**International Journal of Science Academic Research**
Vol. 04, Issue 03, pp.5247-5253, March, 2023
Available online at http://www.scienceijsar.com

ISSN: 2582-6425

**Research Article**

# INFLUENCE OF ELECTROMYOSTIMULATION AND MODERATE PHYSICAL ACTIVITY ON BODY COMPOSITION AND SOMATOTYPE IN MENOPAUSAL WOMEN

***Tatyana Dzimbova and Kalinka Yordanova**

Faculty of Public health, Health Care and Sport, South-West University "Neofit Rilski" Bulgaria

**Received** 15th January 2023; **Accepted** 10th February 2023; **Published online** 14th March 2023

**Abstract**

Menopause is a permanent cessation of menstruation due to loss of ovarian follicular function. There are several symptoms that are associated with menopause: hot flashes, urinary incontinence, urinary tract infection, vaginal atrophy, decreased sexual function, depression and in many cases obesity. The reason for the weight gain in these women is not clear. Some of the scientists' arguments are that estrogen deficiency is probably an important trigger for obesity. Although studies strongly suggest that obesity impairs lymphatic function, the mechanisms that regulate these effects remain unknown. The aim of the study was to monitor changes in key anthropometric parameters such as weight, body fat percentage, muscle mass, skin folds and girth in a combination of exercise and electromyostimulation in menopausal women. The study started in May 2020. As a result of the study, individuals slightly reduced their weight and changed the endomorphic and mesomorphic components of the somatotype, the main change being in the circumference of the waist, thigh and knee. The main conclusions we made from the study are that increasing physical activity inevitably leads to benefits in terms of weight, body composition and circumferences. Combination of methods for improving lymphatic circulation results in the release of excess water from the body. Positive results were obtained in overweight women, but not in those with a normal body mass index, which means that the methods are more effective in them. The inclusion of physical activity has a beneficial effect on quality of life.

**Keywords:** Obesity, Physical activity, EMS, Somatotype.

## INTRODUCTION

Menopause is a permanent cessation of menstruation due to loss of ovarian follicular function. Clinically, menopause is diagnosed after 12 months of amenorrhea. The average age at menopause is about 51 years (Greendale *et al.,* 1999). There are several symptoms that are associated with menopause: hot flashes, urinary incontinence, urinary tract infection, vaginal atrophy, decreased sexual function, and depression. In addition to the symptoms listed above, overweight and obesity are common in menopausal women. The reason for the weight gain in these women is not clear. Some of the scientists' arguments are that estrogen deficiency is probably an important trigger for obesity (Clegg, 2012). Estrogen deficiency exacerbates metabolic dysfunction predisposing to type 2 diabetes, metabolic syndrome and cardiovascular disease. The age of the last menstrual cycle is of internal clinical and public interest, as it can be a marker of general aging and health (Gold, 2011). The effects of body weight and obesity have been extensively studied as a potential determinant of this age (Gold *et al.,* 2001). Weight gain has often been reported in middle-aged women, but the links between obesity, weight gain and menopausal transition remain unclear. Due to differences in the plans of the study, analysis or different control of the independent variables, contradictory findings were observed in the study of the relationship between body weight and age at menopause. Some studies report that both elevated body mass index (BMI) and upper body fat distribution (indicated by the waist-to-hip ratio) are associated with later onset of natural menopause (Rödström *et al.,* 2003; Reynolds and Obermeyer, 2005; Daniell, 1978), while many other studies do not report a significant association of BMI with age at natural menopause (Luoto *et al.,* 1994; Stanford *et al.,* 1987; Gold *et al.,* 2000; Bromberger *et al.,* 1997; Den Tonkelaar *et al.,* 1990). In a large study of women's health in America (SWAN), the analysis did not show a link between obesity and the age of natural menopause, but obesity is more likely to be associated with surgical menopause (Gold *et al.,* 2001). Weight gain in middle age is mainly influenced by age and not by the last menstrual cycle. However, menopause is associated with an increase in abdominal subcutaneous and visceral adipose tissue, as seen in a study using computed tomography (CT) showing an increase in subcutaneous adipose tissue with age, regardless of menopausal status, while visceral and total body fat increase only in postmenopausal women during the 4 years of follow-up(Lovejoy *et al.,* 2008). The change in visceral obesity is accompanied by a decrease in circulating estradiol and an increase in FSH and has been attributed by the authors to the effect of estrogen on lipoprotein lipase activity and lipolysis (Lovejoy *et al.,* 2008); this is also reflected in a study showing increased waist circumference and waist / hip ratio in menopausal women, even after controlling BMI and other factors (Donato *et al.,* 2006). Another study using magnetic resonance imaging (MRI) showed an increase in abdominal subcutaneous and visceral adipose tissue at menopause, but without a change in BMI or waist circumference (Franklin *et al.,* 2009). These changes are sometimes described as a transition from a gynecoid to an android pattern of fat distribution (Abdulnour *et al.,* 2012; Ho *et al.,* 2010). Accumulation of abdominal fat in postmenopausal women appears to be a critical factor in the development of insulin resistance and type 2 diabetes (Lobo *et al.,* 2014). This constellation of adverse effects often includes an abnormal lipid profile, with an increase in low-density lipoprotein cholesterol and a decrease in the ratio of total cholesterol to high-density lipoprotein cholesterol (Franklin *et al.,* 2009).

