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Original Research Article

Influence of the Pilates Method and Anti-cellulite Massage for Maintaining Healthy Body Composition Parameters

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Abstract

The aging process leads to many changes in body composition, often without changes in body weight and body mass index (BMI). In general, with age, the percentage of body fat increases and lean body mass and bone mineral density decrease.The aim of the study was to compare basic anthropometric indicators such as weight, body fat percentage, muscle mass, skin folds and circumferences in the two groups. Two groups of subjects participated in the study. The first group of women (age 29.7 ± 6.7 years, height 165.7 ± 5.5 cm, weight 55.7 ± 2.4 kg) performed twice a week Pilates training, and the second group (age 40.3 ± 4.1 years, height 166.1 ± 4.6 cm, weight 59.1 ± 4.3 kg) are physically active women engaged in a variety of physical exercises, but conduct once a week anti-cellulite massage.Research shows that physical activity leads to benefits in terms of weight and body composition. By combining the method of body composition determination and somatotyping, the characteristic features of the body of the person could be measured and give guidelines for correction in physical activity and massage procedures. In addition, women over the age of 40 can keep their body fat percentage within normal limits by combining physical activity with anti-cellulite massage. The increase in muscle mass can continue at the age of 40 with regular exercise. Last but not least, the role of nutrition should be noted. It is extremely important for a healthy weight, but in the studied groups it is necessary to adjust the amounts of carbohydrates and proteins. Increasing the amount of carbohydrates in the form of whole grains, fruits and vegetables would contribute to increased intake of vitamins, minerals and fiber, which will have a good effect on the general condition of individuals. Reducing the amount of protein will not interfere with the normal synthesis of muscle proteins, but will support the liver, kidneys and protect the body from calcium excretion. This study provokes many more questions about the effect of both methods on weight and body composition. If it is possible to conduct planned research (cancellation of the emergency epidemic situation), it would be good to make measurements over time, which will allow to compare the effect of Pilates and anti-cellulite massage.

Keywords*:* Physical activity, Nutrition, Somatotype, Women health

INTRODUCTION

It has long been known that malnutrition and obesity increase morbidity and mortality (Buzby et al., 1980; Weinsier et al., 1979). Epidemiological studies also show that low and high body mass index (BMI) values increase morbidity and mortality(Allison et al., 1997; Heitmann et al., 2000). On the other hand, research also shows that

body composition, not BMI, is a major determinant of health and a better predictor of mortality risk than BMI (Van Itallie et al., 1990).

The aging process leads to many changes in body composition, often without concomitant changes in body weight and body mass index (BMI) (St-Onge, 2005). In general, with age, the percentage of body fat increases and lean body mass and bone mineral density decrease. In addition, the increase in fat mass is distributed in the abdominal area, an area associated with cardiovascular disease and diabetes. It is generally accepted that changes in body composition are due to changes in energy balance, with a positive energy balance leading to weight gain and a negative balance leading to weight loss. However, changes in body composition associated with aging often occur in the absence of fluctuations in weight. It was found (Gaba and Pridalova, 2014) that the most significant increase in body weight in the study of women aged 18-89 was observed between women aged 30-39 years and women aged 40-49 years (difference = 5.5 kg, p = 0.05). The same study also showed a difference in body fat mass between these age groups. Over the years, muscle mass decreases slightly, but as the increase in fat mass is greater overall weight and BMI increase.

Another study showed (Bazzocchi et al., 2013)that women's fat mass increased until the age of 40 and remained stable thereafter. On the other hand, muscle mass is constant for 20 to 70 years in healthy active women.

The most commonly used method is the anthropometric somatotype of Heath and Carter (Carter and Heath, 1990). This mathematical method uses a three-component somatotype index, including endo-morphy (measurement of relative obesity), mesomorphy (measurement of musculoskeletal components), and ectomorphy (measurement of longitudinal body characteristics).The mean value of the endomorphic component in women was found to be significantly lower in the 18–30 age group than in all other age groups except 71–80 years. No differences in endomorphic component values were found between the age groups 31–40, 41–50, 51–60 and 61–70. The mean values of the mesomorphic component are significantly higher in the age groups 31–40 than in 18–30 years, continuing to increase in the group 41–50 years. From the age of 50 onwards, the mean values of the mesomorphic component decrease; however, the changes are statistically insignificant. The mean values of the ectomorphic component become significantly lower between 18–30, 31–40 and 41–50. After the age of 50, there are almost no changes in the mean values of the ectomorphic component.

