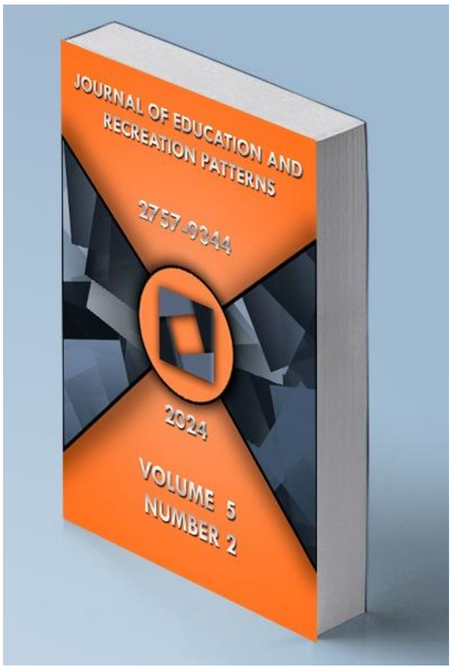

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The Effects of Short-Term Electromyostimulation Exercises and Different Diet Types on Body Composition in Obese Women

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ABSTRACT

Obesity is one of the world's most risky health problems with increasing prevalence. This study aimed to investigate the effect of calorie-restricted diet and intermittent fasting diet on body composition with electromyostimulation (EMS) applications in obese females. The study was conducted with 90 obese females. Participants were randomly divided into 5 groups, EMS, EMS+intermittent fasting (EMS+IF), EMS+calorie restricted (EMS+CR), intermittent fasting (IF), and calorie restricted (CR) diet groups. EMS groups received 27min/2g/week EMS exercise protocol for 4 weeks. Furthermore, dietary interventions were conducted with all groups (except EMS). Body composition measurements of the participants were obtained with a bioelectrical impedance device. Two-way repeated measures ANOVA was used to analyze the obtained data. BMI, body mass, and body fat weight decreased significantly in the EMS+IF, and EMS+CR groups compared to the EMS group while skeletal muscle weight decreased dramatically in all four groups compared to the EMS group. In body analysis regional (right-left arm, right-left leg, and trunk) parameters, fat weight decreased significantly in EMS+IF, and EMS+CR groups compared to the other groups. Moreover, muscle mass decreased more in the EMS+CR and EMS+IF groups compared to the other groups. Dietary interventions in the form of CR or IF with EMS significantly affected body composition measurements in obese participants. EMS and IF dietary interventions may be therapeutic tools to combat obesity.

Keywords: Calorie-Restricted Diet, Electromyostimulation, Exercise, Intermittent Fasting, Obesity

INTRODUCTION

Obesity is a metabolic disease that occurs when dietary energy intake is higher than energy expenditure and is characterized by a higher-than-normal amount of fat mass in the body mass index (Kurt, 2019). Obesity is an important risk factor for metabolic syndrome, type 2 diabetes, cardiovascular diseases, and especially for females in terms of preventing healthy pregnancy process, increasing infertility rate, negatively affecting contraception methods, and delaying milk production during lactation (Zehra et al., 2018). Overall, the World Health Organization (WHO) estimates that approximately 13% of the world's adult population (11% of males and 15% of females) was obese in 2016 and that obesity has almost tripled since 1975 (WHO, 2024). There is a consensus that obesity is one of the most important public health problems of this century due to its increasing prevalence and significant impact on health and medical costs.

Obesity is mainly caused by an imbalance between reduced exercise, excessive intake of high-calorie foods, lifestyle changes, and diet composition (Marinelli et al., 2022). The management of overweight and obesity includes exercise, dietary advice, psychological interventions, pharmacotherapy when needed, and bariatric surgery in people with severe obesity (Oppert et al., 2021). The key rule in the treatment of obesity with diet is to mathematically ensure that the energy expended by the person is more than the energy intake (Baysal et al., 2002). Diet is a modifiable factor in weight gain leading to obesity and weight loss to return to (or maintain) a healthy weight. The same diets consumed by different individuals can lead to different metabolic and health effects (Elagizi et al., 2020). Exercise and low-calorie diets, together with the use of specific medications, constitute the clinical treatment of obesity by promoting a reduction in body fat, an increase in lean mass, and a reduction in comorbidities caused by excess fat (Fonseca-Junior et al., 2013).

