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ORIGINAL ARTICLE

THE EFFECTIVENESS OF NUTRITIONAL EDUCATION AMONG WOMEN AGED 60-85 ON THE BASIS OF ANTHROPOMETRIC PARAMETERS AND LIPID PROFILES

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ABSTRACT

Background. After several years of experience with guiding of an original program on health-promoting nutritional education for women during menopause, which by inducing changes in nutritional behaviour resulted in many favorable health promoting effects, on request of the students of the Association of Third Age University, an original educational program "Comprehensive stimulation of senior citizens to activity" was developed out and implemented.
Objective. The objective of this study was to assess the effectiveness of four-month nutritional education and adjustments in diets of women aged 60-85, on the basis of the measurements of the selected lipid parameters in their blood tests.
Material and methods. This research project was joined by 37 female subjects aged 60-85, who are the members of the University of the Third Age in Szczecin, and whose average BMI was 31.7 kg/m^2. Before the nutritional education commenced and after it was completed, the female subjects' nutritional status was assessed (BMI, WC, WHR, WHtR) and the energy and nutritional value of their diets was examined based on the subjects' regular journal-keeping. *Keys' atherogenic* score in their diets were also computed.
Results. The applied nutritional education led to changes in the energy and nutritional value of the female subjects' diets, which specifically improved their anthropometric parameters and the resulting BMI, WC and WHtR parameters. This fact was also reflected in a substantial decrease of the glucose level and a substantial increase of HDL-C level in the blood of the examined female subjects, as well as in the improvements in the assessed parameters TC/HDL-C, LDL-C/HDL-C, TG/HDL-C.
Conclusions. The analysis of the results allows to confirm, that the four-month nutritional education of elderly women resulted in changes of their erroneous dietary habits and an improvement in their nutrition.

Key words: *old elderly women, nutritional education, lipid parameters and indexes*

STRESZCZENIE

Wprowadzenie. Prowadząc od wielu lat autorski program prozdrowotnej edukacji żywieniowej dla kobiet w okresie menopauzalnym, która poprzez zmiany w zachowaniach żywieniowych powodowała wiele korzystnych i tym samym prozdrowotnych efektów, na prośbę słuchaczek Stowarzyszenia Uniwersytetu Trzeciego Wieku, opracowano i zrealizowano autorski program edukacyjny pt." Wszechstronna aktywizacja seniorów".
Cel. Celem pracy była ocena skuteczności czteromiesięcznej edukacji żywieniowej i zmian zachowań żywieniowych kobiet w wieku 60-85 lat na zmiany profilu lipidowego krwi w oparciu o wybrane wskaźniki lipidowe.
Materiał i metody. W badaniach udział wzięło 37 kobiet słuchaczek szczecińskiego Stowarzyszenia Uniwersytetu Trzeciego Wieku, w wieku 60-85 lat, o średniej wartości BMI 31,7 kg/m^2. Przed rozpoczęciem i po zakończeniu szkolenia dokonano oceny stanu odżywienia kobiet (BMI, WC, WHR, WHtR) oraz oceny wartości energetycznej i odżywczej jadłospisów uzyskanych metodą bieżącego notowania. Obliczono również wskaźnik aterogenności diety *Keys'a*. Na podstawie wyników stężenia glukozy oraz parametrów gospodarki lipidowej (TG, TC, LDL-C, HDL-C) w surowicy krwi badanych kobiet wyliczono i zinterpretowano wybrane wskaźniki lipidowe (TC/HDL-C, LDL-C/HDL-C, TG/HDL-C oraz HDL-C/TC).
Wyniki. Stwierdzono, że przeprowadzona edukacja żywieniowa miała wpływ na zmiany wartości energetycznej i odżywczej diet kobiet, co indywidualnie przyczyniło się do poprawy cech antropometrycznych i wyliczonych na ich podstawie wartości wskaźników BMI, WC i WHtR. Znalazło też odzwierciedlenie w istotnym spadku stężenia glukozy i istotnym wzroście stężenia frakcji HDL-C w krwi badanych kobiet oraz w korzystnych zmianach wartości wyliczonych wskaźników TC/HDL-C, LDL-C/HDL-C, TG/HDL-C.
Wnioski. Analiza uzyskanych wyników pozwoliła na stwierdzenie, że 4-miesięczna edukacja żywieniowa starszych kobiet spowodowała zmiany ich nieprawidłowych zachowań żywieniowych oraz poprawę sposobu żywienia.