The aim of the study was to compare basic anthropometric indicators such as weight, body fat percentage, muscle mass, skin folds and circumferences in the two study groups.

MATERIAL AND METHODS

Participants

The study included nine women (age 29.7 ± 6.7 years, height 165.7 ± 5.5 cm and weight 55.7 ± 2.4 kg) practicing Pilates (hereinafter referred to as the first group) and nine physically active women (age 40.3 ± 4.1 years, height 166.1 ± 4.6 cm and weight 59.1 ± 4.3 kg) performing anti-cellulite massage procedures (hereinafter referred to as the second group). Prior to the start of the study, participants were familiar with its methods and objectives and signed a declaration of informed consent. The study was approved by University Research Ethics Committee of South-West University,B lagoevgrad.

Procedure

Determination of weight and body composition

Determination of body composition is performed with OMRON BF511. The device measures the percentage of fat in the body using the method of bioelectrical impedance. To determine the amount of adipose tissue, the device passes an extremely weak electric current through the body with a frequency of 50 kHz and a power of less than 500 μA. In addition to the percentage of fat, the device records the percentage of skeletal muscle, the level of visceral fat and the basal metabolism.

Determination of somatotype

The measurement was performed by the Heath-Carter method, determining three skin folds (triceps, subscapular, supraspinale), two diameters (humerus, femur) and two circumferences (arm and calf). Appropriate formulas are used to obtain the values of the somatotype components.

Determining the energy value of the usual diet of the subjects

The determination of the energy value of the usual diet is done through a pre-prepared questionnaire for nutrition (Kirkova, et al., 2019)for the conditions in Bulgaria. Each person fills out a pre-coded questionnaire that automatically calculates the total amount of kilocalories they normally consume and, accordingly, the amount of carbohydrates, proteins and fats in their menu.

Anti-cellulite massage

Subjects visit the massage studio twice a week for the

Table 1. Basic nutrients and energy intake in the usual diet of the subjects from the first group.

ID	BMR, kcal	Energy intake, kcal	Proteins, g	Carbohydrates, g	Fat, g
P1	1278	2087	120	242	71
P2	1336	1630	150	109	66
P3	1233	1991	149	270	35
P4	1272	1992	97	284	52
P5	1332	1801	108	205	61
P6	1267	1849	110	197	69
P7	1219	2046	130	251	58
P9	1278	1921	123	220	61
P10	1283	1951	99	265	55
Mean	1277.6	1919	121	227	59
±SD	38.7	141	20	53	11

Table 2. Basic nutrients and energy intake in the usual diet of the subjects from the second group.

ID	BMR, kcal	Energy intake, kcal	Proteins, g	Carbohydrates, g	Fat, g
M1	1255	1808	103	205	64
M2	1319	1955	88	250	67
M3	1220	1944	105	237	64
M4	1387	1972	108	268	52
M5	1320	1897	72	238	73
M6	1334	1897	77	242	69
M7	1335	1843	83	281	43
M8	1372	2045	105	278	57
M9	1316	2089	96	253	77
Mean	1318	1939	93	250	63
±SD	52	90	13	24	11

first 15 procedures lasting 45 minutes. Followed by visits once a week, and with visible results they are reduced to 2 massages per month. All subjects have undergone a course of 15 massages and currently visit the studio twice a month for a supportive massage.

Pilates

Subjects performed a series of exercises lasting 60 minutes. Exercises include warm-up - 10 minutes, work for individual joints and muscles - 40 minutes and stretching 10 minutes. The trainings are held in a group twice a week.

Data collection and analysis /Statistical analysis

GraphPadPrism (Ver. 3.0) was used for data processing and analysis. Mean valuesand standard deviations of all variables are calculated by descriptive statistics. Experimental data are presented in two ways: - as means ± SD; and - as individual values for each subject. The statistical software GraphPadPrism is used for statistical analysis of the results (Mann Whitney test).

RESULTS

On the day of the study, individuals completed a nutrition questionnaire to give us a general idea of eating habits and the amount of energy and nutrients they typically consume. The results obtained from the nutrition questionnaire are presented in Tables 1 and 2.

The anthropometric data of the persons measured with OMRON BF511, as well as the corresponding indices obtained from these data are presented in Tables 3 and 4.

Table 3. Anthropometric indicators and body composition of the group of women practicing Pilates.

