Research Paper

The Effects of Resistance Training With and Without Electrical Muscle Stimulation on Body Composition of Obese Women

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ABSTRACT

Background and Purpose: Nowadays, total body resistance exercise has been added to instability training and has become popular for improving health and sports performance. Resistance training is a beneficial way to improve body composition and increase muscle strength. This study aims to evaluate the effect of suspension training (total resistance exercises [TRX]) with and without electrical muscle stimulation (EMS) on body composition and muscle strength in obese women.

Materials and Methods: This quasi-experimental research is an applied study in terms of research goal. A total of 36 Class 1 obese women (Mean±SD age: 30.9±5.3 years, Mean±SD body mass: 95.4±9.4 kg, Mean±SD height: 168.2±7.8 cm) were randomly selected from qualified volunteers and grouped randomly into three groups (n=12 for each group): EMS, TRX, and TRX-EMS. The TRX group performed 8 weeks of suspension resistance training (3 sessions per week), and the TRX-EMS group performed the TRX exercises wearing a whole-body suit that provided electrical stimulation. EMS intervention includes 3 applications of 90 min/3 days per week for 8 weeks. Data were analyzed by analysis of covariance at a significance level of 0.05 using SPSS software.

Results: Findings of this study demonstrate significant differences in body composition measurements among three groups after 8 weeks of interventions (P≤0.05). All three interventions increased muscle strength after 8 weeks. TRX+EMS was the most effective intervention on body composition measures (-4.3% in body mass index [BMI], -7.2% in body fat mass [BFM], and +3.6% in skeletal muscle mass [SMM]) and muscle strength (21.93% in BP-1RM and 27.4% in LP-1RM). Also, these findings may indicate that EMS was the least effective intervention on body composition and muscle strength compared with the TRX and TRX-EMS.

Conclusion: According to these results, it is suggested that obese women use EMS with suspension training to lose weight and improve body composition and strength.

Keywords: Resistance training, Electrical stimulation, Overweight, Body mass index (BMI), Muscle strength, Body composition

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1. Introduction

Being overweight and obesity are major public health issues that are characterized by an excessive amount of body fat. The national prevalence rate of overweight/obesity among Iranian adults (both sexes) was 59.3% (58.7%-59.9%) [1]. Obesity and overweight are associated with high mortality, increased cardiovascular disease, hypertension, dyslipidemia, diabetes mellitus, cancers, osteoarthritis, and mental health disorders [2, 3]. Physical activity and exercise have been recommended as the key components of lifestyle management for people with overweight/obesity [4]. Physical activity/exercise are the most effective ways to increase energy consumption [5]. Exercise may also attenuate the negative outcomes associated with overweight/obesity by modulating adipokine levels [6]. Exercise changes fat profile and reduces excess body fat by lowering Low-density lipoprotein-cholesterol (LDL-C) and increasing high-density lipoprotein-cholesterol (HDL-C) [7]. Also, exercise reduced wanting scores for high-fat foods and trait markers of overeating [8].

The researchers attempting to prescribe a program of exercise for individuals with overweight/obese face a problem: which exercise is the best choice for reducing body weight and body fat? Regarding exercise training interventions, aerobic training is suggested as the main component for weight loss, whereas resistance exercise has been recommended to improve body composition, which is associated with metabolic health. Resistance training increases muscle strength and the level of health [9]. Also, resistance training has potentially positive effects on muscle function and morphology [10], and force production capacity and muscle quality (force to muscle mass ratio) were increased following resistance training [11]. Although proper and professional instructions have always emphasized aerobic and endurance exercises to lose and maintain weight [12]. Recently, various studies have stated that resistance training can also be effective for reducing and maintaining weight and reducing fat mass [13].

