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BODY COMPOSITION ANALYSIS IN WOMEN AGED 50-80 IN KUJAWSKO-POMORSKIE VOIVODESHIP

ANALIZA SKŁADU CIAŁA KOBIET WOJEWÓDZTWA KUJAWSKO-POMORSKIEGO MIĘDZY 50 A 80 ROKIEM ŻYCIA

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S u m m a r y

Obesity is a problem which is more and more common in Polish population. The reason for that is excessive energy delivery from food against the quantity used by organism, as well as too small physical activity. These factors lead to excessive increase of body fat quantity which has a detrimental impact on the health condition.

The purpose of the study is a body composition assessment in women aged 50-80 living in Kujawsko-Pomorskie Voivodeship.

1902 female inhabitants of Kujawsko-Pomorskie Voivodeship participated in the study which was divided into six age groups. The fat mass level and the fat free mass level

of the body was evaluated with the assistance of electrical bioimpedance method. The content of water in the organism and, indirectly, the basic metabolism level were also determined.

With age women exhibit the decrease of fat free body mass and water level in the organism; whereas the body mass and, at the same time, the body fat content are observed to increase for women between 50 and 70 years of age. Above the age of 70 this tendency is reversed and the body mass and the body fat level decline. It was also observed that with age the basic metabolism level systematically diminishes within the population.

S t r e s z c z e n i e

Otyłość to problem coraz częściej występujący w polskiej populacji. Przyczyną jest nadmierne dostarczanie energii z pokarmów w stosunku do ilości zużywanych przez organizm, a także zbyt mała aktywność fizyczna. Czynniki te prowadzą do nadmiernego zwiększenia ilości tkanki tłuszczowej, niekorzystnie wpływającej na stan zdrowia.

Celem badania jest ocena składu ciała kobiet między 50 a 80 rokiem życia zamieszkujących województwo kujawsko-pomorskie.

W badaniu uczestniczyły 1902 mieszkanki województwa kujawsko-pomorskiego, które podzielono na sześć grup wiekowych. Oceniono u nich za pomocą metody bioimpedancji elektrycznej poziom masy tłuszczowej i beztłuszczowej ciała. Określono również zawartość wody w organizmie i pośrednio poziom podstawowej przemiany materii.

Wraz z wiekiem u kobiet następuje obniżenie beztłuszczowej masy ciała i poziomu wody w organizmie. Obserwuje się natomiast wzrost masy ciała i jednocześnie zawartości tkanki tłuszczowej u kobiet między 50 a 70 rokiem życia.

Powyżej 70 roku życia tendencja ta ulega odwróceniu i dochodzi do spadku masy ciała i poziomu tkanki tłuszczowej. Jednocześnie zaobserwowano, że wraz z wiekiem

poziom podstawowej przemiany materii systematycznie ulega zmniejszeniu w populacji.

Key words: body composition, fat mass, BIA, elderly women

Słowa kluczowe: skład ciała, masa tkanki tłuszczowej, analiza impedancji bioelektrycznej, kobiety w wieku starszym

INTRODUCTION

Within the last two decades there was an increase in scientific interest in elderly people. The reason for this situation is prolongation of life followed by the increase in the population of people over 60. In Poland as well as in Europe it is statistically estimated that life expectancy will rise from current 79.8 in women to 82.9 in 2035. Along with prolongation of life, health problems which are specific for this age group come into existence. One of basic diseases of elderly people is obesity which leads to other numerous medical complications. It is associated with an excess intake of calories and diminishing of the basic metabolism as well as the decrease in physical activity level, which is usually connected with withdrawal from job duties. It leads to being overweight and obesity regardless of race and age. Research shows that in 2002 1.4 billion people worldwide were touched by overweight and obesity [1,2], in 2005 this problem already referred to 1.6 billion people worldwide, out of whom 522 million were obese people [3]. The latest studies published in 2014 show that 2.1 billion people worldwide are overweight and 671 million people are obese [4].

Studies conducted on American population show even worse results. Being overweight or obese is a characteristic feature of people over 60 years old for 78.4% of male population and 68.6% of female population [5]. Polish research from 2011 shows that there are 54% of overweight people in the country and two years earlier the estimation was 52%. In 2009 in 50-59 years age group 43% people were overweight, 23% were obese; in age group 60-69, 44% were overweight and 28% were obese and in age group 70-79, 46% were overweight and 24% were obese. The percentage of the total number of women in 2009 weighing too much was 46.2%, out of which 30.4% were overweight and 15.8% were obese. As for men, the numbers are even bigger, namely as much as 63.6%, out of which 46.3% - overweight and 17.3% - obese [6].