***Corresponding Author:** ***Tatyana Dzimbova***
Faculty of Public health, Health Care and Sport, South-West University "Neofit Rilski" Bulgaria

Interventions to treat obesity include physical activity, a calorie-controlled diet, pharmacotherapy, or bariatric surgery. Menopausal hormone therapy has been associated with a reduction in central obesity and an increase in insulin sensitivity, as observed in most randomized controlled trials (Sørensen *et al.,* 2001; Yüksel *et al.,* 2006; Davis *et al.,* 2000), but hormone therapy should not be prescribed for this purpose alone. Metformin is effective in slowing the progression of impaired glucose tolerance to type 2 diabetes (Goldberg *et al.,* 2013). Lifestyle modifications, such as diet and exercise, have been more effective in randomized controlled trials to reduce the incidence of diabetes in those at high risk (Knowler *et al.,* 2002). Menopausal women are ideal candidates for preventive measures such as diet modification and physical activity, and health care providers should encourage these women to adhere to these lifestyle changes to prevent obesity-related diseases. and aging. Obesity leads to pathological changes in almost every organ system and is a leading cause of morbidity and mortality (Weitman *et al.,* 2013). The cardiovascular system is the main focus of research on the pathology caused by obesity, and recent studies have clarified some of the mechanisms by which obesity causes vascular disorders. Although the effects of obesity on the cardiovascular system have been extensively studied, there are relatively few studies on how changes in diet or fat accumulation affect the lymphatic system. This is important because the lymphatic system plays a critical role in the return of interstitial fluid and lipids to the cardiovascular system. Because lymph nodes are key regulators of inflammation, they may play a major role in regulating cardiovascular damage in obesity. Therefore, understanding how obesity and dietary changes regulate lymphatic function and immune responses is important and can provide important information about the pathology of obesity.

The hypothesis that obesity or dietary changes may cause pathological changes in the lymphatic system is supported by several studies. For example, recent reports indicate that obese patients have significantly impaired tissue clearance of macromolecules (Arngrim *et al.,* 2013; Greene *et al.,* 2012). In addition, clinical reports have documented the spontaneous development of lymphedema, a disease clinical condition characterized by interstitial fluid accumulation and localized fat deposition in obese patients. Similarly, postoperative weight gain has been shown to increase the risk of lymphedema in patients undergoing lymph node dissection, suggesting that the detrimental effects of obesity and surgery are additional (McLaughlin *et al.,* 2008). Finally, experimental studies in hypercholesterolemic mice have shown that these animals develop progressive lymphatic dysfunction leading to tissue swelling, lymphatic drainage, and impaired immune cell traffic (Lim *et al.,* 2009). Although all of these studies strongly suggest that obesity impairs lymphatic function, the mechanisms that regulate these effects remain unknown. The aim of the study was to monitor changes in key anthropometric parameters such as weight, body fat percentage, muscle mass, skin folds and circumferences in a combination of exercise and electromyostimulation in menopausal women.

## MATERIAL AND METHODS

### Subjects

Five women (age 49.8 ± 4.7 years and height 169.6 ± 8.5 cm) participated in the study. The study was conducted in the period May - June 2020 at the Aesthetic Center for Beauty and Holistic Treatment "Divine" in Blagoevgrad. Prior to the start of the study, participants were familiar with its methods and objectives and signed a declaration of informed consent. Its holding has been approved by the Scientific Research Committee of South-West University "Neofit Rilski".

### Determination of weight and body composition

Determination of body composition is performed with TANITA Inner ScanV. The device presents not only analyzed results for body composition, but also basal metabolism. The participants in the study were maximally undressed and barefoot. From the results obtained, weight, body mass index (BMI), fat percentage, muscle mass and basal metabolism were used.

### 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 were used to obtain the values of the somatotype components.

### Measuring circumferences

Measurements were performed on three circumferences - waist, thigh and knee. All measurements are made with a tape measure to the nearest 0.5 cm, the circumferences being taken parallel to the floor.

### 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 number of kilocalories they normally consume and, accordingly, the amount of carbohydrates, proteins and fats that are on their menu.