Słowa kluczowe: *kobiety w wieku starszym, edukacja żywieniowa, parametry i wskaźniki lipidowe*

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INTRODUCTION

Recently, life expectancy in Poland has lengthened and currently Polish women's life expectancy is 81 years. According to various authors, this is mainly due to a decrease in the mortality rates caused by cardiovascular diseases. The National Health Programme has undertaken its strategic goal in the years 2016-2020 to lengthen life expectancy of Poles to improve their quality of life and to counter social inequalities in terms of health [12].

The improvement in life expectancy and the social and cultural changes which take place in Poland result in the fact that during their retirement many women decide to join various groups and associations, and take up hobbies and interests once their professional career is complete. One of those forms include education, for instance nutritional education.

The effectiveness of this education has been confirmed by our earlier research concerning women aged 65-85. It has been affirmed that the rules of proper nutrition learned and later applied by the subjects have had a positive effect on their body weight and those blood parameters [6] as well as their body composition and the fat tissue loss [7].

Therefore, in our next original education programme titled "Comprehensive stimulation of senior citizens to activity", commissioned by the Health and Social Policy Department at Szczecin City Council (WZiPS-IV/WP/12/2012), we have decided to assess an influence of a four-month pro-health nutritional education and diet modification in women aged 60-85 on their blood lipid profile, on the basis of selected lipid parameters in the diet and in the blood.

MATERIALS AND METHODS

56 women underwent the educational programme, and 37 of them were qualified for tests; aged 60 to 85 (69.9±6.3), they were students of Third Age University in Szczecin. A disqualifying factor was the type of medication used by the subjects.

The four-month educational programme, covering nutritional education, was run between October and January and comprised of weekly classes lasting 90 minutes each (lectures and workshops). The programme covered the following subjects: basic information on the functioning of the digestive system, changes resulting from aging and dietary recommendations for the elderly, nutrient sources and requirements and their physiological role, vitamins, micro- and macroelements, the role of water in the digestive system and the general water balance in the body. Other topics covered elements of human physiology, nutritional physiology, dietetics and pathophysiology of the elderly. The workshops covered the meal composition and preparation, reading food labels, choosing the products with the right glycemic index, etc.

On the basis of the subjects' menus, the second week of the programme covered the basic corrections of nutritional routines of the subjects, which included: regulating the time, amount and type of meals, and explaining the beneficial impact of these modifications for the human body. Further recommendations were implemented individually, according to the issues discussed in the course at the time and individual needs. These recommendations concerned the amounts of certain nutrients, according to current recommended dietary requirements [11] and recommendations of the experts from the research group PROT-AGE [1]: protein – 1g per 1 kg of the current body weight, with ±30% of animal protein, and for the overweight – no more than 25% of the caloric value of a daily ration; carbohydrates – 60% of the caloric value of a daily ration [11], but no more than 10% of energy coming from sucrose [28]. The source of particular nutrients and their beneficial impact on the body were also discussed.

Information about the subjects' nutrition was received twice: before the education programme commenced and after its conclusion. After prior instruction, the subjects individually noted down the time, type and amount of consumed food during 24 hours, in three randomly selected days of the week, including one day of the weekend. The size of the portions was established on the basis of the "Photograph album of food and dishes' [25]. 111 full-day food rations, gained from the subjects' regular journal-keeping, were compiled with the use of a computer programme "Dieta 5D" from the National Food and Nutrition Institute, Warsaw, Poland establishing the food intake for each day, and subsequently an average intake from 3 days, which was later individually compared: energy to estimated energy requirement (EER), vitamins and mineral elements (A, B1, B2, B6, B12, niacin, C, Ca, P, Mg, Fe, Zn, Cu) to the estimated average requirements (EAR) and (D3, E, Na, K, water) to the adequate intake (AI) according to age and sex [11].