Exercise is an integral part of obesity management and health promotion. Physical activity is widely recommended as a strategy for weight control, and exercise interventions improve body composition in both males and females (Donelly et al., 2009). In addition to potential effects on body weight through increased energy expenditure, habitual physical activity and exercise improve markers of appetite control, such as increased satiety response to food and gastric emptying (Beaulieu et al., 2016; Horner et al., 2015). One of the current approaches in the treatment of obesity with exercise is electromyostimulation (EMS) exercises (12). EMS is a technological exercise model that stimulates motor neurons and intramuscular axonal branches with electrical impulses using pads placed on the skin surface (Gobbo et al., 2014). It was reported that periodic stimulation of several muscle groups with EMS increases weight loss, improves exercise capacity, increases peripheral muscle strength, positively accelerates insulin effect, and increases glucose metabolism (André et al., 2005; Kendall et al.,2005). Kemler et al. (2021) reported in a systematic review and meta-analysis of 16 studies including 19 separate whole-body EMS exercise groups representing 897 participants that whole-body EMS exercises had a significant positive effect on muscle mass and strength parameters but had no effect on total body fat mass in non-athletic adults. Bellia et al. (2020) reported that whole-body electromyostimulation with calorie restriction in middle-aged sedentary individuals with metabolic syndrome may improve insulin resistance and lipid profile compared with diet alone. Reljic et al. (2020) reported that whole-body EMS exercise can be considered a feasible and time-efficient exercise option to improve body composition, muscle strength, and cardiometabolic health in obese females with metabolic syndrome. Willert et al. (2019) reported that the combination of whole-body EMS exercise and higher protein intake is an effective tool to positively influence body composition in overweight premenopausal females following a moderate energy deficit. However, it is not clear what the additional contributions of different diets combined with EMS exercises may be to regulate body composition in obese females. For these reasons, it is thought that intermittent fasting diet and calorie restricted diet complexes to be applied together with EMS exercise, which will be preferred as an exercise type, may be an effective method in the treatment of obesity. The study was prepared on this hypothesis.