### Electromyostimulation

EMS was performed with VipLine (Italy). The tool is an 8-channel system (4 channels for each side of the body), which allows operation in different modes. For the purposes of the study we used isometric stimulation with a frequency of 20 pulses per second for 6 seconds. The whole procedure lasts 40 minutes, with the subject lying on the couch with electrodes fixed on his body. The electrodes are fixed as follows on the posterolateral abdominal wall, on the thighs 3 cm distal to the inguinal fold, 2 cm from the upper border of the patella, on the calves, just below the knees and at the point where the soleus ends and the Achilles tendon begins. The intensity of stimulation for each muscle was increased during the training program according to the tolerance of the subjects to always be at the maximum allowable value.

### Pilates

The subjects performed a series of exercises lasting 45 minutes and the average amount of energy expended in the group was about 180 kcal. Exercises include warm-up - 5 minutes, work for individual joints and muscles - 35 minutes and exercises

with dumbbells of 2 kg - 5 minutes. The trainings are held in a group.

### Research design

The study began in May 2020. At the first meeting with the respondents, they were introduced to the objectives of the study and the methods that will be used and signed a declaration of informed consent. The first anthropometric measurements were performed, determining height, hip and waist circumference, weight, fat percentage, muscle mass, body mass index, and basal metabolism using the TANITA Inner Scan V. Three skin folds (triceps, subscapular, supraspinale), two diameters (humerus, femur) and two circumferences (arm and calf) were measured to determine somatotype. The subjects received a survey to determine the energy value of commonly consumed food. A schedule was drawn up for electromyostimulation procedures and Pilates exercises. All subjects performed 10 electromyostimulation procedures and attended eight exercise sessions. After the end of the electromyostimulation procedures, the second anthropometric measurements were performed. The participation of all subjects in this study was necessary in compiling the full schedule. Despite the emerging epidemic situation, the smooth running of the study had to be ensured. The participants in the study were asked to limit their contacts outside the study in order not to get COVID-19 and thus to break the established schedule. We relied entirely on their motivation and awareness. At each stage of the study and during all procedures the rules for safety work in this environment were observed, as the premises and instruments were disinfected, the trainings were held in a well-ventilated hall with a large distance (more than 2 m) between the participants. Compliance with all these measures is the main reason for the small number of respondents.

### Data analysis

Graph Pad Prism (Ver. 3.0) is used for data processing and analysis.

Mean values, standard deviations and coefficients of variation 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 (Wilcoxon signed rank test) and generation of graphs.

## Results

The participants in the study filled in a nutrition questionnaire and the results are presented in a Table 1. In the subjects, the energy received from different sources is presented in Figure 1.

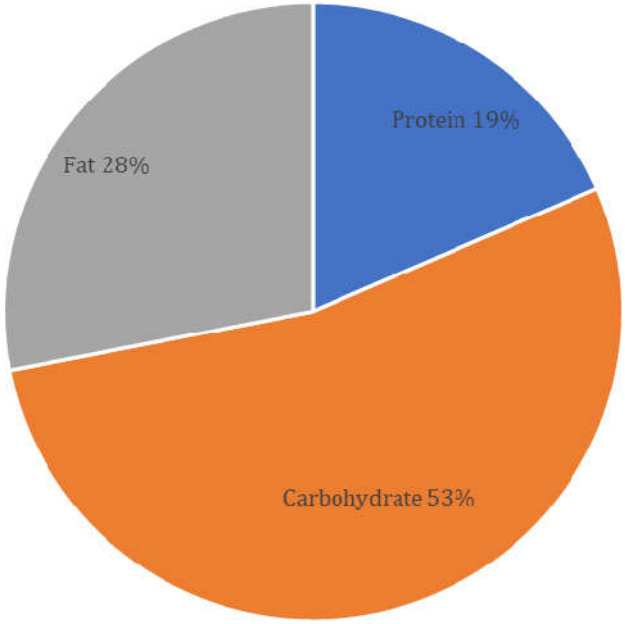


**Fig. 1. Percentage of energy from the three main food sources - carbohydrates, fats and proteins**

Data from anthropometric studies, somatotype components and circumferences are presented in Table 2, 3 and 4, respectively.

**Table 1. Essential nutrients and energy intake in the usual diet of the subjects**

| ID | Basal metabolism, kcal/day | | Amount | | | | |
|---|---|---|---|---|---|---|---|
| | Determined byTanita ScanV | Calculated by Harris-Benedict equation | Energy, kcal/day | Energy corrected by 5% underestimation (Nothlings, et al., 2007) | Proteins, g | Carbohydrates, g | Fats, g |
| KY1 | 1310 | 1341 | 1264 | 1327 | 79 | 121 | 68 |
| KY2 | 1453 | 1511 | 1533 | 1610 | 73 | 187 | 52 |
| KY3 | 1289 | 1335 | 1641 | 1723 | 52 | 275 | 29 |
| KY4 | 1695 | 1652 | 1845 | 1937 | 68 | 100 | 47,5 |
| KY5 | 2020 | 1887 | 1954 | 2052 | 52 | 254 | 22 |
| Mean | 1545 | 1553 | 1647 | 1730 | 64,8 | 187,4 | 43,7 |
| ±SD | 232 | 307 | 270 | 284 | 12,3 | 77,7 | 18,4 |