Keys' atherogenic score was also established, as it allows to assess the risk of cardiovascular diseases, according to the formula: 1.35 x (2 x % energy from polyunsaturated fatty acids) + 1.5x$\sqrt{}$(cholesterol/1000 kcal) [15].

Before and after the educational programme, the antopometric measurements of the female subjects were made: the body weight in light clothes, measured with the use of medical sales Radwag WPT- 200; height in the standard anatomical position, measured with the use of a stadiometer SECA 215; and waist circumference, measured in the middle of the distance between the lower costal margin and the upper iliac crest, with the use of *Gulick's* anthopometric tape. On the basis of thus collected anthopometric data, the following parameters were computed: BMI (Body Mass Index) according to the formula: body weight [kg]/height $[m]^2$ [17]; WC (Waist Circumference); and WHtR (Waist-to-Height Ratio) [18].

Each student gave her consent after consultation with her GP in order to synchronize the recommended periodic health examinations. Subsequently, in the Central Laboratory of the Curie-Sklodowska Polyclinical Hospital in Szczecin, the subjects' blood samples were taken twice: in early October, and after the educational programme was concluded (end of January). The blood samples were taken between 7.30 am and 8.00 am from the basilic vein. In the centrifuged blood serum, the following concentration levels were marked: glucose GL (enzymatic hexokinase method), triacyroglicerole TG (enzymatic colorimetric assay) and its fractions LDL-C i HDL-C (colorimetric enzymatic assay). The marking was done in a closed suction system, with the use of reagents from Roche Diagnostica, on COBAS C6000. The results were compared to those recommended by the European Heart Journal [22].

On their basis, the lipid profiles in the blood serum were established and correlated with the risk of cardiovascular diseases [3, 19, 20, 23]. These included: TG/HDL-C (AIP Atherogenic Index of Plasma); TC/HDL-C (CRI-I Castelli's Risk Index); LDL-C/HDL-C (CRI-II Castelli Risk Index); (TC– HDL-C)/HDL-C (AC Atherogenic Coefficient) and HDL-C/TC.

The measured level of glucose was referenced against the recommendations of the Polish Diabetological Association. The data concerning the lipid profiles was referenced against the recommendations of the European Society of Cardiology [22].

After The Shapiro–Wilk test of normality and the Levene's test for the equality of variances were applied, a logarithm was used against the results (for normality) and to conduct statistical measurements with the use of T test, for connected variables, with statistical significance of $p \leq 0.05$ $p \leq 0.01$, with the use of a computer statistical program Statistica® 10.0.

RESULTS

The analysis of full-day food rations, noted down by the female subjects before the commencement of the nutritional education programme (Table 1), has shown that the caloric value of the analysed menus covered only 79% of the requirements. It has been established that the amount of consumed digestible carbohydrates, fibre, potassium, calcium and D_3 vitamin was insufficient, while the consumption of animal protein, general fat and mineral elements Na, P, Fe, Zn, Cu and A, B_2, B_{12}, PP vitamins was excessive. The caloric value coming from the basic nutrients in the analysed menus (Table 2) varied from the recommended amounts and the value was too high for protein and fat and too low for carbohydrates.

The four-month nutritional education and individual adjustment of subjects' diets have caused a significant ($p \leq 0.01$) increase in the caloric value of the diet (95.4% EAR), a significant ($p \leq 0.01$) increase in fibre and D_3, E, B_6 and C vitamin consumption, with an insignificant increase of digestible carbohydrates consumption and a decrease in the consumption of animal protein and a significant decrease ($p \leq 0.01$) in the consumption of A and B_2 vitamins. The changes in the consumption of the caloric energy, cholesterol and saturated fatty acids led to a significant ($p \leq 0.01$) decrease in Keys' atherogenic score (Table 1).