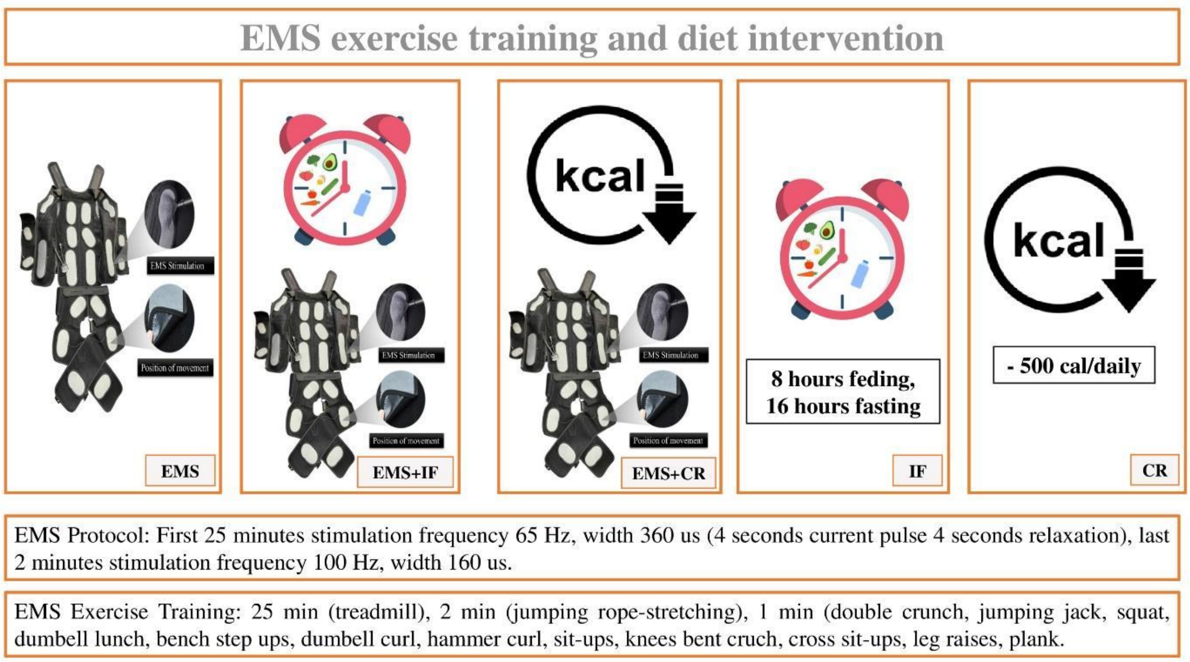
METHOD

Study Design

The ethical declaration of the study was obtained from the Fırat University Non-Interventional Research Ethics Committee with the approval of the ethics committee dated 29.12.2022, session number 2022/16-07. The study was designed voluntarily and a written consent form was obtained from all participants. Moreover, the study was conducted with an experimental research design, one of the quantitative research types, with a pretest-posttest control group design. It was determined that the minimum sample size required to find a significant difference using this test should be 14 for each group when the sample size was type I error (alpha) 0.05, the power of the test (1-beta) 0.8, the effect size 0.82 and the alternative hypothesis (H1) was two-way. However, to obtain stronger results, 20 participants were assigned to each group. Sedentary and obese females between the ages of 30-45, without any disability or disease, who did not follow any diet and exercise program, were included in the study. Participants who did not comply with the diet and exercise protocol and did not continue were excluded. For this reason, although 100 obese female participants were initially determined, 10 participants who did not meet the stated criteria were excluded from the study. The participants in the study were divided into 5 different groups control group (EMS), EMS+intermittent fasting diet group (EMS+IF), EMS+calorie restricted diet group (EMS+CR), intermittent fasting diet group (IF), calorie-restricted diet group (CR). Participants in the EMS exercise group underwent the EMS exercise protocol for 27 minutes a day, 2 days a week for 4 weeks (Figure 1). Descriptive information of the participants is shown in Table 1.

Figure 1

EMS exercise training and diet intervention demonstration



Diet Protocols

Medical nutrition histories of the participants were obtained and daily energy needs were calculated for all participants using the Mifflin St-Jeor equation ((10 x Body Weight (kg) + 6.25 x Height (cm) - 4.92 x Age - 161). Intermittent fasting and calorie-restricted diet protocols were then determined (Agostoni et al., 2013).

Intermittent Fasting Diet

The time-restricted diet module of the intermittent fasting diet system was applied in the study. Participants were fasted for 16 hours of the day and fed for the remaining 8 hours (Köktürk et al., 2021). Participants consumed only calorie-free foods during the fasting hours. Feeding hours were adjusted and applied according to the life routines of the participants. As a standard, the first meal was planned to end at 12:00 noon, the snack at 4:00 pm, and the evening meal at 8:00 pm.

Calorie restricted diet

The diet program was adjusted by restricting 500 kcal from the daily energy requirement of the person calculated using the Mifflin St-Jeor equation. The diet program consisted of 45-60% carbohydrate, 25-35% fat, and 12-15% protein (Baysal et al., 2002) (Figure 1).

Table 1

Descriptive information about the participants

Group	Age (Year) Mean ± SD	Height Length (cm) Mean ± SD	Body Weight (kg) Mean ± SD
EMS	37.89±6.26	162.83±5.26	94.41±9.85
EMS+IF	35.72±6.42	164.11±7.45	89.5±12.12
EMS+CR	39.06±4.83	164.66±9.06	91.55±12.96
IF	37.39±5.89	163.66±6.69	97.05±16.09
CR	37.22±5.73	167.05±6.97	97.68±13.01

EMS; Electromyostimulation group, EMS+IF; Intermittent fasting diet group with EMS exercise, EMS+CR; Group on calorie-restricted diet combined with EMS exercise, IF; intermittent fasting diet group, CR; calorie-restricted diet group.