**Table 2. Anthropometric data of the subjects in both measurements**

| ID | Age, years | Height, cm | Weight, kg | | BMI, kg/m$^2$ | | % FM | | MM, kg | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| KY1 | 47 | 163 | 63,3 | 63,5 | 23,7 | 23,9 | 30,8 | 30,1 | 41,6 | 42.1 |
| KY2 | 57 | 158,5 | 86,8 | 86,4 | 34,5 | 34,4 | 46,2 | 43,1 | 44,4 | 44,4 |
| KY3 | 47 | 163,5 | 62,5 | 63,4 | 23,4 | 23,7 | 31,2 | 31,7 | 40,8 | 39,7 |
| KY4 | 52 | 177,5 | 95,4 | 93,5 | 30,3 | 29,7 | 41,7 | 36 | 52,8 | 54,6 |
| KY5 | 46 | 180 | 116,6 | 115,1 | 36 | 35,5 | 43,9 | 39,9 | 62,1 | 62,7 |
| Mean | 49,8 | 168,5 | 84,9 | 84,4 | 29,6 | 29,4 | 38,8 | 36,2 | 48,3 | 50,4 |
| ±SD | 4,7 | 9,6 | 22,8 | 21,8 | 5,9 | 5,6 | 7,3 | 5,4 | 9,0 | 10,3 |

BMI - body mass index, FM– fat mass, MM - muscle mass, Mean - average; ± SD - standard deviation, 1 - measurement on 28.05.2020, 2 - measurement on 26.06.2020

**Table 3. Change in somatotype components during the study**

| ID | Endomorph | | Mesomorph | | Ectomorph | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 |
| KY1 | 4.6 | 4.0 | 5.1 | 5.4 | 2.1 | 2.1 |
| KY2 | 4.4 | 4.8 | 9.6 | 9.3 | 0.5 | 0.5 |
| KY3 | 3.9 | 3.3 | 5.1 | 5.6 | 1.7 | 1.5 |
| KY4 | 2.4 | 1.8 | 4.6 | 5.4 | 0.5 | 0.5 |
| KY5 | 3.5 | 2.9 | 7.4 | 7.2 | 0.5 | 0.5 |
| Mean | 3.7 | 3.3 | 6.3 | 6.6 | 0.8 | 0.7 |
| ±SD | 0.9 | 1.1 | 2.1 | 1.7 | 1.0 | 1.0 |

Mean - average; ± SD - standard deviation, 1 - measurement on 28.05.2020, 2 - measurement on 26.06.2020

**Table 4. Circumferences of the subjects in both measurements**

| ID | Waist circumference, cm | | Thigh circumference, cm | | Knee circumference, cm | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 |
| KY1 | 86 | 85 | 58 | 57 | 42 | 42 |
| KY2 | 111 | 107 | 68 | 66 | 46 | 45 |
| KY3 | 103 | 101 | 63 | 61 | 49 | 47 |
| KY4 | 86 | 85 | 58 | 54 | 42 | 42 |
| KY5 | 121 | 115 | 71 | 70 | 48 | 47 |
| Mean | 101,4 | 98,6 | 63,6 | 61,6 | 45,4 | 44,6 |
| ±SD | 15,4 | 13,4 | 5,9 | 6,5 | 3,3 | 2,5 |

Mean - average; ± SD - standard deviation, 1 - measurement on 28.05.2020, 2 - measurement on 26.06.2020

## DISCUSSION

The study involved 5 women aged 49.8 ± 4.7 years and height 169.6 ± 8.5 cm. As can be seen from age, they are all at the beginning of the menopausal period with a sedentary lifestyle, which inevitably affects their physical condition. Most of them are overweight or obese. In addition, all reported various anxiety and depressive states, mood swings. Fatigue and the inability and unwillingness to deal with basic everyday problems are one of the main problems for everyone. This creates preconditions for poor quality of life and subsequent health problems. Each of them joined the study with the clear awareness that they want to change their weight and lifestyle by introducing mandatory physical activity in their daily lives.