Apart from genetic factors and the hormonal state of the organism, obesity is influenced by nutrition, quantity and quality of physical activity. BMI, eva-

luated by many authors, is used for population-based screening determination of the prevalence of cases of being overweight and obese.

Recently, Polish literature has indicated the lack of studies presenting the body fat and other body composition components level in elderly people of Kujawsko-Pomorskie Voivodeship. The only screening research published on the Internet by TGI of Milward-Brown Agency referring to 07.2015- 12.2015 of Kujawsko-Pomorskie Voivodeship shows that our rank is number 8 as far as the excess body mass in the country is concerned, with 47.99% of the citizens. In this respect, it seems to be of paramount importance to determine the elderly people's overweight level within the society in accordance with the respective body composition parameters division. The electrical bioimpedance method will prove to be useful while conducting measurements.

MATERIAL AND METHODS

1902 female participants took part in the study which was conducted in 2010-2011 on women participating in Senior Physical Activity Regional Programme of Kujawsko-Pomorskie Voivodeship. Women taking part in the study were informed about the purpose and methodology of the study and they endorsed written consents. All women were examined by a doctor assisted by a nurse. The examination included an interview, arterial blood pressure and heart contraction frequency measurement, EKG, lung auscultation, examining of reflexes, balance and color vision. Next, the physiotherapist (with a MA degree) measured height, body mass, waist and hips circumference, and the body composition with the TANITA SC 330 device. With the assistance of this device the basic body composition parameters were achieved, such as Muscle Mass in % and kg, Fat Mass in % and kg, Total Body Water, Body Mass Rate. All examinations were conducted in the afternoon, in rooms meeting the safety standards, in temperature 18-22°C, 4 hours after the last meal.

The bioelectrical impedance method is characterized by the difference's evaluation between the electrical current conduction in the part representing water mass and the fat mass of the body. This method involves the measurement of the total resultant body electrical resistance which consists of the resistance and reactance phenomena [7]. Resistance refers to the electrical resistance process of particular organism tissues, while reactance is a derivative of cell membranes electrical volume, which due to their physical features act as condensers. The size of organism resistance is directly proportional to length (L) and proper resistance (p), and inversely proportional to its cross-section surface (A), whereas reactance is inversely proportional to electrical current frequency and system electrical volume. With respect to the fact that within an organism the particular structures are connected in series as well as collaterally, the device uses mathematical operations which give the following impedance formula:

$$Z = \frac{X_c R}{\sqrt{X_c^2 + R^2}}$$

Due to the fact that a human organism is not homogenous and its resistance and electrical volume are changeable in particular tissues, one must be aware of the fact that water together with the electrolytes has a special property. Extracellular water as well as fat tissue do not demonstrate reactance but they have resistance. However, reactance comes into existence on cell membranes of tissues with a big water content which act as condensers [8]. Most of all, reactance has influence on a phase shift of the applied alternating current in the vectorial aspect by the phase angle, and resistance causes the voltage drop. Received during the measurement process, the outcome of the total system impedance resultant after mathematical transformations in the device allows the water value in the system to be received. This parameter, after the next mathematical transformations, allows calculation of the level of the other body composition values [9].

Due to the fact that during the examination a very low amperage current is applied to the human body – below 1mA - the whole process is extremely safe and it is conducted below sensibility threshold, especially in case of this measurement device model in which only two electrodes are employed under the examined person's feet. Because of placing the electrodes under the thick skinfold on the foot plantar part, it is of

paramount importance to clean the feet and electrodes with alcohol before examination in order to remove contamination and ensure the best possible electrical conduction.

On the basis of weight and height measurement results the BMI was calculated. The mean values of the BMI were: 27.5 in the first age group; 28 in the second; 28.1 in the third; 28.3 in the fourth; 28 in the fifth and 27.8 in the last one, respectively (Table I). According to WHO classification, on the basis of the BMI, women examined in the study in all age groups are within range of the first degree of overweight.