In Table 1, the mean ages for the research groups are as follows: the EMS group has an average age of 37.89±6.26, the EMS+IF group is 35.72±6.42, the EMS+CR group is 39.06±4.83, the IF group is 37.39±5.89, and CR group is 37.22±5.73. The mean heights (cm) for the groups are reported as follows: EMS group with a height of 162.83±5.26, EMS+IF group at 164.11±7.45, EMS+CR group at 164.66±9.06, IF group at 163.66±6.69, and CR group at 167.05±6.97. Additionally, the mean body weights (kg) are documented for each group: EMS group at 94.41±9.85, EMS+IF group at 89.5±12.12, EMS+CR group at 91.55±12.96, IF group at 97.05±16.09, and CR group at 97.68±13.01.

Body Composition Analysis

Body composition was assessed with an Inbody 120 bioelectrical impedance device using a standardized protocol. The participants were measured under controlled conditions, being barefoot and without any metal objects (watches, rings, necklaces, phones, keychains, etc.), and wearing light clothing. Measurements were taken in the morning (09:00-11:00) following a 12-hour overnight fast after participants had visited the restroom. Height was measured with a stadiometer while the subjects were standing in an upright position. Body mass index (BMI), body weight, body fat weight, skeletal muscle weight, right arm muscle weight, right arm fat weight, left arm muscle weight, left arm fat weight, right leg muscle weight, right leg fat weight, left leg muscle weight, left leg fat weight, trunk muscle weight, and trunk fat weight were obtained (Yasul et al., 2023).

Statistical analysis

IBM SPSS 22.0 package program was used to analyze the data obtained in the study. Arithmetic mean and standard deviation techniques were used as descriptive statistics. Shapiro-Wilk test, histogram, kurtosis, and skewness values were analyzed to test the normality of the distribution and it was determined that the distribution was normal. Two-way repeated measures ANOVA [5 groups (EMS, EMS+IF, EMS+CR, IF, CR) x 2 times (pretest-posttest)] was used to test the change between groups and measurements. Again, Partial eta squared values were calculated to assess effect sizes. Finally, the effect size obtained was categorized as <0.2 insignificant, 0.2-0.49 small, 0.5-0.79 medium, and >0.8 large effect (Cohen, 1988). Statistical significance was accepted as p<0.05.

FINDINGS

In the study, statistical analysis findings related to body composition were shown in tables.

Table 2

Body analysis parameters and ratios

Parameters	Groups	Pre-Test Mean±SD	Post-Test Mean±SD	Change (%)	Time	Time x Group	Group
Body weight (kg)	EMS	94.4±9.85	92.78±10.51	1.72	F=150.09 p=0.000* $\eta p2$=0.638	F=3.606 p=0.009* $\eta p2$=0.145	F=1.405 p=0.239 $\eta p2$=0.062
	EMS+IF	89.50±12.12	85.27±11.52	4.72			
	EMS+CR	91.55±12.96	86.76±13.02	5.23			
	IF	97.05±16.09	91.87±15.33	5.31			
	CR	97.68±13.01	93.49±12.73	4.28			
Body fat weight (kg)	EMS	42.50±8.33	41.12±8.36	3.24	F=108.615 p=0.000* $\eta p2$=0.561	F=1.900 p=0.118 $\eta p2$=0.082	F=2.029 p=0.098 $\eta p2$=0.087
	EMS+IF	38.64±8.43	35.45±7.84	8.25			
	EMS+CR	38.06±7.06	34.73±7.17	8.74			
	IF	43.97±12.11	40.61±11.33	7.64			
	CR	43.42±8.10	40.57±7.80	6.56			
Body skeletal muscle weight (kg)	EMS	28.86±2.87	28.67±2.99	0.65	F=59.235 p=0.000* $\eta p2$=0.411	F=2.331 p=0.062 $\eta p2$=0.099	F=0.383 p=0.820 $\eta p2$=0.018
	EMS+IF	28.48±4.55	27.73±4.66	2.63			
	EMS+CR	29.78±5.66	28.92±5.53	2.88			
	IF	29.48±3.73	28.43±3.62	3.56			
	CR	30.20±4.62	29.41±4.73	2.61			
BMI $(kg/m)^2$	EMS	35.70±4.40	35.06±4.47	1.79	F=186.503 p=0.000* $\eta p2$=0.687	F=4.223 p=0.004* $\eta p2$=0.166	F=1.733 p=0.150 $\eta p2$=0.075
	EMS+IF	33.37±3.81	31.72±3.45	4.94			
	EMS+CR	33.77±4.13	32.10±4.22	4.94			
	IF	36.19±5.14	34.23±4.69	5.41			
	CR	34.96±3.69	33.44±3.53	4.34			