Nutrition is one of the main reasons for weight gain. In our preliminary conversations with the participants in the study and acquaintance with their attitude to change in lifestyle, we found that they are least inclined to change their diet. On their first visit, they filled out a questionnaire about their usual diet in order to analyze it and find out how much it affects their current physical condition. 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 / m2 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 below this minimum. This is due to the fact that usually when filling out questionnaires (Nothlings *et al.,* 2007) women reduce the amount of food they eat by an average of about 5%. The adjusted values of food intake are on average about 1730 kcal / day, which corresponds to the energy needs of the studied group of people. In addition, there are no questions in the questionnaire related to the use of alcohol, which is known to supply a large amount of energy (7 kcal per 1 g of alcohol). One glass of wine gives about 140 kcal of energy, which must also be added to the energy consumed by the subjects. Many age-related changes that affect energy needs occur continuously throughout the adult life cycle. BMR decreases with age at a rate of 1 to 2% per decade (Keys *et al.,* 1973). An average reduction of 2.9 and 2.0 percent per decade for men and women of normal weight (BMI of 18.5 to 25.0 kg/m$^2$), respectively, was calculated rather (Roberts and Dallal, 2001). The recommendations differ from country to country, but the general recommendations are as follows (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; Food and Agriculture Organisation and World Health Organisation, Carbohydrates in Human Nutrition, 1998): - Enjoy your food; - Eat a diet of adequate nutritional value, consisting of a variety of foods; - Reduce fat intake, especially saturated fat (total fat should provide 30-35% of daily calories): 8-10% of total calories from saturated fatty acids, up to 10% of total calories from polyunsaturated fatty acids, up to 15% of total calories from monounsaturated fatty acids: - Achieve and maintain an appropriate body weight; - Increase consumption of complex carbohydrates and dietary fiber; - Reduce sodium intake (<6 g / day); - Consume alcohol in moderation (no more than 2 drinks per day). Children and pregnant women should refrain; - Carbohydrates should provide 55-60% of the daily energy intake, and most of them should be fruits, vegetables and whole grains. From these recommendations we can conclude that in a properly structured diet the percentage of energy from carbohydrates should be about 55-60%, from fat - 30-35% and respectively from protein - 15-20% (Figure 1). As can be seen, the nutrition of the participants in the study did not differ significantly from the recommendations, so we did not take any interventions in the diet during the study. On the other hand, any change in diet would have some effect on body weight and composition, and in combination with the methods used in the study, it would be difficult to interpret the data. Therefore, the subjects were asked to continue to eat in their usual way.

The changes we applied during the study, which lasted one month, were ten electromyostimulation procedures and eight Pilates exercises. At the beginning and at the end of the period, anthropometric measurements were performed in order to establish the influence of the applied methods on body weight and composition. As can be seen from the table, the age of the participants is in the range of 46 - 57 years, ie the difference between the youngest and the oldest is 11 years. As the condition was voluntary inclusion in the study, as well as the participation of close people, given the epidemic situation, the study was conducted with these subjects. Height and weight in the group also vary greatly. Height ranged from 158.5 to 180 cm and weight from 62.5 kg to 116.6 kg at the beginning of the study. As the aim of the study was to monitor the effect of electromyostimulation and moderate exercise with Pilates exercises, this study group was appropriate. For a period of four weeks using both methods in the study group, an average weight loss of 0.5 kg was observed. However, analyzing the individual changes, it can be seen that two of the subjects had a slight increase in weight, and the other three slightly reduced it. These results, respectively, affect the values of BMI, as it depends on body weight. The expected effect of applying the procedures during the study is to reduce the percentage of body fat. This effect was seen in four of the subjects, with only one

of them having a slight increase of 0.5%. The inclusion of exercise twice a week resulted in a slight increase in muscle mass in four of the subjects, and again there was a decrease in only one of the participants in the study. Electromyostimulation (Crognale *et al.,* 2009; Banerjee *et al.,* 2005; Banerjee *et al.,* 2009; Nuhr, et al.., 2004; Rostrup, et al.., 2014) is a proven method for stimulating muscles and improving their work. The combination of EMS and exercise has a beneficial effect on the anthropometric performance of four of the five subjects. During the study, the somatotypes of the study group and how their components were affected by the applied weight loss methods were monitored. At the beginning of the study, the mean somatotype was 3.7-6.3-0.8, while at the end of the study it was changed to 3.3-6.6-0.7, respectively. as can be seen from the values of the components, all have changed slightly, with the largest change in the endomorphic component, which decreased by 0.4, followed by the mesomorphic component, which increased by 0.3 and the smallest change in the ectomorphic component, which decreased by 0.1. There is no statistically significant difference in the change of all three somatotype components, but since we work with few subjects, this is to be expected. Analyzing the individually obtained values of the somatotype components, it can be seen that in only one of the individuals the endomorphic component increased slightly in the second measurement. The mesomorphic component increased slightly in three of the study participants, while it decreased slightly in the other two. The ectomorphic component is least affected by the applied methods. No correlations were found between anthropometric data and somatotype components.