Amendments in nutrition have also caused a significant ($p \leq 0.01$; $p \leq 0.05$) decrease in the contribution of energy coming from fats and sucrose and a significant ($p \leq 0.01$) increase of that coming from carbohydrates. A smaller consumption of energy coming from saturated fatty acids was also established (Table 2).

Advantageous influence of education could also be noticed in favourable changes in the intervals of percentage of people realizing the values recommended in standards (Table 1 and Table 2).

The analysis of the results led to a conclusion that the educational programme and diet adjustment have significantly ($p \leq 0.01$) influenced the change in anthropometric parameters (Table 3). During the four-month nutritional education programme the average weight loss was 2.7 kg, and the greatest weight loss was 9 kg. The implemented education program has significantly ($p \leq 0.01$) influenced the waist circumference, which on average became smaller by 2.6 cm (the largest reduction of this parameter was 9 cm). The introduced changes have led to a significant ($p \leq 0.01$) decrease of WC and WHtR parameters.

Adjustments in nutrition of the examined female subjects have also influenced the selected parameters of the metabolism of carbohydrates and lipids (Table 4). A significant ($p \leq 0.05$) decrease in the glucose level in the blood was established among 46% of subjects. A decrease in the level of triacyrogliceroles, total cholesterol and its fraction LDL-C were also observed, but these changes were not statistically significant. However, an increase in HDL-C fraction was significant, and in all subjects it exceeded the reference level of 46 mg/ml.

The established positive changes in the lipid parameters of the blood were reflected in the levels of the examined lipid profiles. The average level of TC/HDL-C (CRI-I) before the educational programme was 4.3 and it was higher than the recommended level by <4.0. After the educational programme, it was significantly ($p \leq 0.05$) reduced to a more acceptable 3.5. A positive decrease in this parameter was evident in 38% of the subjects.

Table 1. Energy value and nutrients levels in daily food rations of women before and after the nutrition awareness course ($\overline{X} \pm SD$, n=111 menus)