In the past decade, more attention has been directed toward the use of Electrical Muscle Stimulation (EMS) in promoting exercise [14]. Electrical stimulation is used for two general purposes: to evaluate sensory and motor functions. Currently, methods and devices are designed and applied to restore motor function [15]. Electrical stimulation is potentially designed and applied to restore relatively normal walking to patients with sagging feet and stimulate the common peroneal nerve, forcing only one muscle group called the dorsiflexor of the foot to contract by electrodes in a single-channel form [16]. In this system, the simulation is started when placing the heel at the beginning of the swing phase of walking and causes dorsiflexion and eversion movement, and the simulation ends when placing the heel on the ground at the beginning of the stability phase of walking [17]. Electrical muscle stimulation involves establishing electrical conduction by dermal electrodes to depolarize adjacent motor nerves, causing muscle contraction, and is sometimes applied to help people with nerve damage or muscle weakness [18]. This action causes the muscles that cannot move to stay in a relatively good condition, and electric stimulation of muscle has the same effect as exercise [19].

According to what was discussed, in obese people who often suffer from inactivity and lack the motivation to do proper and regular exercise, electrical stimulation can be used to prevent muscular atrophy due to inactivity by creating muscle contracting. The present research studies the effect of suspension training (total resistance exercises [TRX]) with and without electrical muscle stimulation on the body composition and muscle strength of obese women.

2. Materials and Methods

Participants

This is an applied and quasi-experimental research. The statistical population includes women with overweight according to the body mass index (BMI) index (BMI of 25 to 30) in Sari City, Iran, in the autumn of 2018. To calculate the sample size for the Analysis of Covariance (ANCOVA), a priori power analysis was performed using G×Power software (G×Power 3.1.7; Kiel University, Germany). An α error and a power (1-β err prob) were set at 0.05 and 0.90, respectively. Based on the previous studies [20-22], we assumed effect size of 0.7. The critical sample size was calculated to be 30, and we recruited 36 obese women, ensuring an adequate sample size. Then, they were randomly selected from qualified people and grouped by a simple random method (drawing). The research setting was one of the female fitness clubs in Sari. The inclusion criteria were as follows: class 1 obese women according to body mass index ($35>BMI\geq30$ kg/m^2), no cardiovascular disease, no joint and bone diseases, no special medicine taking, no blood pressure, diabetes, and any disease affecting the results. The exclusion criteria were as follows: not going to the gym three times continuously or four times alternatively, the occurrence of illness, physical problem, or injury during exercise, and training simultaneously at another gym. Subjects will not take any dietary supplements during the research period and will not have regular physical exercise other than the desired protocol. Research groups included group 1: the suspension training (total resistance exercises [TRX]) group; group 2: the Electrical Muscle Stimulation (EMS) group; group 3: the suspension training with electrical muscle stimulation (TRX-EMS) group.

All subjects were informed about the possible risks and benefits of the interventions and then provided written consent forms before participating in this research.

The main measurement tools for collecting data were as follows: personal information form; food diary questionnaire (recommending to subjects to eat similar foods at night before performing the protocol); weight measurement (with the accuracy of 0.01 kg); medical height measurement (with the accuracy of 0.1 cm) (Seca, Germany); chronometer (Jemis, Japan); and body composition device (Inbody 270).

The body composition device (Inbody 270) was used to determine the body composition. A bioelectrical impedance device, the InBody 270 (InBody Co., Ltd, South Korea), was used for baseline and follow-up determinations of body composition. A trained examiner performed all tests. According to the manufacturer's guidelines (InBody User's Manual), exams were performed in the morning, with subjects in a fasting state for at least 2 hours, with minimal clothes, and without metal objects, relaxed, barefoot, and in the upright position for 5 minutes before testing. Among the various body composition determinations recorded by the InBody device, we focused on weight, BMI, body fat mass (BFM), and skeletal muscle mass (SMM) [23].

One-repetition maximum bench press (BP-1RM) and leg press (LP-1RM) are used respectively to evaluate the upper and lower torso muscle strength. One-repetition maximum (1RM) for the lower torso and upper torso was calculated by Hoosh et al. (1995) and Ros Frisancho (1974), respectively [24].

All the tests will be carried out in a Pre-test in the morning between 10 AM to 1 PM, 24 hours before performing the protocol. Finally, after 8 weeks of performing the protocol and completing the sessions by the subjects, once again, a Post-test including all tests and Pre-test measurements was performed in the same conditions for all subjects with a difference of 48 hours after the last training session (same time, repeating the diet of the Pre-test day, etc.). Meanwhile, all the results will be confidential due to ethical principles in the research. One week before starting the research protocol, the subjects will become familiar with the correct way of performing techniques, movements, and tests, and data such as age, height, weight, BMI, and body fat percentage will be measured. Before the exercise training, all the players in the three groups underwent three familiarization sessions.

