of glucose for proper functioning. However, it should not come from the foodstuffs containing monosaccharides, and as dfr analysis of the respondents indicated, the subjects consumed their higher quantity than it is recommended. These products stimulate hyperglycemia and hypoglycemia symptoms, disturb appetite regulation in hypothalamus by changes in hunger and satiety center and influence growth of serotonin genes expression (*Sert*), especially among females [10, 22]. Thus, in the course of the nutrition education, the subjects were recommended to eat vegetables and fruit rich in, for instance, fiber, which improves glucose tolerance and physiological mechanisms regulating its concentration in blood. This is especially crucial as among the subjects were women with diagnosed and treated high blood pressure, type 2 diabetes and atheromatosis.

Polyunsaturated amino acids (PUFA) are necessary for building and appropriate functioning of pineal gland, while a low intake of docehexanoic acid (DHA) has an impact on a decrease in melatonin synthesis. The conducted dfr analysis has indicated high contents of energy coming from fats, mainly those constituted in saturated fatty acids, resulting from a high intake of meat and eggs. However, a low consumption of fish, which are a good source of PUFA acids, was ascertained, therefore during their nutrition education the subjects were recommended to eat fish twice to three times a week.

Vitamins are cofactors in enzymatic reaction of transformation of amino acids into functional transmitters, which regulate, for instance, the sleep-wake cycle. The lowest intake of vitamin B_1, evident among the oldest respondents, might lead to its deficiency in the organism, which results in transketolation disorders taking place during oxidational metabolism of glucose, especially in the nervous system, which draws energy only from its transformation [11]. On the other hand, despite the appropriate intake of vitamin B_6, the observed low intake of foliates among the respondents might have led to decreased melatonin synthesis, especially in the oldest women. What is more, the deficiency of an active form of vitamin B_9 (5-metylotetrahydrofoliate) leads to mood disruptions, which are also one of the causes of sleep disorders.

A low intake of vitamin D_3 among the subjects might directly cause the decrease of synthesis and transmission of serotonin, leading to mood imbalance and lowering of melatonin synthesis. Indirectly, it may also lead to osteoarticular pain and inappropriate glycaemia, especially in people with type 2 diabetes [15].

Zn, Ca, Mg, Fe, Cu and Se, which are the ingredients of cerebrospinal fluid, are those minerals which are important in the synthesis of neurotransmitters conditioning the sleep-wake cycle. This research has shown a low intake of potassium and magnesium among the subjects, which might be the cause of disruptions in the active transportation of calcium through cell membranes, thus affecting the transmission of nerve impulses and indirectly influencing pathogenesis of sleeplessness.

What is also crucial in the appropriate and uninterrupted sleep cycle is the quantity and quality and drunk liquids and the times when liquids are drunk in a 24-hour cycle. Liquids should not be drunk directly before sleep (except when necessary to administer medicine), because increased diuresis causes night wakening, which is especially inconvenient for elderly people. A low intake of liquids observed among the subjects could be explained by inhibited thirst occurring in old age, and anxiety of frequent diuresis. During the nutrition workshops the subjects' attention was called to the quantity and types of drank liquids, as well as the quantity of caffeine consumed with various products (foodstuffs or medicine). On the one hand, a reasonable caffeine consumption (100 – 300 mg/24 hours) influences the increased secretion of catecholamine, stimulating the central nervous system, which positively affects mental and physical efficiency, thinking, concentration, decrease in tiredness and sleepiness. On the other hand, the caffeine contained in coffee and/or strong tea has elongated pharmacological activity from 8 to 14 hours in the elderly because of a decreased liver metabolism; that is why consuming caffeine in the late afternoon or evening hours increases diuresis during the night, which becomes the reason of sleep deprivation.

Taking into account the fact that the subjects are ageing, it is worth emphasizing that the analysis of nutritious value of the protein intake has indicated that significantly the lowest intake of amino acids was observed in the oldest subjects, in comparison to amino acids contained in standard protein FAO. In diets of all

groups of subjects leucine was the amino acid limiting the utilization of the consumed protein, including tryptophan, in spite of its significant quantity in the diets. It resulted from the low intake of foodstuffs which are its natural source, such as leguminous seeds and nuts, fish and dairy products. Insufficient intake of leucine, which takes part in protein metabolism, growth hormone synthesis and appropriate glycaemia, might be also the reason behind the catabolism of muscle protein and inhibited tissue rebuilding. Therefore, during their nutrition education it was recommended that the subjects provide themselves with all necessary amino acids, that is, animal source foods: light cottage cheese, lean poultry, lean fish from fresh water and seas and eggs. They should be supplemented with plant protein mainly from legumes seeds, wheat products, vegetables, fruit and nuts.

To summarize, the inappropriate nutrition habits of the subjects (particularly the oldest group) predestines them to suffer from the reported sleeping disorders as well as well-being deterioration after sleepless nights, as it is possible that their dietary intake habits influence the synthesis of neurotransmitters regulating the sleep-wake cycle and melatonin.

CONCLUSIONS

1. The nutritional habits of subjects in all age groups was characterized by an unbalanced intake of energy and nutritive value, which could have affected the proper synthesis of neurotransmitters regulating sleep-wake cycle and melatonin hormone.
2. It is essential to provide pro health education to elderly women, which mentions dietary intake habits as well as sleeping hygiene.

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Conflict of interest

The authors declare no conflict of interest.

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