Components	Intake		% of daily allowance EAR or AI		Statistically significant	Percentage of food rations implementing EAR or AI					
						<90		90-110		>110	
	before education	after education	before education	after education		before education	after education	before education	after education	before education	after education
Energy (kcal)	1492.3±404.4	1777.6±144.4	79.4±23.0	95.4±8.5	**	68.2	27.7	26.4	69.6	5.4	2.7
Total protein (g)	67.5±17.3	72.1±13.4	93.8±24.0	100.1±18.6	-	43.2	21.6	43.3	62.2	13.5	16.2
Animal protein (g)	48.6±11.2	46.0±15.3	202.5±46.5	191.7±63.8	-	8.1	0	0	0	91.9	100
Total fat (g)	58.6±18.9	62.0±13.1	111.7±23.6	105.7±34.2	-	37.8	16.2	19.0	40.6	43.2	43.2
Cholesterol (mg)[1]	226.6±76.6	200.5±73.6	75.5±25.5	66.8±24.5	-	78.3	91.9	13.6	2.7	8.1	5.4
Saturated fatty acids (g)[2]	21.4±7.2	17.9±3.6	DRV		-						
Polyunsaturated fatty acids (g)[2]	10.0±4.5	11.7±3.8	DRV		-						
Keys indicator[3]	47.3±14.6	32.1±5.1	135.0±41.8	91.8±14.7	**	18.9	40.5	2.7	51.4	78.4	8.1
Assimilable Carbohydrates (g)	172.6±65.4	179.1±29.6	57.5±21.8	59.7±9.9	-	86.5	100	10.8	0	2.7	0
Dietary fibre[4] (g)	17.7±5.4	24.9±5.4	59.1±18.1	82.9±17.9	**	91.9	64.9	5.4	27.0	2.7	8.1
Sodium (mg)	1662.7±740.2	1674.6±512.5	134.0±41.0	133.0±59.2	-	13.5	18.9	18.9	18.9	67.6	62.2
Potassium (mg)	3045.1±817.4	3360.0±580.7	64.8±17.4	71.5±12.4	*	89.2	94.6	8.1	5.4	2.7	0
Calcium (mg)	538.4±106.5	618.5±249.2	53.8±10.7	61.8±24.9	-	81.1	100	10.8	0	8.1	0
Phosphorus (mg)	1160.6±189.8	1101.2±273.6	200.1±32.7	189.9±47.2	-	0	0	0	0	100	100
Magnesium (mg)	270.0±76.9	296.3±64.9	101.9±29.0	111.8±24.5	-	43.2	18.9	27.1	40.6	29.7	40.5
Ferrum (mg)	10.5±1.8	9.9±2.9	174.3±30.2	164.6±48.1	-	0	0	8.1	0	91.9	100
Zinc (mg)	8.9±2.1	8.3±1.4	130.3±31.1	122.1±20.2	-	8.1	2.7	18.9	27.1	73.0	70.2
Copper (mg)	1.3±0.2	1.1 ±0.3	155.0±46.4	189.9±32.8	**	0	0	13.5	0	86.5	100
Retinol Equivalent (µg)	1254.4±523.4	781.2±320.9	250.9±104.7	156.2±64.2	**	8.1	0	21.6	0	70.3	100
Vitamin D_3 (µg)	3.6±4.6	10.1±2.2	24.3±30.5	70.8±29.2	**	94.6	86.5	0	5.4	5.4	8.1
Vitamin E (mg)	8.4±3.8	12.3±3.5	104.7±48.1	154.2±43.8	**	56.8	5.4	13.5	2.7	29.7	91.9
Vitamin B_1 (mg)	0.8±0.2	0.8±0.2	92.4±26.4	89.2±21.6	-	56.8	62.2	27.0	21.6	16.2	16.2
Vitamin B_2 (mg)	1.5±0.2	1.4±0.3	169.7±23.8	154.6±37.2	*	0	0	10.8	0	89.2	100
Vitamin B_6 (mg)	1.4±0.4	1.8±0.4	109.7±29.8	139.5±31.8	**	35.1	2.7	27.1	73.0	37.8	24.3
Vitamin B_{12} (µg)	3.5±2.2	4.4±2.7	172.7±107.1	218.9±135.9	-	10.8	2.7	8.1	18.9	81.1	78.4
Witamin PP (mg)	15.8±4.5	15.6±4.5	143.4±40.5	142.2±41.0	-	0	8.1	24.3	18.9	75.7	73.0
Witamin C (mg)	75.3±36.7	191.4±83.5	125.5±61.2	319.0±139.1	**	32.5	0	8.1	0	59.4	100
Water (g)	2013.3±512.4	2085.6±569.1	100.7±25.6	104.3±28.5	-	43.2	27.0	24.3	32.5	32.5	40.5

* – statistically significant difference $p \leq 0.05$; **- statistically significant difference $p \leq 0.01$;
1 – reference to the maximum recommended intake 300 mg/day
2 – the lack of reference values DRV (*Dietary Reference Values*)
3 – reference to the recommended limit values 35
4 – reference to the recommended amount 30g

Table 2. Percentage of protein, carbohydrates and lipids in daily food rations of women before and after nutritional education course ($\overline{X}$± SD, n=111 menus)

Components	Intake		% of daily allowance		Statistically significant	The percentage of food rations implementing					
						<90		90-110		>110	
	before education	after education	before education	after education		before education	after education	before education	after education	before education	after education
Protein	18.8±4.5	17.8±2.2	125.4±30.3	119.0±15.2	-	2.7	5.4	40.5	18.9	56.8	75.7
Carbohydrates	46.5±8.5	55.7±6.2	77.4±14.1	89.5±11.0	**	89.2	35.1	5.4	59.5	5.4	5.4
Saccharose	9.6±3.1	8.1±3.7	80.9±37.5	95.9±30.6	*	64.9	51.3	13.5	24.4	21.6	24.3
Fat:	35.4±5.2	29.4±6.6	141.7±20.7	117.8±26.6	**	21.6	0	13.5	0	64.9	100
Saturated[1]	13.9±6.0	9.1±2.0	not determined DRV		-						
Polyunsaturated[1]	6.4±3.4	6.0±2.2	not determined DRV		-						