Food dairy questionnaire, a retrospective method, was used to control the nutrition and calculate the subjects' calorie of diet. This questionnaire would be completed three days before performing the training protocol or during Pre-tests and three days after ending the training protocol or during the Post-test. Moreover, the questionnaire was completed every week for another day by the subject [25].

Training intervention consists of 8 weeks (3 sessions per week) performing TRX training protocol in two experimental groups. Each week includes three sessions of training with at least one-day interval between each session. Training protocol includes a 10-minute warm-up before the main program and a 5-minute cool-down after performing the program in each session. Warm-up will be done with the stretching, walking, and jogging. Exercises at TRX training protocol are according to Table 1. This program was performed equally for both TRX and TRX-EMS groups (Figure 1a & 1b). To equalize how to perform exercises, the acceleration of exercises for all subjects is standardized by a metronome of one hit per second, and the exercises were performed in a way that the joint has its entire range of movement.

Moreover, a professional coach will closely monitor the stabilization of body posture and any harmful effects during the practice. TRX training protocol will be done in 3 or 4 sets. The repetition number in each exercise was 8 to 12 times. Also, the rest time between the sets was reduced from 2 minutes to 1 minute, and the rest between movements was reduced from 3 minutes to 2 minutes during exercise progress [26, 27].

The EMS and TRX-EMS group performed 8 weeks (90 min/3 days per week) of exercise using a whole-body electromyostimulation device (E-Fit, 1280US, Hungry) (Figure 1c). The application unit was connected via electrical cords to a stimulation vest and belts. The 10-channel output allows the device a more flexible and complete electrode distribution throughout the body. All muscle areas could be stimulated synchronously with impulse intensity (40mA) for 4 dermal electrodes

Figure 1. Subject's exercises in TRX-EMS group with integrated electrodes (A & B); Whole-body electromyostimulation device (C).

EMS: Electrical Muscle Stimulation; TRX: Total Resistance Exercises (suspension training)

of 3×8 cm. Each player was asked to wear a vest that fit her, and the trainer ensured that the locations of all electrodes covered all muscles involved in the training. The subjects performed the electrical stimulation with a frequency of 30-85 Hz, depending on week and intensity. Each single lift impulse lasted 6 seconds and was followed by a 6-second rest period. During all sessions, safety precautions, such as the pain feeling and techniques in performing the exercises, were checked by the trainer [28, 29]. The intensity for each muscle group was controlled by Borg's 10-scale category ratio; the intensity started at 5-6 and eventually reached 7-8.

The Mean±SD values of the variables were calculated. Variables were tested for normality with the Shapiro-Wilks test, and all variables in the three groups were normally distributed. Group differences were examined using the analysis of covariance (ANCOVA) with a Pretest as a covariate factor. The homogeneity of regression assumptions was tested and confirmed before analysis. The Bonferroni post hoc tests were conducted on any significant analyses of covariance. Effect Sizes (ES) were calculated via eta-squared. The significance level was considered at 0.05. Statistical analyses were performed in SPSS, version 25 (IBM, USA).

3. Results

Descriptive characteristics of the subjects by the group are presented in Table 2. It shows Mean±SD values for age, height, and weight of the three groups at the study's baseline. All three groups presented similar mean ages and heights of participants. Similarly, participants' weights were similar among groups at the study's baseline.

Results for the body composition measurements are presented in Table 3. The Body Mass Index (BMI) and Skeletal Muscle Mass (SMM) of the EMS group did not change over the training period. The Body Fat Mass (BFM) of the three groups decreased over the study period. All the other body composition measurements were changed after 8 weeks in TRX and TRX-EMS groups. BMI decreased by about 2.3% in the TRX group

Table 1. Workouts performed in TRX and TRX-EMS groups

Row	Protocol	Set×Repetition
1	Bench press with TRX	3-4×8-12
2	Single leg lunge with TRX	3-4×8-12
3	Seated Cable Rows with TRX	3-4×8-12
4	Plank with TRX	3-4×8-12
5	Hamstring extension with TRX	3-4×8-12

EMS: Electrical Muscle Stimulation; TRX: Total Resistance Exercises (suspension training).