*; p<0.01, EMS; Electromyostimulation group, EMS+IF; Intermittent fasting diet group with EMS exercise, EMS+CR; Group on calorie-restricted diet combined with EMS exercise, IF; intermittent fasting diet group, CR; calorie restricted diet group, η_p^2; Partial Eta Squared.

According to Table 2, the body weight variable was statistically significantly different in terms of pre-post test (p<0.01). There was no statistically significant difference between the groups in body weight (p>0.05). The pre-post test results of body fat weight were statistically significantly different (p<0.01). When statistical analysis was analyzed according to the groups, no significant difference was detected (p>0.05). A significant difference was found between the pre-post test averages of body skeletal muscle weight when statistical analysis was analyzed according to time (p<0.01). There was no significant difference in the statistical analysis according to the groups of this variable (p>0.05). There was a statistically significant difference between the pre-post test averages of the BMI variable (p<0.01). The BMI variable did not show a significant difference according to the groups (p>0.05).

Table 3

Fat and muscle ratios of the upper extremity

Parameters	Groups	Pre-Test Mean±SD	Post-Test Mean±SD	Change (%)	Time	Time x Group	Group
Right Arm Muscle (kg)	EMS	2.88±0.32	2.86±0.41	0.69	F=0.325 p=0.570 ηp2=0.004	F=4.545 p=0.002** ηp2=0.176	F=0.560 p=0.692 ηp2=0.026
	EMS+IF	2.94±0.58	3.23±0.66	9.86			
	EMS+CR	3.00±0.55	2.85±0.71	5			
	IF	2.97±0.38	2.86±0.40	3.7			
	CR	3.09±0.54	2.97±0.55	3.88			
Right Arm Fat (kg)	EMS	4.04±1.41	3.85±1.32	4.7	F=33.270 p=0.000** ηp2=0.281	F=1.624 p=0.176 ηp2=0.071	F=2.183 p=0.078 ηp2=0.093
	EMS+IF	3.14±1.32	3.02±1.11	3.82			
	EMS+CR	3.34±1.05	2.90±0.97	13.1			
	IF	4.33±2.18	3.82±1.92	11.7			
	CR	3.80±1.55	3.73±1.18	1.84			
Left Arm Muscle (kg)	EMS	2.84±0.36	2.84±0.41	0	F=0.113 p=0.738 ηp2=0.001	F=3.362 p=0.013 ηp2=0.137	F=0.469 p=0.759 ηp2=0.022
	EMS+IF	2.90±0.57	3.17±0.74	9.3			
	EMS+CR	2.98±0.57	2.88±0.69	3.35			
	IF	2.94±0.36	2.83±0.39	3.74			
	CR	3.07±0.54	2.93±0.58	4.56			
Left arm Fat (kg)	EMS	4.07±1.40	3.90±1.34	4.17	F=28.221 p=0.000** ηp2=0.249	F=1.918 p=0.115 ηp2=0.083	F=2.327 p=0.063 ηp2=0.099
	EMS+IF	3.12±1.31	3.05±1.08	2.24			
	EMS+CR	3.32±1.06	2.93±0.99	11.7			
	IF	4.37±2.20	3.86±1.93	11.6			
	CR	4.18±1.32	3.74±1.15	10.52			

*; p<0.01, EMS; Electromyostimulation group, EMS+IF; Intermittent fasting diet group with EMS exercise, EMS+CR; Group on calorie-restricted diet combined with EMS exercise, IF; intermittent fasting diet group, CR; calorie restricted diet group, η_p^2; Partial Eta Squared.