The most significant changes in all subjects were observed in the values of the measured circumferences: waist, thigh and knee. As can be seen from the data in Table 4, all participants in the study had changes in these circumferences. Only two of them have no changes in the knee circumference, but otherwise all other circumferences have changed. It is noteworthy that the most serious change in the circumference is observed at the waist circumference. The average change there is 2.8 cm, and only in two of the subjects the change is 1 cm, while in the other three it is 2, 4 and 6 cm. The circumference of the thigh follows as the average change is 2 cm. Only in two of the subjects it is 1 cm, while the rest is 2 and 4 cm. The smallest change is in the circumference of the knee, the average value is 0.8 cm - in two there is no change, and in the other 3 it is 1 cm. Fat accumulates in the area of waist and hips and this change gives hope for the effectiveness of weight loss methods. Weight gain leads to an increase in subcutaneous and visceral fat, which inevitably leads to an increase in girth in the relevant areas. In addition to tracking weight, weight loss can be effectively monitored by measuring circumferences in several areas of the body, and the change in these circumferences can monitor the process of weight loss. However, reducing the circumference is not always associated with a reduction in the percentage of body fat. Often this is due to a reduction in the amount of water retained in the body. Our assumption in connection with the change in the circumference of the waist, thigh and knee is that it is due to the release of retained fluids, as there is no significant change in the percentage of adipose tissue in the study group. Two of the subjects were in the normal range of BMI, while the other three were obese. The applied methods had a greater impact on the overweight participants, as they observed changes in all measured parameters. The increase in physical activity and additional electromyostimulation without a change in diet leads to an increase in energy expenditure and hence to weight loss and a change in body composition. Releasing the body from retained fluids leads to a significant reduction in body circumference in obese women. As there is evidence in the literature that electromyostimulation helps to improve the condition of the lymphatic system, this gives us reason to assume that the effects observed in the essay participants are due to the better functioning of this system. As a result of the established organization of the study, in addition to the changes in the body, significant changes in their general condition are observed in the examined persons. Although no psychological tests were performed, participants reported feeling more energetic, and as the study progressed, they became more enthusiastic and motivated to change their lifestyle. They cope with their daily tasks with greater ease and the feeling of fatigue has poured in. They start to like more activity. This positive attitude towards change is an extremely important result.

**Conclusion**

As a result of the study, the following conclusions can be drawn: -Increasing physical activity inevitably leads to benefits in terms of weight, body composition and girth; - Combining exercise with muscle electrical stimulation improves the functions of the lymphatic system and frees the body from excess water; - The methods used are more effective in overweight women than in those with normal BMI; - The applied methods have a positive effect on the mood of the participants and their ability to cope with everyday tasks; - Lifestyle change with the inclusion of physical activity at all ages has a beneficial effect on quality of life. This study raises many more questions about the effect of both methods on body weight and composition. Future research could answer these questions, and this will provide an opportunity to create a weight loss methodology that can benefit women with similar problems.

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

## REFERENCES

Abdulnour, J., Doucet, E., Brochu, M., Lavoie, J.-M., Strychar, I., Rabasa-Lhoret, R., and Prud'homme, D. (2012). The effect of the menopausal transition on body composition and cardiometabolic risk factors: a Montreal-Ottawa New Emerging Team group study. *Menopause*, 19, 760-767.

Arngrim, N., Simonsen, L., Holst, J. J., and Bulow, J. (2013). Reduced adipose tissue lymphatic drainage of macromolecules in obese subjects: a possible link between obesity and local tissue inflammation? *Int J Obes (Lond)*, 37, 748-750.

Avis, N. E., Brambilla, D., McKinlay, S. M., and Vass, K. (1994). A longitudinal analysis o f the association between menopause and depression. Results from t h e Massachusetts Women's Health Study. *Ann Epidemiol*, 4, 214-220.

Banerjee, P., Caulfield, B., Crowe, L., and Clark, A. (2005). Prolonged electrical muscle stimulation exercise improves strength and aerobic capacity in healthy sedentary adults. *J Appl Physiol*, 99, 2307–2311.

Banerjee, P., Caulfield, B., Crowe, L., and Clark, A. L. (2009). Prolonged electrical muscle stimulation exercise improves

strength, peak VO2, and exercise capacity in patients with stable chronic heart failure. *J Card Fail*, 15, 319-326.

British Nutrition Foundation. (2018). Извлечено от https://www.nutrition.org.uk/index.php?option=com_content&view=article&id=263:energy-intake-and-expenditure&catid=65&Itemid=199&showall=1&limitstart

Bromberger, J. T., Matthews, K. A., Kuller, L. H., Wing, R. R., Meilahn, E. N., and Plantinga, P. (1997). Prospective Study of the Determinants of Age at Menopause. *American Journal of Epidemiology*, 145, 124-133.

Clegg, D. J. (2012). Minireview: the year in review of estrogen regulation of metabolism. *Molecular Endocrinology*, 26, 1957–1960.

Crognale, D., Crowe, L., Devito, G., Minogue, C., and Caulfield, B. (2009). Neuro-muscular electrical stimulation training enhances maximal aerobic capacity in healthy physically active adults. *Annu Int Conf IEEE Eng Med Biol Soc*, *1*, 2137-40.

Daniell, H. W. (1978). Smoking, obesity, and the menopause. Lancet, 2, 373.

Davis, S. R., Walker, K. Z., and Strauss, B. J. (2000). Effects of estradiol with and without testosterone on body composition and relationships with lipids in postmenopausal women. Menopause, 7, 395-401.