Table 2. Baseline characteristics of the participants

Variable	Mean±SD		TRX-EMS
	EMS	TRX	
Age (y)	29.17±3.460	32.58±6.403	31.08±6.082
Height (cm)	166.92±6.11	169.42±9.60	168.17±7.71
Weight (kg)	96.67±8.91	96.58±9.61	93.00±9.59

EMS: Electrical Muscle Stimulation; TRX: Total Resistance Exercises (suspension training).

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Table 3. Changes of Pre-test and Post-test of body composition measures in three groups

Variables	Stages	Mean±SD		
		EMS	TRX	TRX-EMS
BMI (kg/m^2)	Baseline	34.6±4.5	33.8±3.6	33.02±3.0
	After 8 wk	34.6±4.2	33.0±3.5	31.6±4.1
BFM (kg)	Baseline	32.0±5.5	31.9±5.4	33.3±5.7
	After 8 wk	31.4±5.6	30.7±5.4	30.9±5.1
SMM (kg)	Baseline	27.7±3.8	26.2±4.9	28.0±4.2
	After 8 wk	27.6±3.5	27.0±4.1	29.0±3.8

EMS: Electrical muscle stimulation; TRX: Total resistance exercises (suspension training); BFM: Body fat mass; SMM: Skeletal muscle mass.

Table 4. Analysis of covariance Post-test body composition measures in three groups

Variables	Resources	SS	df	MS	F	Sig.	Eta Squared
BMI	Corrected model	553.293	3.00	184.43	320.08	0.0009	0.968
	Constant effect	0.69	1.00	0.69	1.21	0.280	0.036
	Pre-test	497.83	1.00	497.83	863.99	0.0009	0.964
	Group	14.86	2.00	7.43	12.90	0.0009	0.446
BFM	Corrected model	940.936a	3.00	313.65	533.67	0.0009	0.980
	Constant effect	0.02	1.00	0.02	0.03	0.862	0.001
	Pre-test	937.84	1.00	937.84	1595.73	0.0009	0.980
	Group	18.12	2.00	9.06	15.41	0.0009	0.491
SMM	Corrected model	487.300a	3.00	162.43	320.86	0.0009	0.968
	Constant effect	14.24	1.00	14.24	28.12	0.0009	0.468
	Pre-test	461.30	1.00	461.30	911.22	0.0009	0.966
	Group	10.08	2.00	5.04	9.96	0.0009	0.384

BFM: Body fat mass; SMM: Skeletal muscle mass; BMI: Body mass index.

Table 5. Bonferroni post hoc tests for pairwise comparisons of body composition measures

Groups		BMI		BFM		SMM	
		MD (I-J)	Sig.	MD (I-J)	Sig.	MD (I-J)	Sig.
EMS	TRX	0.952	0.013	0.63	0.159	-0.797	0.032
	TRX+EMS	1.583	0.0009	1.727	0.0009	-1.284	0.0009
TRX	EMS	-0.952	0.013	-0.63	0.159	0.797	0.032
	TRX+EMS	0.63	0.153	1.098	0.004	-0.49	0.325
TRX+EMS	EMS	-1.583	0.0009	-1.727	0.0009	1.284	0.0009
	TRX	-0.63	0.153	-1.098	0.004	0.49	0.325

EMS: Electrical muscle stimulation; TRX: Total resistance exercises (suspension training); BFM: Body fat mass; SMM: Skeletal muscle mass; BMI: Body mass index.