According to Table 3, there was no statistically significant difference between the pre-posttest means of right arm muscle analysis (p>0.05). The pre-posttest means of right arm fat analysis of body composition were statistically significantly different (p<0.01). When the left arm muscle section was analyzed, it was observed that the pre-test and post-test averages did not differ significantly (p>0.05). There was a statistically significant difference between the pre-posttest averages of the left arm fat variable according to time (p<0.01). No significant difference was found in the analysis of the same variable according to groups (p>0.05).

Table 4

Fat and muscle ratios of the lower extremity

Parameters	Groups	Pre-Test Mean±SD	Post-Test Mean±SD	Change (%)	Time	Time x Group	Group
Right Leg Muscle (kg)	EMS	7.55±1.23	7.62±0.92	0.92	F=34.910 p=0.000** ηp2=0.291	F=12.050 p=0.000** ηp2=0.362	F=1.834 p=0.130 ηp2=0.079
	EMS+IF	7.72±1.15	7.13±1.63	7.64			
	EMS+CR	8.03±1.67	6.24±2.43	22.29			
	IF	8.22±1.49	7.89±1.21	4.01			
	CR	8.29±1.19	8.15±1.20	1.68			
Right Leg Fat (kg)	EMS	6.17±1.09	5.92±1.21	4.05	F=93.105 p=0.000** ηp2=0.523	F=13.881 p=0.000** ηp2=0.395	F=0.909 p=0.462 ηp2=0.041
	EMS+IF	5.85±1.40	5.03±1.11	14.01			
	EMS+CR	6.81±1.13	4.95±1.04	27.31			
	IF	6.59±2.39	5.98±1.99	9.25			
	CR	5.73±0.99	5.73±0.99	0			
Left Leg Muscle (kg)	EMS	7.77±0.92	7.64±0.91	1.67	F=51.201 p=0.000** ηp2=0,376	F=14.688 p=0.000** ηp2=0.409	F=1.672 p=0.164 ηp2=0.073
	EMS+IF	7.71±1.14	7.14±1.59	7.39			
	EMS+CR	8.05±1.62	6.23±2.44	22.6			
	IF	8.10±1.36	7.80±1.17	3.7			
	CR	8.26±1.16	8.12±1.17	1.69			

Left Leg Fat (kg)	EMS	6.10±1.06	5.87±1.20	3.77	F=104.923 p=0.000** $\eta p2$=0.552	F=14.423 p=0.000** $\eta p2$=0.404	F=0.848 p=0.499 $\eta p2$=0.038
	EMS+IF	5.86±1.42	4.97±1.07	15.18			
	EMS+CR	6.77±1.14	4.88±1.02	27.9			
	IF	6.52±2.33	5.91±1.95	9.35			
	CR	6.06±0.99	5.70±0.98	5.94			

*; p<0.01, EMS; Electromyostimulation group, EMS+IF; Intermittent fasting diet group with EMS exercise, EMS+CR; Group on calorie-restricted diet combined with EMS exercise, IF; intermittent fasting diet group, CR; calorie restricted diet group, η_p^2; Partial Eta Squared.

According to Table 4, it was determined that there was a statistical difference between the pre-posttest averages of the right leg muscle variable (p<0.01). There was no significant difference according to the groups (p>0.05). The pre-posttest means of the right leg fat variable were statistically different according to time (p<0.01). The pre-posttest means of the left leg muscle variable were statistically significantly different according to time (p<0.01). There was no significant difference according to the groups (p>0.05). When the left leg fat variable was examined, it was determined that the pre-test and post-test results showed a statistically significant difference in terms of time (p<0.01). The left leg fat variable did not show a significant difference according to the groups (p>0.05).

Table 5

Body fat and muscle ratios

Parameters	Groups	Pre-Test Mean±SD	Post-Test Mean±SD	Change (%)	Time	Time x Group	Group
Trunk Muscle (kg)	EMS	22.42±5.40	23.49±2.41	4.77	F=11.439 p=0.001** $\eta p2$=0.119	F=6.137 p=0.000** $\eta p2$=0.224	F=1.196 p=0.318 $\eta p2$=0.053
	EMS+IF	23.95±3.44	22.60±4.02	5.63			
	EMS+CR	24.27±3.49	20.53±5.54	15.4			
	IF	24.15±2.38	23.54±2.63	2.52			
	CR	25.07±3.32	24.38±3.37	2.75			
Trunk Fat (kg)	EMS	20.60±3.64	20.09±3.55	2.47	F=92.339 P=0.000** $\eta p2$=0.521	F=10.745 p=0.000** $\eta p2$=0.336	F=0.561 p=0.692 $\eta p2$=0.026
	EMS+IF	20.51±3.49	17.97±3.65	12.38			
	EMS+CR	21.73±2.57	17.67±3.26	18.68			
	IF	20.62±3.52	19.53±3.74	5.28			
	CR	21.38±3.62	20.20±3.64	5.51			