ID	Age, years	Height, cm	Weight, kg	BMI, kg/m^2	% BF	BF, kg	BFI, kg/m^2	% MM	MM, kg	FFM, kg	FFMI, kg/m^2	BMR, kcal	VF
P1	36	160	58,0	22,9	30,8	17,9	7,0	29,7	17,2	40,1	15,7	1278	5
P2	35	172	58,4	19,7	26,7	15,6	5,3	30,0	17,5	42,8	14,5	1336	3
P3	22	163	52,6	19,8	28,8	15,1	5,7	27,8	14,6	37,5	14,1	1233	3
P4	22	161	57,7	22,3	35,9	20,7	8,0	24,9	14,4	37,0	14,3	1272	4
P5	22	172	58,5	19,8	27,7	16,2	5,5	29,5	17,3	42,3	14,3	1332	3
P6	31	165	55,2	20,3	29,2	16,1	5,9	28,4	15,7	39,1	14,4	1267	3
P7	40	158	53,7	21,5	28,5	15,3	6,1	30,0	16,1	38,4	15,4	1219	4
P8	29	170	53,3	18,5	23,3	12,4	4,3	30,9	16,5	40,9	14,1	1278	2
P9	30	170	53,9	18,7	21,3	11,5	4,0	32,7	17,6	42,4	14,7	1283	2
Mean	29,7	165,7	55,7	20,4	28,0	15,6	5,7	29,3	16,3	40,1	14,6	1278	3
±SD	6,7	5,5	2,4	1,5	4,2	2,7	1,2	2,2	1,2	2,2	0,6	39	1

BMI - body mass index; BF - body fat, body fat; BFI - body fat index; MM - muscle mass; FFM - fat-free mass; FFMI - fat-free mass index, fat-free body mass index; BMR - basal metabolic rate, basic metabolism; VF - visceral fat.

Table 4. Anthropometric indicators and body composition of the group of women applying massage procedures.

ID	Age, years	Height, cm	Weight, kg	BMI, kg/m^2	% BF	BF, kg	BFI, kg/m^2	% MM	MM, kg	FFM, kg	FFMI, kg/m^2	BMR, kcal	VF
M1	36	165	53,7	19,7	27,4	14,7	5,4	28,9	15,5	39,0	14,3	1255	3
M2	43	165	58,7	21,6	25,0	14,7	5,4	32,6	19,1	44,0	16,2	1319	4
M3	44	162	51,5	19,6	25,2	13,0	4,9	30,4	15,7	38,5	14,7	1220	4
M4	42	169	65,1	22,8	32,4	21,1	7,4	28,4	18,5	44,0	15,4	1387	5
M5	43	166	59,0	21,4	26,8	15,8	5,7	31,0	18,3	43,2	15,7	1320	4
M6	40	160	62,9	24,6	31,0	19,5	7,6	30,5	19,2	43,4	17,0	1334	6
M7	37	170	58,8	20,3	25,2	14,8	5,1	31,7	18,6	44,0	15,2	1335	3
M8	45	175	60,2	19,7	26,9	16,2	5,3	29,8	17,9	44,0	14,4	1372	3
M9	33	163	61,7	23,2	34,5	21,3	8,0	27,4	16,9	40,4	15,2	1316	5
Mean	40,3	166,1	59,1	21,4	28,3	16,8	6,1	30,1	17,8	42,3	15,3	1318	4
±SD	4,1	4,6	4,3	1,8	3,5	3,1	1,2	1,6	1,4	2,3	0,9	52	1

BMI - body mass index; BF - body fat, body fat; BFI - body fat index; MM - muscle mass; FFM - fat-free mass; FFMI - fat-free mass index, fat-free body mass index; BMR - basal metabolic rate, basic metabolism; VF - visceral fat