Table 6. Analysis of covariance Post-test muscle strength measures in three groups

Variables	Resources	SS	df	MS	F	Sig.	Eta squared
BP-1RM	Corrected model	553.293[a]	3.00	184.43	320.08	0.0009	0.968
	Constant effect	0.69	1.00	0.69	1.21	0.280	0.036
	Pre-test	497.83	1.00	497.83	863.99	0.0009	0.964
	Group	14.86	2.00	7.43	12.90	0.0009	0.446
LP-1RM	Corrected model	940.936a	3.00	313.65	533.67	0.0009	0.980
	Constant effect	0.02	1.00	0.02	0.03	0.862	0.001
	Pre-test	937.84	1.00	937.84	1595.73	0.0009	0.980
	Group	18.12	2.00	9.06	15.41	0.0009	0.491

BP-1RM: One-repetition maximum bench press; LP-1RM: One-repetition maximum leg press.

Table 7. Bonferroni post hoc tests for pairwise comparisons of muscle strength (1RM)

Groups		Bench press 1RM		Leg press 1RM	
		MD (I-J)	Sig.	MD (I-J)	Sig.
EMS	TRX	-2.174	0.033	-7.573	0.0009
	TRX+EMS	-4.202	0.0009	-8.909	0.0009
TRX	EMS	2.174	0.033	7.573	0.0009
	TRX+EMS	-2.01	0.055	-1.34	0.856
TRX+EMS	EMS	4.202	0.0009	8.909	0.0009
	TRX	2.01	0.055	1.34	0.856

EMS: Electrical muscle stimulation; TRX: Total resistance exercises (suspension training); 1RM: One-repetition maximum.

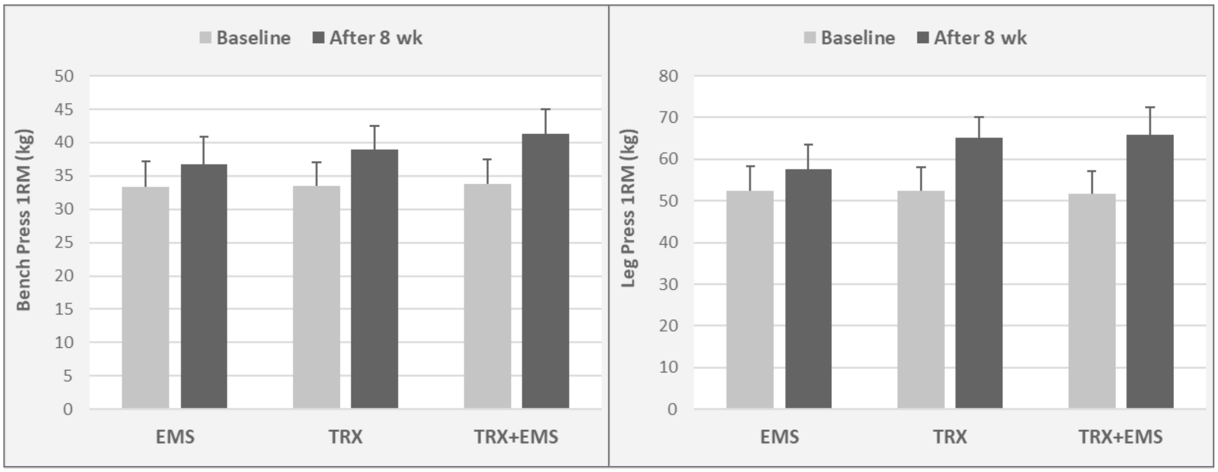

Figure 2. Comparing muscle strength among three groups at baseline and after 8 weeks intervention

a: Upper body; b: Lower body

EMS: Electrical muscle stimulation; TRX: Total resistance exercises (suspension training).

and 4.3% in the TRX-EMS group but did not change in the EMS group. BFM decreased in EMS, TRX, and TRX-EMS groups (1.8%, 3.8%, and 7.2% respectively). In contrast, SMM increased in TRX (3.1%) and TRX-EMS (3.6%) groups but decreased slightly in the EMS group (0.3%).

Covariance analysis showed significant differences in body composition measurements among the three groups (Table 4). The body composition analysis revealed a main group effect for the BMI (P<0.001), BFM (P<0.001), and SMM (P<0.001). Thus, the main effects were further analyzed using pairwise comparisons with Bonferroni post hoc tests (Table 5).