*; p<0.01, EMS; Electromyostimulation group, EMS+IF; Intermittent fasting diet group with EMS exercise, EMS+CR; Group on calorie-restricted diet combined with EMS exercise, IF; intermittent fasting diet group, CR; calorie restricted diet group, η_p^2; Partial Eta Squared.

According to Table 5, there was a significant difference between the pre-post test averages of the trunk muscle kg variable (p<0.01). There was a statistically significant difference between the pre-posttest means of the trunk fat variable (p<0.05). A significant difference was observed according to the groups (p>0.05).

DISCUSSION

This study aimed to determine the effects of 4-week EMS exercise, calorie-restricted diet, and intermittent fasting diet protocol on body composition in obese females. The main finding of the study was that, following the hypothesis, the combined application of a calorie-restricted diet and intermittent fasting diet had positive effects on the body composition of obese female individuals.

According to the findings of the study, it was determined that EMS exercise, calorie-restricted diet, and intermittent fasting diet had beneficial effects on BMI, which is one of the criteria for evaluating body composition. It can be stated that EMS exercise and diet protocols play a role in reducing BMI. It was observed that EMS exercise alone was sufficient to reduce BMI, but its effect was much higher when it was applied together with diet. In addition, it can be stated that the diet-only groups (IF and CR) were also effective in reducing BMI. In this regard, Özdal et al. (2016) reported that the BMI levels of females who practiced EMS exercise for 8 weeks decreased significantly. Again, Akçay et al. (2022) compared the effects of EMS exercise with a specific diet program and only EMS exercise in 104 participants and reported that BMI decreased significantly in both groups.

In a study supporting the effectiveness of exercise in reducing BMI levels, Akbulut et al. (2020) reported the positive effect of 8-week resistance exercise on BMI. The findings of the current study are in parallel with previous studies. In this direction, it can be stated that EMS exercises and diet protocols may be beneficial to reduce BMI to healthy limits. In contrast to these findings, Pocari et al. (2005) reported that 8-week electrical muscle stimulation did not lead to a significant decrease in BMI levels in healthy adults. This may probably be due to the difference in the frequency of exercise applied.

When the 4-week change in the body weight parameter, which is one of the body composition parameters, was examined, it was observed that it decreased in all groups. The biggest decrease curve was observed in the intermittent fasting group. In addition, it can be stated that the diet groups may be significantly more effective than the group that only practiced EMS exercise. Previous studies have reported that EMS exercises are a type of exercise that has an effect on body weight and provides many benefits in improving physical fitness (Çetin et al., 2017; Kemmler et al., 2010). Junger et al. (2020) reported that individuals who practiced EMS exercise and had regular eating habits had a weight loss of 4.3 kg and individuals who only practiced EMS exercise had a weight loss of 2.45 kg. Similarly, in the 8-week EMS exercise study conducted by Özdal and Bostancı (2016) on female participants, the presence of a significant difference in body weight statistical results was determined. All these research results show that information parallel to the findings of the present study was obtained.

When the body fat weight variable was taken into consideration, it was noticed that there was a statistically significant difference between the pre-test and post-test results. It was observed that the post-test results were lower in all groups. It can be stated that there was a higher percentage of change in the groups in which EMS exercise and diet were applied together (EMS+IF and EMS+CR) and that the EMS group was the least effective method in reducing body fat weight. In a study conducted on this subject, the effect of EMS applications on the body composition of overweight postmenopausal females was followed for 16 weeks. According to the results of this study conducted on 90 participants between the ages of 25-50, body fat weight decreased significantly (Junger et al., 2020). The literature supports the findings of the current study and it can be stated that EMS exercises can be an effective method to reduce body fat weight.