1 –DRV (*Dietary Reference Values*)
*- statistically significant difference $p \leq 0.05$; **- statistically significant difference $p \leq 0.01$;

Table 3. Changes in body weight. BMI, WC and WHtR of obese women exposed to 4-month-long health-enhancing nutrition awareness course ($\overline{X}$ ± SD, n=37)

Trait	Before education	After education	Change in the traits	Statistically significant
Body weight (kg)	79.8±12.2 58.7 - 103.0	77.1±11.2 56.6 - 97.0	2.7±2.3	**
Body height (cm)	158.6±7.1 143.0 - 171.0	158.6±7.1 143.0 - 171.0	-	-
BMI (kg/m^2)	31.7±4.5 24.1 - 44.5	30.6±4.0 24.0 - 39.9	1.1±1.0	**
BMI	(%)			
<22 (underweight)	0	0	-	
22-23 (risk underweight)	0	0	-	
24-27 – (normal)	13.5	13.5	-	
27- 32 – (overweight)	37.8	48.7	10.9	
>32 (obesity)	48.7	37.8	10.9	
Waist circumference (cm)	100.4±10.9 77.0 - 121.0	97.9±10.0 77.0 - 121.0	2.6±2.8	**
WHtR (cm/cm)	0.63±0.08 0.49 - 0.89	0.62±0.07 0.45 - 0.85	0.02±0.2	**

*- statistically significant difference $p \leq 0.05$; **- statistically significant difference $p \leq 0.01$;

Table 4. Effects of health-promoting nutritional education and changed dietary habits on serum concentration of chosen indicators ($\overline{X}$ ± SD, n=37)

Indicator	Normative values	Before education		After education		Statistically significance
		$\overline{X}$ ± SD	percent of women with abnormalities	$\overline{X}$ ± SD	percent of women with abnormalities	
GL (mg/dl) Min - Max	< 99	103.3±18.9 80.0 – 165.0	89.2	94.5±11.7 80.0 – 135.0	45.9	*
TG (mg/dl) Min - Max	<150	120.9±41.2 62.0 – 219.0	43.2	113.3±30.4 60.0 – 201.0	40.5	-
TC (mg/dl) Min - Max	<190	214.4±43.7 153.0 – 348.0	75.9	209.4±28.7 172.0 – 305.0	75.9	-
LDL – C (mg/dl) Min - Max	< 115	126.7±34.8 69.0 – 18.0	59.5	118.6±24.8 83.0 – 190.0	48.6	-
HDL –C (mg/dl) Min - Max	>46	52.5±11.9 32.0 – 77.0	24.3	62.4±9.7 47.0 – 80.0	0	**
TC/HDL-C Min - Max	<4.0	4.3±1.6 2.3 – 10.9	56.8	3.5±0.9 2.4 – 6.5	18.9	*
LDL-C/HDL-C Min - Max	<3.0	2.6±1.1 1.1 – 6.8	27.0	2.0±0.7 1.2 – 4.0	10.8	*
TG/HDL-C Min - Max	<3.0	2.5±1.1 1.1 – 5.3	64.9	1.9±0.9 0.8 – 3.3	5.4	*
HDL-C/TC Min - Max	>0.24	0.25±0.1 0.09 – 0.43	91.9	0.30±0.2 0.15 – 0.41	70.3	**

*- statistically significant difference $p \leq 0.05$; **- statistically significant difference $p \leq 0.01$;

Likewise, the lipid profile parameter LDL-C/HDL-C (CRI-II), which is correlated with metabolic syndrome, after a change in diet has been significantly ($p \leq 0.05$) reduced (on average from 2.6 to 2.0) among 16% of subjects.