Table I. *Characteristics of the subjects*

	Age Group	Number of subjects	Age (year)		Body height (cm)		Body weight (kg)		BMI	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	50-54	493	52.1	±1.6	162.1	±5.6	72.3	±13.1	27.5	±4.5
2	55-59	650	57.2	±1.4	160.7	±5.1	72.4	±12.4	28	±4.5
3	60-64	527	61.8	±1.4	160.4	±5.3	72.3	±12.8	28.1	±4.7
4	65-69	152	66.6	±1.4	159.8	±6.2	72.3	±11.3	28.3	±4.2
5	70-74	61	71.4	±1.5	159.3	±5.7	71.3	±11.3	28	±3.9
6	75-79	19	76.4	±1.5	157.8	±7.8	69.2	±10.9	27.8	±4

Table II. *Characteristics of the subjects II*

	Age Group	Number of subjects	Waist circumference (cm)		Hips circumference (cm)		WHR	
			Mean	SD	Mean	SD	Mean	SD
1	50-54	493	89.6	±11.5	105.1	±9.4	0.85	±0.1
2	55-59	650	91.1	±11.4	106.6	±9.5	0.85	±0.1
3	60-64	527	90.9	±11.1	106.7	±9.8	0.86	±0.1
4	65-69	152	91.9	±10.5	106.8	±9	0.86	±0.1
5	70-74	61	91.4	±10.1	107	±9.4	0.85	±0.1
6	75-79	19	91.1	±9.9	106.6	±9.5	0.85	±0.1

RESULT

All participants of the study were tested with respect to the body composition evaluation. The body fat content measured in kg as well as assessed in percentage is on the rise from the youngest age group in which it is 26.1kg (35.1%). In the second age group it is already 26.8kg (36.1%), in the third age group –

27kg (36.3%) and in the fourth group of women 65-69 years old it is 27.1kg (36.7%). The last two age groups show the decrease of fat tissue level and, respectively, in the 70-74 years age group it is 26.2kg (36%) and in the last group – 24.3kg (34.2%). The muscle mass in the examined groups of women is decreasing from 43.8kg in the youngest group of 50-54 years to 43.9 in the group 74-79 years. The same tendency is shown in the water level in the organism, namely, in the youngest group the percentage is 45.2; and in the oldest one the percentage is 44.3. The body mass rate level, like in case of the previous two indexes, is decreasing from 1392 kcal in the group of women 50-54 years old to 1337 kcal in the age group 75-79.

Table III. *Study results „Body composition”*

	Age Group	Number of subjects	Fat Mass (%)		Fat Mass (kg)	
			Mean	SD	Mean	SD
1	50-54	493	35.1	±6.6	26.1	±9.3
2	55-59	650	36.1	±6.1	26.8	±8.7
3	60-64	527	36.3	±6.2	27	±9.1
4	65-69	152	36.7	±5.5	27.1	±7.7
5	70-74	61	36	±5.7	26.2	±7.6
6	75-79	19	34.2	±7.4	24.3	±8.6

Table IV. *Study results “Body composition II”*

	Age Group	Number of subjects	Muscle Mass (kg)		Total Body Water (%)		Body Mass Rate (kcal)	
			Mean	SD	Mean	SD	Mean	SD
1	50-54	493	43.8	±4.4	45.2	±4.2	1392	±149.2
2	55-59	650	43.3	±4.3	44.4	±4	1375	±155.1
3	60-64	527	43	±4.1	44	±4	1366	±141.5
4	65-69	152	43	±4.2	43.7	±3.5	1363	±137.1
5	70-74	61	42.9	±4.6	43.2	±4.7	1356	±142.7
6	75-79	19	42.9	±4	44.3	±6	1337	±127.6

DISCUSSION

The phenomenon of being overweight and obese is becoming more and more common. It is observed that middle-aged people enter elderly age already being visibly overweight and this phenomenon is progressing in the following years of their lives. The aging process generates changes in organism functioning, changes in metabolism, changes in internal organs working. The total energy expenditure is observed to drop and this decreasing tendency refers to all its components: basic metabolism, food's thermal action, physical activity. The consequence of this process is body composition changing, such as fat content increase.