It was determined that the amount of skeletal muscle weight, one of the variables included in the study, changed significantly. It was observed that skeletal muscle decreased in all groups, especially in the groups in which EMS was applied together with diet and in the groups in which only the diet program was applied. The last change was noticed in the EMS group. Pano-Rodriguez et al. (2020) emphasized that EMS directly affects the synthesis of skeletal muscle proteins and thus increases muscle mass. In a meta-analysis study examining the effect of whole-body EMS on body composition, 1183 participants were examined and it was concluded that EMS had a significantly positive effect on muscle mass (Rodrigues-santana et al., 2021). In a similar study, Shink et al. (2018) stated that EMS exercises with a protein-supported nutrition program can improve body composition and help increase skeletal muscle mass. The study of Gondin et al. in 2011 also pointed out similar results and stated that EMS exercise led to increases in the muscle fiber domain. When the literature is examined, it is seen that EMS applications have positive effects that can increase body muscle mass. However, different findings were obtained in the present study. The decrease in muscle mass in this study is thought to be due to the short duration of the exercise period (4 weeks) and insufficient protein intake.

In addition, Kemmler and von Stengel (2012) stated in their study that longer EMS exercise may have positive effects on muscle mass.

When the regional analyses included in the study were evaluated, it was observed that there was no significant change in right and left arm muscle weights. When the literature is examined, it is seen that research results support this finding (Kirişçioğlu, 2019; Godin et al., 2011). According to these results, it can be stated that short-term EMS and dietary intervention complexes are insignificant for muscle mass in the right and left arm. However, it is thought that different results may be obtained in longer-term studies.

A significant difference was observed in the statistical analysis of right and left arm fat masses. It can be stated that both EMS exercises and diet types are effective in reducing arm fat, especially in the IF group and EMS+CR group. In the study in which 53 female participants doing Pilates were examined, it was found that right and left arm circumference showed a significant difference in favor of the post-test (Aslan, 2019). The study conducted by Song et al. on 20 participants for 12 weeks also contains results that support the current study (Song et al.,).

In the leg region, significant changes in favor of the post-test were observed in both fat and muscle changes for both legs. Similar results were found for trunk muscle mass and trunk fat mass. It was observed that the EMS+CR group was more effective than the other groups in reducing both the amount of fat and muscle mass. Therefore, it may be recommended that EMS exercise should be practiced especially in females with hip and belly fat and the type of diet to be applied with exercise should be a calorie-restricted diet. The reason for the decrease in muscle mass in the leg region for all groups may be insufficient protein input and the fact that the study examined short-term effects. When the literature on the variable is reviewed, similar results to the study are observed (Song et al., 2012; Aslan 2019). The study conducted by Cho et al. in 2017 supports both the literature information and the current study. In the study, 31 participants were examined and it was stated that right and left arm muscle mass parameters showed significant changes (Cho et al., 2017).

Conclusion

4 weeks of EMS exercises and different diet types on obese females had positive effects on body composition, EMS exercise can be used as an alternative method in the treatment of obesity, moreover, EMS exercise will show much more effective results when applied together with IF or CR diets. In addition, although intermittent fasting and calorie-restricted diets are important in the management of obesity, we believe that these diets have a more dramatic effect when combined with EMS exercise. Therefore, it can be stated that diet programs combined with EMS exercises will show an important will to improve body composition in obese females.

Recommendation

In future studies, evaluating the metabolic and hormonal effects of the EMS system in addition to its long-term effects, and revealing its effects on different research groups will increase the depth of knowledge in this field. In addition, changing the current intensities at which EMS is applied, applying different EMS modules and diversifying exercise activities can be included in the research. In addition, further research on different dietary protocols, different gender and age groups, and different risk groups will make important contributions to the literature in this field.

Limitations

The limitations of the study were that the participants were between the ages of 30-45, their gender was female, only IF and CR were applied as diet programs, only EMS exercises were applied as exercise types, the exercises and diets applied were limited to 4 weeks, and the weight loss module of the EMS exercise system was preferred.

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