Bonferroni corrections revealed significant pairwise differences for the BMI during eight weeks of interventions (P≤0.05), with the TRX-EMS group showing significantly lower BMI than other groups (Figure 2). Pairwise comparisons for the EMS and TRX also showed significant differences between these groups, but the difference between TRX and TRX-EMS was not significant (Table 5).

For body fat mass, the Bonferroni post hoc test showed significant pairwise differences (P≤0.05) between TRX-EMS and TRX and between TRX-EMS and EMS. BFM was significantly lower in the TRX-EMS compared with EMS and TRX groups. There was no significant difference among TRX and EMS groups after 8 weeks of intervention (Table 5).

Post hoc analysis also revealed significant (P≤0.05) pairwise differences among groups for skeletal muscle mass. There was a significantly greater SMM in both resistance training intervention groups (TRX and TRX-EMS) than in EMS, but the difference between TRX and TRX-EMS was not significant (Table 5).

Covariance analysis showed that there were significant differences in upper (BP-1RM) and lower body (LP-1RM) muscle strength measurements among the three groups (Table 6). The body composition analysis revealed a main group effect for BP-1RM (P< 0.001) and LP-1RM (P<0.001). Thus, the main effects were further analyzed using pairwise comparisons with Bonferroni post hoc tests (Table 7).

Bonferroni corrections revealed significant pairwise differences for the Bench press 1RM (BP-1RM) during eight weeks of interventions (P≤0.05), with the TRX-EMS group showing significantly greater 1RM than other groups. Pairwise comparisons for the EMS and TRX also showed a significant difference between these groups, but the difference between TRX and TRX-EMS was not significant (Table 7).

Post hoc analysis also revealed significant (P≤0.05) pairwise differences among groups for Leg press 1RM (LP-1RM). There was a significantly greater LP-1RM in both resistance training intervention groups (TRX and TRX-EMS) than in EMS, but the difference between TRX and TRX-EMS was not significant (Table 7).

4. Discussion

This research aimed to examine the effect of suspension training (TRX) with and without electrical muscle stimulation (EMS) on body composition and muscle strength in obese women. The main findings of this study demonstrate significant differences in body composition measurements among three groups after 8 weeks of interventions. All three interventions increased muscle strength after 8 weeks (21.93% in BP-1RM and 27.4% in LP-1RM for TRX+EMS; 16.2% in BP-1RM and 24.4% in LP-1RM for TRX, and 9.7% in BP-1RM and 9.8% in LP-1RM for EMS). TRX+EMS was the most effective intervention on body composition measures (-4.3% in BMI, -7.2% in BFM, and +3.6% in SMM) and muscle strength. Also, these findings may indicate that EMS was the least effective intervention for body composition and muscle strength compared with the TRX and TRX-EMS groups.

These results are consistent with a previous investigation. Jalali, Shabani, and Nazari's study on the effect of simultaneous resistance-endurance exercises on body composition showed that the body mass index, weight, fat percentage, and subcutaneous fat were significantly decreased [30]. According to the present research and the results from the first hypothesis, fat mass, muscle mass, muscle percentage, and BMI have significantly changed caused by suspension exercises; therefore, the results from the first hypothesis are consistent with the results from Jalali et al.'s study. According to the results from Azizi Fatahabad and Mousavi Rad for the effect of TRX exercises on the BMI and abdominal fatness in non-sportswomen, it is shown that TRX exercises have positive and significant effects on BMI and abdominal fatness [31]. Therefore, the results of the current study are consistent with the results from Fatahabad and Mousavirad's study. The results from Rasti and Eidi Vandi for the effect of TRX exercises on some physical fitness indices of Basketball girls showed that TRX exercises with a barbell could effectively develop the physical fitness index in athletes [32]. Based on the present research and the results from the second hypothesis, bench press (upper torso strength) and leg press (lower torso strength) changed significantly by suspension exercises. Therefore, the results from the second hypothesis are consistent with those from Rasti and Eidi Vandi's study. The findings by Kiani and Fattahi for the effect of TRX exercises on the strength of girl students showed the positive effect of TRX training on the strength of subjects so that the mean scores of variables after exercises increased compared to the control and Pre-test groups [33]. Thus, the results from the second hypothesis are consistent with those from Kiani and Fattahi. According to the results from Ranjbar et al. for the effect of resistance TRX training on the body composition of inactive men, the body fat percentage in the TRX group has decreased significantly [27].