It is paramount to conduct anthropometric measurements to determine the existence of overweight and obesity. One of the most commonly

used anthropometric indicators is BMI (Quetelet). According to WHO, BMI value ≥ 30 means obesity [10]. The Norwegian studies conducted in 1994-1995 in Tromso and North-Trondelag in 1995-1997 on a group of 19515 women and men showed that BMI above 25 within both sexes is associated with mortality increase. Additionally, together with BMI increase above 30, the percentage of women dying of cardiovascular, respiratory and cancerous diseases is advancing by several dozen with respect to women with BMI below 30 [11]. Nevertheless, this index should be determined only as a screening examination method or additionally, due to its low authoritativeness. This index does not determine the diversification between fat mass content and fat free mass content in the body. The relation between the fat content within the body and BMI depends on many factors: age, race, sex, hormonal condition, physical activity. Due to this fact it is vital to use more precise metrological methods which will consequently allow for detailed body composition parameters assessment. Such methods include, for instance: dual energy X-ray absorptiometry (DEXA), magnetic resonance method, isotopic labelling method or electrical bioimpedance method.

One of the most accurate methods nowadays, yet difficult to be used in screening – DEXA, was used in the Brazilian study involving 120 women with average age of 67.2 ± 5.2 determining fat tissue content on the level of 38.9 ± 4.5 (kg) and 37.3 ± 6.9 (%). BMI was estimated at 27.4 ± 3.9 [12].

In Italian study, also performed with DEXA method, in which 1423 women participated, average age was 67 ± 5 years and with age range of the examined group from 60 to 88 years, BMI was 26.2 ± 3.5 with the 18.9 to 37.5 range. The fat content in kg was 23.8 ± 6.7 with the 7.9 to 47.8 range and the percentage of fat tissue was on the level of 37.7 ± 6 with the 18 to 55.4 range [13].

Also, Oyen and associates, conducting the studies with DEXA method in 1998-2000 on a group of 667 Norwegian women aged 71-74, determined fat mass (kg) at 27.3 ± 9.1 ; fat mass in % at 40.9 ± 7.7 and also lean body mass (kg) 37.8 ± 4 and BMI at 26.3 ± 3.9 [14].

In our study conducted on a group of women from Kujawsko-Pomorskie Voivodeship we used the electrical bioimpedance method (BIA) which is noninvasive, fast in application and highly repetitive. The BIA measurement gives the possibility of the body

composition evaluation as far as the fat mass and fat free mass content of the body is concerned. Other authors also willingly use this kind of method in their studies.

The example may be studies by Ihasz and associates who examined 1198 women in 3 different age groups out of which a group of 405 women between 61 and 80 years of age is comparatively interesting. According to authors, with age the level of fat tissue and BMI are on the increase and the muscle mass is on the decrease. In the above mentioned age group the results were as follows: for BMI: 29.36 ± 4.85 , muscle mass (%) 32.56 ± 3.89 [15].

In the study by Arago et al. conducted on 158 healthy postmenopausal Caucasian women in two groups: study group and control group. Prior the tests, the body composition was examined and the results are as follows. In 70-person control group the average age of which was 56.90 ± 4.96 , the results were, respectively, BMI 28.64 ± 4.93 , FM (kg) 27.54 ± 8.40 , FM % 39.24 ± 7.04 , skeletal muscle mass (kg) 22.32 ± 2.90 . The measurements were performed with the assistance of the bioimpedance method, with InBody 720 apparatus, Biospace, Seoul, Korea [16].

Similar results were achieved by Polish authors Wasiluk and Sawczuk while examining 180 women in Bielsko Biala with the average age of 65.3 ± 4.68 . Using Akern BIA apparatus, they received the following results: BMI 28.3 ± 4.5 , % of fat tissue content which was 40.5 ± 7 , and FM (kg) 30.2 ± 9.4 ; LBM in kg 59.6 ± 6.9 and TBW in % 47.3 ± 5.1 [17].

In the German study conducted in 1994 in Giessen, Germany within Gisel project, the body composition was examined with Akern-RJL apparatus, BIA 101/S; Data Input, Frankfurt, Germany. A group of 164 women participated with the average age of 67.7 ± 5.6 . Its results were as follows: BMI 26.4 ± 3.7 ; Fat Mass (kg) 30.3 ± 6 ; Fat Mass (%) 44.6 ± 3.7 ; WHR 0.83 ± 0.06 [18].

Another study was conducted in the capital of the Czech Republic – Prague – on a group of 53 women before the beginning of physical training. It was also performed with the bioimpedance method, with B.I.A. 2000 M device, Data Input, Germany. The average age of women was 68.7 ± 5 and the results were, respectively: Body Mass (kg) 69.9 ± 7.9 , Fat Mass (%) 37.5 ± 5.1 , Fat Free Body Mass (kg) 43.7 ± 6.8 [19].