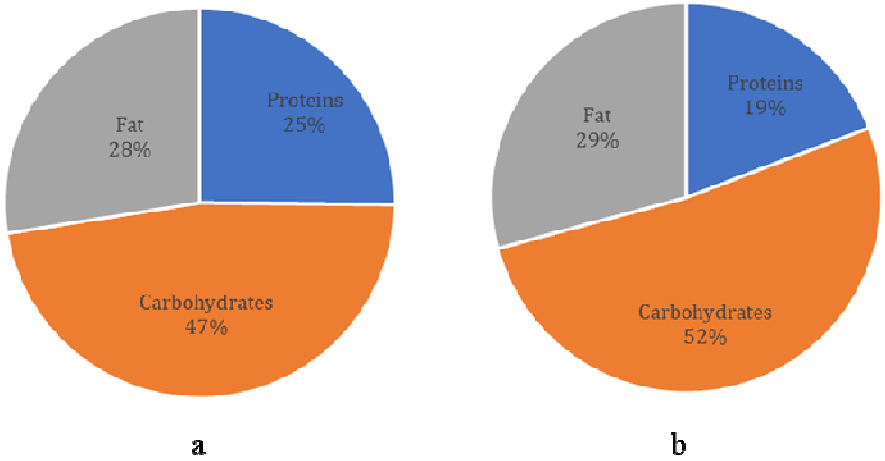
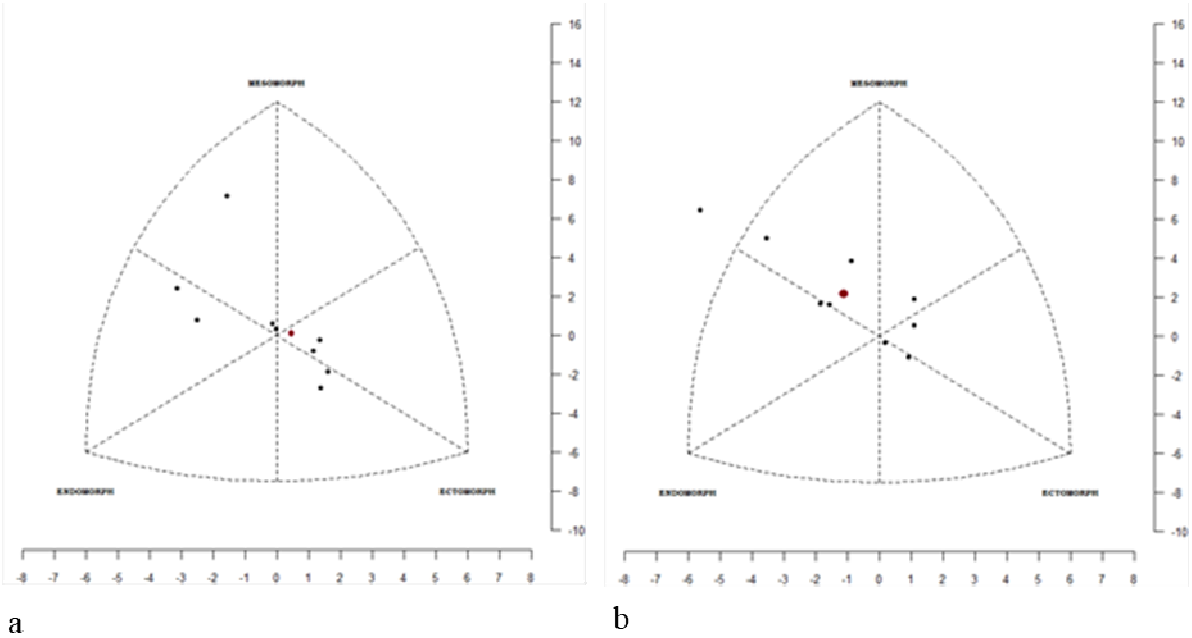


Figure 1. Percentage of energy from the three main food sources - carbohydrates, fats and proteins (a - first group of subjects; b - second group of subjects).

The energy obtained from different sources as a mean value for the subjects is presented in Figure 1. The somatotypes of the first and second groups are presented in figure 2, and the average somatotype of the



a b

Figure 2. Somatograms of the subjects: a - the first group, b - the second group, with red dots are the average somatotypes in the groups.

first is 3.3-3.5-3.1, and of the second 3.7-4.2-2.5. Although some differences in the values of the somatotype components were observed in the two groups, there was no statistically significant difference.

DISCUSSION

The dietary energy intake of a healthy, well-nourished population must allow the maintenance of an adequate BMI at the usual level of energy expenditure of the population. At the individual level, a normal range of 18.5 to 24.9 kg / $m^2$of BMI is usually accepted. To maintain this BMI range, the recommended energy intake for women at this age is approximately 1900 kcal / day (British Nutrition Foundation, 2018). This amount of energy would ensure the normal functioning of the body and a varied diet, including whole grains and dairy products, fruits and vegetables, nuts, would supply the body with the necessary vitamins and minerals. The energy intake of the subjects is above this minimum. This shows that the subjects eat adequately, being able to provide with food the energy needed for their daily needs and to be physically active from an energy point of view, the diet of the subjects is balanced, which shows their commitment to maintain a healthy weight and gain weight. the body needs energy.