Similarly, the level of parameter TG/HDL-C (API), which is used to assess the risk of atherosclerosis due to the link between hyperlipidemia and insulin resistance, has decreased significantly ($p \leq 0.05$) in 59.5% of subjects, and a significant ($p \leq 0.01$) increase in the parameter HDL-C/TC shows a decrease in the risk of the coronary artery disease.

DISCUSSION

The main factor which influences the nutrition of a body is a varied and full diet, adjusted to one's age. The assessment of subjects' diets before the commencement of the four-month nutritional education programme showed that there was a number of irregularities in their diets, both in terms of their caloric and their nutritious values. These were irregularities that were easy to correct; therefore, the objective of the educational programme was to improve the nutritional habits of the subjects in terms of the amount of food consumed, the times and regularity of meals, and the choice of the sources of basic nutrients. On the other hand, the individual adjustments in diets were supposed to personalize dietary recommendations, but without a specialist dietary guidance when it comes to existing disorders.

The results were influenced by a number of factors, one of them being the subjects' age (from 60 till 85), which determined the pace and the range of implemented adjustments. Another important influence on the form of this research was an argument provided by the subjects: "*if I want to treat myself, I will take the right medicine*…" However, the most influential factor was, as usual, a possibility of weight loss. After many years of health education, we find weight loss to be the main motivating factor for women who undertake an effort to change their dietary habits, irrespectively of their age, body mass and health [4, 5].

After the four-month nutritional educational programme and individual adjustment of diets, it has been established that a number of beneficial changes in terms of dietary habits and nutrition of the female subjects was implemented.

It is reflected in the improvement of the caloric value of the diet, amounts of basic nutrients, changes in the sources of those nutrients, with a special consideration of the sources of lipids, which significantly reduced the Keys' atherogenic score.

Advantageous changes in the method of nourishment were observed in most of women under research. However, taking into consideration age of the examined, especially important seem changes of the percentage of women whose nourishment was insufficient. The highest improvement of nutrition regarded the increase of energetic value of the diet resulting from increased consumption of recommended basic nutritious components and thus other components which they contained. Change in nutrition behaviour could also be observed in women whose nutrition was presbyopic. However it should be observed, that these changes were significantly smaller and not always advantageous.

The changes thus achieved were the cause of an individual weight loss of the overweight and obese women among the subjects. About 11% of female subjects moved from the obese category to the overweight category.

During the process of aging, the fat tissue is not only gained, but also redistributed. The amount of visceral and muscle fat rises in relation to the amount of subcutaneous fat tissue and its general weight [2]. Among the female subjects the average waist circumference pointed at visceral obesity. Adjustments in nutrition and diet individually reduced waist circumference, which was reflected in significant reductions of parameters WC and WHtR. These are the parameters that are taken into account during an assessment of risk of circulatory diseases and glucose tolerance impairment [8, 10, 27].

The observed weight loss, despite the increase of the average caloric value of the diets and a change in the value of assessed parameters, could have been linked not only to a regulation of times of meals and intervals between them, but also to a change in nutrition, and an increase in the consumption of vitamin D_3, calcium and magnesium.

It has been shown already that a low consumption of calcium, which, if in deficit, fails to lead to stimulation of lipolysis and an inhibition of lipogenesis in adipocytes, leads to accumulation of fat tissue [29]. Therefore, its higher consumption, as well as a significant increase in the consumption of vitamin D_3 could have activated the aforementioned processes. What is more, an increase in the consumption of magnesium could have led to an increased use of glucose in the tissues, which inhibits liponeogenesis and lowers the risk of insulin resistance in peripheral tissues [13].