Den Tonkelaar, I., Seidell, J. C., Van Noord, P. H., Baanders-Van Halewijn, E. A., and Ouwehand, I. J. (1990). Fat distribution in relation to age, degree of obesity, smoking habits, parity and estrogen use: A cross-sectional study in 11825 Dutch women participating in the DOM project. *International Journal of Obesity*, 14, 753-761.

Diokno, A. C., Brown, M. B., and Herzog, A. R. (1990). Sexual function in the elderly. *Arch Intern Med*, 150, 197-200.

Donato, G. B., Fuchs, S. C., Oppermann, K., Bastos, C., and Spritzer, P. M. (2006). Association between menopause status and central adiposity measured at different cutoffs of waist circumference and waist-to-hip ratio. *Menopause*, 13, 280-285.

Fantl, J. A., Cardozo, L., and McClish, D. K. (1994). Estrogen therapy in the management of urinary incontinence in postmenopausal women: a meta-analysis. *Obstet Gynecol*, 83, 12-18.

Food and Agriculture Organisation, and World Health Organisation. (1998). *Carbohydrates in Human Nutrition*. Rome: FAO.

Food and Agriculture Organisation, World Health Organisation, and United Nations. (1985). *Energy and Protein Requirements*. Technical Report Series No. 724. Geneva: WHO.

Food and Agriculture Organization, and World Health Organisation. (1994). *Fats and Oils in Human Nutrition*. Rome: FAO.

Franklin, R. M., Ploutz-Snyder, L., and Kanaley, J. A. (2009). Longitudinal changes in abdominal fat distribution with menopause. *Metabolism*, 58, 311-315.

Gold, E. B. (2011). The timing of the age at which natural menopause occurs. *Obstet Gynecol Clin North Am*, 38, 425-440.

Gold, E. B., Bromberger, J., Crawford, S., Samuels, S., Greendale, G. A., Harlow, S. D., and Skurnick, J. (2001). Factors associated with age at natural menopause in a multiethnic sample of midlife women. *American Journal of Epidemiology*, 153, 865-874.

Gold, E. B., Sternfeld, B., Kelsey, J. L., Brown, C., Mouton, C., Reame, N., Salamone, J., Stellato, R. (2000). Relation of demographic and lifestyle factors to symptoms in a multi-racial/ethnic population of women 40-55 years of age. *American Journal of Epidemiology*, 152, 463-473.

Goldberg, R., Temprosa, M., Otvos, J., Brunzell, J., Marcovina, S., Mather, K.,Arakaki, R., Watson, K., Horton, E., Barrett-Connor, E. (2013). Lifestyle and Metformin Treatment Favorably Influence Lipoprotein Subfraction Distribution in the Diabetes Prevention Program. *The Journal of Clinical Endocrinology and Metabolism*, 98, 3989-3998.

Greendale, G. A., Hogan, P., and Shumaker, S. (1996). Sexual functioning in postmenopausal women: the postmenopausal estrogen/progestin interventions trial. *J Womens Health*, 5, 445-458.

Greendale, G. A., Lee, N. P., and Arriola, E. R. (1999). The menopause. *THE LANCET*, 363, 571-580.

Greene, A. K., Grant, F. D., and Slavin, S. A. (2012). Lower-extremity lymphedema and elevated body-mass index. *N Engl J Med*, 366, 2136-2137.

Hay, A. G., Bancroft, J., and Johnstone, E. C. (1994). Affective symptoms in women attending a menopause clinic. *Br J Psychiatry*, 164, 513-516.

Hinton, P., Tweddell, A. L., and Mayne, C. (1990). Oral and intravaginal estrogens alone and in combination with alpha adrenergic stimulation in genuine stress incontinence. *Int Urogynecol J*, 1, 80-86.

Ho, S. C., Wu, S., Chan, S. G., and Sham, A. (2010). Menopausal transition and changes of body composition: a prospective study in Chinese perimenopausal women. *International Journal of Obesity*, 34, 1265-1274.

Hunter, M. S. (1990). Psychological and somatic experience of the menopause a prospective study. *Psychosom Med*, 52, 357-367.

Kaufert, P. A., Gilbert, P., and Tate, R. (1992). The Manitoba Project: a reexamination of the link between menopause and depression. *Maturitas*, 14, 143-155.

Keys, A., Taylor, H. L., and Grande, F. (1973). Basal metabolism and age of adult man. *Metabolism*, 22, 579–587.

Kirkova, M., Markov, A., and Dzimbova, T. (2019). Development and Validation of a New Simple Food Frequensy Questionnaire for Bulgarians. *SocioBrains*, 58, 54-57.

Knowler, W. C., Barrett-Connor, E., Fowler, S. E., Hamman, R. F., Lachin, J. M., Walker, E. A., and Nathan, D. M. (2002). Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *New England Journal of Medicine*, 346, 393-403.