Ignasiak et al. performed anthropometric parameters measurements I 114 physically inactive women aged 71 ± 7.27 and they received the following

results: BMI 27.38 ± 4.17 ; Fat Mass (%) 38.6 ± 3.08 , Fat Mass (kg) 26.35 ± 5.93 and WHR 0.84 ± 0.06 [20].

Latorre et al. received a little different results in the study on 68 women with the average age of 72.76 ± 4.68 . They were as follows: BMI was 30.40 ± 4.28 ; Fat Mass (%) 43.77 ± 6.01 ; Muscle Mass 21.12 ± 2.67 [21].

Also, the researchers coming from the majority of the other hemisphere countries willingly use the BIA devices as a tool for the body composition measurement. This is demonstrated by two Australian studies. The first one was conducted on 52 female volunteers aged 55-90 in New South Wales, in which the average age was 73.9 ± 8.5 . The measurement was performed with the assistance of TANITA Body Composition Analyser device model BC 418 and the results were: BMI 27.9 ± 5.2 ; Fat Mass (%) 34.6 ± 8.6 ; FFM (kg) 48.9 ± 8.5 [22].

The other study was performed by Sweden-Lindblad et al. on a group of 51 women aged 83-96 in Gothenburg in 2008. The average age was 86.5 ± 2.9 . The body composition was measured in the examined women with the electrical bioimpedance device Imp SFB7 Impedimed Brisbane, Australia. The results were as follows: BMI 24.8 ± 3.6 ; Fat Mass (kg) 21.4 ± 5.8 ; Fat Mass (%) 33 ± 5.6 ; SMM (kg) 15 ± 2.5 ; SMM (%) 23.8 ± 3.3 [23].

The Japanese also measured the body composition parameters in a group of 159 women with the bioimpedance method in Nishinomiya with InBody 430 device, Biospace, Tokyo, Japan. Their results were as follows: BMI 22.6 ± 2.9 ; Fat Mass (%) 33 ± 6.9 [24].

The body mass analysis was also made by researchers in Brazil within the Health and Nutrition Survey study who divided the groups of participants into three age categories. In the first age group (60-69.9 years) there were 211 women and their BMI was 26.3 ± 0.33 and WHR 0.85 ± 0.01 ; in the second group (70-79.9 years) there were 130 women and their BMI was 25.5 ± 0.41 , WHR 0.87 ± 0.01 ; in the last age group (over 80) the number of women was 44 and their BMI 24.9 ± 0.68 [25].

So far, smaller groups of women have been taken into consideration during numerous studies. In the study presented by our team of researchers the body composition parameters of a big group of elderly women were determined, which allows the adiposity of the voivodeship population to be defined.

By analyzing the components of women's bodies, the authors came to similar conclusions as in case of other studies in many parts of the world, in various ethnic groups. Namely, the conclusion is that with age the tendency of body mass increase appears, the same refers to the percentage increase of the fat tissue and BMI as well as the decrease of muscle mass. At the same time, the same worldwide studies show that during the late elderly age the increase of body mass and the fat tissue level are inhibited or even diminished [26,27]. This is also confirmed by the study conducted by our team. Within the first four age groups examined by our team, with age span between 50 and 70 years, the body mass, fat mass and WHR index were on the increase in respective groups. In the last two age groups the tendency for the increasing earlier values to be decreasing was observed, despite the fact that the examined group was smaller in number. Very interesting conclusions may be drawn upon analyzing the results of muscle mass of the participants. To put the matter more pointedly, with every passing year of life within this study, muscle mass was observed to decrease, which correlates with the basic metabolism decrease. Another interesting conclusion which confirms the worldwide studies is the fact referring to the decrease of the organism hydration with every passing year of life, which in case of women is in percentage dependent upon the organism fat tissue level, with the total body mass.

What needs to be taken into account is the fact that during analyses various types of devices operating on the basis of the BIA are used, which makes the comparison of particular results more difficult. The BIA measurement gives the possibility to assess the ratio of fat tissue to fat free tissue, which is vital from the point of view of health. Furthermore, each examination performed with this method is comparably authoritative.

The studies show that in order to fight obesity and overweight it is of paramount importance to apply a qualitatively and quantitatively balanced diet as well as physical activity. These factors are considered to be elements of the prophylaxis and also obesity treatment.

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CONFLICT OF INTEREST

The authors declare they have no conflict of interest.

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