The changes in nutrition were also reflected in the changed levels of assessed blood parameters. A significant reduction of the glucose level was noted, which could have resulted from, among other things, an increase in fibre consumption (as it was recommended to consume whole grains, fruit and vegetables), and an increase in energy taken from complex carbohydrates and a decrease in energy taken from sucrose. These changes had to result in flat glycemic response, and, what is connected, a decreased lipogenic secretion of insulin [5].

The analysis of the lipid profile is the basic tool in detecting patients with higher risk of cardiovascular diseases. An increased concentration of fraction LDL-C and lowered HDL-C are independent significant factors in the development of coronary artery disease [24].

The implemented four-month nutritional educational programme and the adjustment of diets of the female subjects have also influenced the assessed lipid parameters of the blood and aterogennic parameters of the lipid profile which was established on this basis.

A significant increase in the concentration of the fraction HDL-C was noted, and in all the subjects it has exceeded the recommended level of 46 mg/dl. This effect was mainly linked to a change in the type of fatty acids, from saturated to unsaturated ones (as a result of introducing olive oil and fat fish into the diet), and to a consumption of vegetables with a higher level of C vitamin. On the other hand, the changes in the concentration of TG and TC and its fraction LDL-C were very individual, which was reflected in the fact that the average change in these parameters was statistically insignificant, which a change of their scope. Nevertheless, a significant decrease was noted in the values of TC/HDL-C, LDL-C/HDL-C, TG/HDL-C, HDL-C/TCf, which inform about the risk of cardiovascular diseases and the coronary artery disease [3, 23]. The reason for the observed significant positive changes in the lipid profile was also the increase in the consumption of fibre, calcium, D3 vitamin, thiamine and pyridoxine. A similar effect of the improvement in the nutrition of the elderly in a long-term care hospital was noted by *Kim* et al. [16].

Previous research has proven that the lipid parameters of the blood and the values of the assessed parameters may be influenced by such factors, as: hormone therapy [14], an increase in physical activity [26], refraining from smoking [9], and/or changes in nutrition [21]. At the same time, it is believed that the changes in proportions between various lipid parameters in the blood are more important than the significance of the changes that take place [14]. It was also reflected in the test results analysed in this research, as only the significant increase in the concentration of the fraction HDL-C significantly reduced the values of parameters which mark the risk of cardiovascular diseases.

Taking the above into account, as well as the age of the female subjects, it is the safest and least invasive to educate the subjects in order to improve their dietary routines. This is confirmed by ESC/EAS [22] Guidelines for the management of dyslipidaemias and the research done by *Friedrich* and *Goluch-Koniuszy* [6]. The implemented four-month nutritional educational programme and individual adjustment of diets of women between 65 and 85 resulted in a significant decrease in the levels of glucose, triglycerides, total cholesterol and its fraction LDL-chol in the blood. Moreover, currently this type of education of elderly women is extremely popular, which is evident in the number of subjects volunteering for such programmes.

To conclude, it may be stated that the implemented four-month nutritional educational programme and change in nutrition were beneficial not only for the value of anthropometric parameters of the female subjects, but also their lipid blood profiles, lowering the list of atherosclerosis, coronary artery disease and metabolic syndrome. In this context, one should not forget other positive changes noted by the subjects: sleep improvement, less cases of the so-called heartburn, improved defecation, smaller joint stiffness in the morning and medically confirmed lowering or normalization of blood pressure level. Each of these positive effects resulted in a smaller dosage or refraining from taking medication by the subjects without a consultation with a doctor.

CONCLUSIONS

The analysis of the results allows to confirm, that the four-month nutritional education of elderly women resulted in changes of their erroneous dietary habits and an improvement in their nutrition, which was reflected in:

1. Weight loss in overweight and obese women and a significant reduction of WC and WHtR parameters.
2. A significant reduction in glucose levels and a significant increase in HDL-C fraction in the blood, which in all subjects exceeded the recommended value and which significantly reduced the risk of cardiovascular diseases.
3. An improvement in well-being and quality of life, which is valuable for the elderly.

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Conflict of interest

The authors declare no conflict of interest

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