Lim, H. Y., Rutkowski, J. M., Helft, J., Reddy, S. T., Swartz, M. A., Randolph, G. J., and Angeli, V. (2009). Hypercholesterolemic Mice Exhibit Lymphatic Vessel Dysfunction and Degeneration. *The American Journal of Pathology*, 175, 1328-1337.

Lindgren, R., Berg, G., Hammar, M., and Zuccon, E. (1993). Hormonal replacement therapy and sexuality in a population of Swedish postmenopausal women. *Acta Obstet Gynecol Scand*, 72, 292-297.

Lobo, R. A., Davis, S. R., De Villier, T. J., Gompel, A., Henderson, V. W., Hodis, H. N., Lumsden M. A., Mack W. J., Shapiro S., Baber, R. J. (2014). Prevention of diseases after menopause. *Climacteric*, 17, 540-556.

Lovejoy, J. C., Champagne, C. M., de Jonge, L., Xie, H., and Smith, S. R. (2008). Increased visceral fat and decreased energy expenditure during the menopausal transition. *International Journal of Obesity*, 32, 949-958.

Luoto, R., Kaprio, J., and Uutela, A. (1994). Age at natural menopause and sociodemographic status in Finland. *Am J Epidemiol*, 139, 64-76.

McLaughlin, S. A., Wright, M. J., Morris, K. T., Giron, G. L., Sampson, M. R., Brockway, J. P., HurleyK. E., RiedelE. R.,Van Zee, K. J. (2008). Prevalence of lymphedema in women with breast cancer 5 years after sentinel lymph node biopsy or axillary dissection: objective measurements. *J Clin Oncol*, 26, 5213-5219.

Milsom, I., Ekelund, P., Molander, U., Arvidsson, L., and Areskoug, B. (1993). The influence of age, parity, oral contraception, hysterectomy and menopause on the prevalence of urinary incontinence in women. *J Urol*, 149, 1459-1462.

Nothlings, U., Hoffmann, K., Bergmann, M. M., and Boeing, B. (2007). Fitting Portion Sizes in a Self-Administered Food Frequency Questionnaire. *The Journal of Nutrition*, 137, 2781–2786.

Nuhr, M. J., Pette, D., Berger, R., Quittan, M., Crevenna, R., Huelsman, M., . . . Pacher, R. (2004). Beneficial effects of chronic low-frequency stimulation of thigh muscles in patients with advanced chronic heart failure. *European Heart Journal*, 26, 136–143.

Osborn, M., Hawton, K., and Gath, D. (1988). Sexual dysfunction among middle aged women in the community. *B M J*, 296, 259-262.

Pearlstein, T., Rosen, K., and Stone, A. B. (1997). Mood disorders and menopause. *Endocrinol Metab Clin North Am*, 26, 279-294.

Reynolds, R. F., and Obermeyer, C. M. (2005). Age at natural menopause in Spain and the United States: results from the DAMES project. *Am J Hum Biol*, 17, 331-340.

Roberts, S., and Dallal, D. E. (2001). Energy requirements and aging. Energy working paper No. 8R. FAO/WHO/UNU Expert Consultation on Energy in Human Nutrition.

Rödström, K., Bengtsson, C., Milsom, I., Lissner, L., Sundh, V., and Bjoürkelund, C. (2003). Evidence for a secular trend in menopausal age: A population study of women in Gothenburg. *Menopause*, 10, 538-543.

Rostrup, E., Slettom, G., Seifert, R., Bjørndal, B., Berge, R. K., and Nordrehaug, J. E. (2014). Effect of combined thermal and electrical muscle stimulation on cardiorespiratory fitness and adipose tissue in obese individuals. *European Journal of Preventive Cardiology*, 21, 1292-1299.

Sørensen, M. B., Rosenfalck, A. M., Højgaard, L., and Ottesen, B. (2001). Obesity and sarcopenia after menopause are reversed by sex hormone replacement therapy. *Obes Res*, 9, 622-626.

Stanford, J. L., Hartge, P., Brinton, L. A., Hoover, R. N., and Brookmeyer, R. (1987). Factors influencing the age at natural menopause. *Journal of Chronic Diseases*, 40, 995-1002.

WeitmanE, S., Aschen, S. Z., Farias-Eisner, G., Albano, N., Cuzzone, D. A., Ghanta, S., Zampell J. C., ThorekD., Mehrara, B. J. (2013). Obesity Impairs Lymphatic Fluid Transport and Dendritic Cell Migration to Lymph Nodes. *PLoS ONE*, 8,e70703.

Yüksel, H., Odabaşi, A. R., Demircan, S., Karul, A., Kozaci, L. D., Köseoğlu, K., KizilkayaK., Başak, O. (2006). Effects of oral continuous 17β-estradiol plus norethisterone acetate replacement therapy on abdominal subcutaneous fat, serum leptin levels and body composition. *Gynecological Endocrinology*, *22*, 381-387.

*******