Based on the present research and the results from the first hypothesis, the fat percentage has not changed significantly by doing suspension training; thus, the results from the first hypothesis are not consistent with the results from Ranjbar et al. study. One of the reasons for the inconsistency of mentioned research with the result from the first hypothesis (fat percentage) is that the population of the two studies is different. In the present research, the subjects were non-sportswomen with overweight, and in the mentioned research, the subjects were inactive men. Moreover, the gender of the subjects was different in the two research, and maybe this affects the inconsistency of the results. Another important point was the different quality of doing suspension training in two tests that resulted in different results. The results from Hasanvand and Ranjbar study for the effect of the resistance TRX training on the physical fitness index of healthy children showed that by doing resistance training with TRX, some improvement in physical fitness indices could be achieved, and this kind of exercise is effective on increasing physical fitness [34], which is consistent with the results from the present research.

Moradi and Moradi's study on the effect of TRX training on some physical fitness indices in elite wrestlers showed that doing TRX exercises significantly affects the physical fitness indices [35]. This finding is consistent with the results of the present research. The results from Bayat study for the effect of electrical simulation on the muscle strength in female basketball players showed that the average strength in the empirical group increased after training [36]. So, based on the present research and the results from the second hypothesis, bench press and leg press have significantly changed by doing suspension training combined with electrical muscle simulation. Therefore, the results from the second hypothesis are consistent with the results from the Bayat study. The results from Moshtaqi, Tarvardi Zadeh, and Dehqan's study on the effect of TRX training on the muscle strength of girl students showed that TRX training could be used according to the available facilities to increase muscle strength [37]. This finding is consistent with the results of the present research.

The results from Nikseresht et al.'s studies on the effect of electrical stimulation on losing weight and decreasing body fat showed that electrical simulation has led to losing weight, decreased BMI and fat percentage, and increased lean mass [38]. This finding is consistent with the results from the present research. However, the fat percentage at the present research has no significant difference, while at the mentioned research the fat percentage has decreased significantly. At this research, population was the women with overweight, but in the research by Nikseresht, Najafian, and Taheri, the population was ordinary women, and this might have affected the results for fat percentage. On the one hand, the quality of electrical muscle stimulation was different in the two research studies and might affect the results. In the research by Medi Zadeh and Haseli on the effect of resistance training on the body composition of fat women and overweight women with type 2 diabetes [39], there was a significant difference between body weights that were consistent with the results from the present research. According to the results from Mouk et al. for the core muscle activity during the suspension training, doing suspension training has significant effect on the muscle strength of the person [40], which is consistent with the results from the present research.

Study Limitations

There were some limitations in this study. The main limitation is the exercise and EMS protocols. Various protocols for exercise and EMS have been used in related studies. However, the physiological adaptations resulting from these protocols are different from each other. It is difficult to say which exercise training and EMS are the best to influence body composition and muscle strength. Therefore, future research should compare different exercise and EMS protocols and their combination. Another limitation of the current study was the lack of measurement of other symptoms and consequences of obesity, such as insulin resistance, blood pressure, lipoprotein profiles, etc. This information is very helpful in evaluating the positive effects of exercise, EMS, and their combination. Therefore, it is suggested that future research should also measure these indicators in addition to body composition.

5. Conclusion

Our findings for the research hypotheses showed a significant difference between the effect of suspension training with and without electrical muscle stimulation on the body composition (significant difference in fat mass, muscle mass, muscle percentage, and BMI and no significant difference in the fat percentage) and muscle strength (significant difference in bench press and leg press) in obese women.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethical committee of Yazd University (Code: IR.YAZD.REC.1401.013).

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Authors contributions

Investigation, Writing–original draft, and Writing–review & editing: All authors; Conceptualization, Methodology, Supervision, Project Administration and review & editing: Taher Afsharnezhad; Resources, Data collection, Validation, Data Curation, and Data analysis: Seyyedeh Yasamin Soumander.

Conflict of interest

The authors declared no conflict of interest.

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