Dietary recommendations differ, but there are some general rules for the ratio of essential nutrients (Food and Agriculture Organisation and World Health Organisation, Carbohydrates in Human Nutrition, 1998; Food and Agriculture Organisation, World Health Organisation, and United Nations, Energy and Protein Requirements. Technical Report Series No. 724, 1985; Food and Agriculture Organization and World Health Organisation, 1994). Fat consumption should provide 30-35% of daily energy needs, with an emphasis on poly- and monounsaturated fatty acids. Carbohydrate intake should provide about 55-60% of daily calories, and they should be taken in the form of complex carbohydrates in combination with a lot of fiber.

From these recommendations we can conclude that in a properly structured diet the share of energy from carbohydrates should be about 55-60%, from fat - 30-35% and respectively from protein - 15-20%.

As can be seen from the diagrams (Figure 1) in both groups there are significant deviations from the correct ratio of essential nutrients. Reducing carbohydrate intake is a characteristic trend in people who strive to maintain weight with the thought that they gain weight. On the other hand, reduced carbohydrate intake is also associated with lower intake of vitamins and minerals, which are mainly contained in carbohydrate sources. This trend in the long run would lead to health problems. Therefore, after the analysis, we talked to the participants in the study and recommended that they increase their intake of carbohydrates in the form of whole grains, fruits and vegetables, which would improve their diet.

With regard to proteins in both groups, their intake is increased, probably due to the fashion in the diet of people engaged in exercise, that they are extremely necessary to support muscle growth and maintenance. Studies have shown (Burke and Deakin, 2015) that the intake of 0.8-1 g protein / kg body weight per day is

completely satisfactory, even in persons engaged in heavy physical activity, where muscle strength is of particular importance. Large amounts of protein in the diet would increase the acidity of the body, lead to liver and kidney problems, as well as reduce calcium in the bones.

As can be seen from the table, the two groups differ significantly in their age. The group dealing with Pilates is on average 10 years younger than the group involved in massage procedures (Mann Whitney test, P value = 0.001). There is a statistically significant difference in weight (Mann Whitney test, P value = 0.02). In healthy women, the difference in weight is most significant between these studied groups (Gaba and Pridalova, 2014), as the difference reported in the literature is a difference = 5.5 kg, p = 0.05. Our study included women who are physically active, taking care of their appearance and body weight and it increases with age, with a difference of 3.4 kg on average, p = 0.02. The study included women with normal weight, which can be seen from the BMI, which averages 20.4 and 21.4 kg / m^2 in both groups. The normal body mass index is in the range of 18.5 - 25 kg / m^2 (Roberts and Dallal, 2001)

Studies show (Bazzocchi, et al., 2013) that significant changes in women's body composition occur at the age of about 40 years. These changes are the result of an increase in fat mass. The study group of 40-year-old women proved that targeted actions in terms of weight maintenance, including physical activity and anti-cellulite massage can reduce the process of fat accumulation in the body, both subcutaneous and visceral. No statistically significant difference (Mann Whitney test, ns) was found in the two study groups with respect to adipose tissue percentage, adipose tissue mass, fat mass index, and visceral fat level. In both groups the average percentage of fat is normal (21.0-32.9% for the first group and 23.0-33.9% for the second group), but in both groups there is one person with a high percentage of body fat - 35.9 in the first and 34.5 in the second, respectively (Gallagher et al., 2000). However, this higher percentage of body fat does not lead to a change in BMI and fat mass index. BMI does not give an idea of the distribution of FFM and BF. As studies show that body composition is a major determinant of health (Segal et al., 1987), FFM and BF should be identified as part of the health assessment. However, they change in height, weight and age. Therefore, it is difficult to determine whether individual subjects have low or high FFM or BF. FFMI and BFMI eliminate differences in FFM and BF due to height and allow the creation of recommended ranges, regardless of age and height. FFMI and BFMI have been reported in studies in a small number of healthy individuals (VanItallie et al., 1990; Westerterp et al., 1992) and patients (Mostert et al., 2000; Engelen et al., 1999; Engelen et al., 1999a). According to a study conducted by Schutz et al. (2002), the normal fat mass index for women aged 35-54 years is 6.2 ± 2.1 kg / m^2. The fat mass indices in the two study groups were 5.7 ± 1.2 kg / m^2 in the first and 6.1 ± 1.2 kg / m^2 in the second, respectively, which shows that it deviates slightly in the direction lower than the normal values.

Visceral fats in the two groups are respectively: first group - third level and second group - 4 level, which falls within the norm, which is from 1st to 9th level (OMRON Healthcare, 2021). An increased amount of visceral fat is thought to be directly linked to an increased risk of disease. Even people with normal weight may have elevated levels of visceral fat, which is associated with metabolic disorders.

If women maintain physical activity, according to (Bazzocchi et al., 2013), their lean body tissue will be preserved in the period from 20 to 70 years. Our study shows that physical activity in both groups leads to the maintenance of normal muscle mass levels (24.3-30.3% for the first group and 24.1-30.1% for the second group). There is no statistically significant difference in the percentage of muscle mass, but the muscle mass of the second group is higher (Mann Whitney test, P value = 0.04) than the muscle mass of the first, and the same dependence is observed in lean body mass (Mann Whitney test, P value = 0.03). Higher weight and BMI lead to higher fat and muscle mass indices. This is because a mathematical BMI is the sum of both indices and as one or both of them increase, so does it.

Normal muscle mass indices range from 14.6 to 16.8 kg / m^2 in women with normal BMI (Kyle et al., 2003; Schutz et al, 2002). In the studied groups this index was 14.6 ± 0.6 in the first and 15.2 ± 0.9 in the second, respectively, which shows that both studied groups are within the normal muscle mass. Higher muscle mass and lean body mass in the second group are clear evidence that continuous physical activity leads to its increase. On the other hand, lean body mass includes not only muscle mass, but the mass of bones and body fluids. It is known (Burke and Deakin, 2015) that maximum bone density with proper nutrition and physical activity can be reached around the 35th anniversary of a person. The second group of women are over 35 years old, while the first are with an average age of 29. 7 years. Since all of them are physically active and from the previous analysis of nutrition they eat well, probably the higher lean body mass is due to the higher bone density in the second group.

Somatotyping is another suitable method for comparing different groups of people. In our case, it was used in order to find the differences in the two studied groups. As we have seen from the anthropometric data, there are no statistically significant differences in most of the data.

Both groups are quite heterogeneous in terms of somatotype and it cannot be used to compare them. Although the subjects have a low percentage of fat mass, it is clear that in the first group there are two women with a predominant endomorphic component, one of them has

a higher percentage of fat mass than the others, while in the other the percentage of fat mass is normal. In the second group, there is only one person with a predominant endomorphic component, but this is not the person with a higher percentage of fat mass. Somatotyping in this case shows the distribution of subcutaneous fat in the body and can be used to correct exercise and massage in the second group.

Both methods for determining body composition and somatotyping allow for individual analysis and follow-up. This can help to create an appropriate set of exercises to help "clear the fat" of specific areas of the body. During the massage you can also pay more attention to certain areas in order to help regenerate the skin and reduce subcutaneous fat.

CONCLUSIONS

As a result of the study, the following conclusions can be drawn: - Physical activity leads to benefits in terms of weight and body composition; - The combination of the two methods: determination of body composition and determination of somatotype can help to determine the characteristic features of the body of the person and give guidelines for correction in physical activity and massage procedures; - Women over the age of 40 can keep the percentage of body fat within normal limits by combining physical activity with anti-cellulite massage; - The increase in muscle mass can continue at the age of 40 with regular exercise; - Nutrition is extremely important for a healthy weight, but in the studied groups it is necessary to adjust the amounts of carbohydrates and proteins. Increasing the amount of carbohydrates in the form of whole grains, fruits and vegetables would contribute to increased intake of vitamins, minerals and fiber, which will have a good effect on the general condition of individuals. Reducing the amount of protein will not interfere with the normal synthesis of muscle proteins, but will support the work of the liver, kidneys and protect the body from calcium excretion;

This study provokes many more questions about the effect of both methods on weight and body composition. If it is possible to conduct planned research (cancellation of the emergency epidemic situation), it would be good to make measurements over time, which will allow to compare the effect of Pilates and anti-cellulite massage.

Conflicts of Interest: The authors declare that there is no conflict of interest..

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