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Orginal Article

Effect of High-Intensity Interval Resistance Training on Appendicular Skeletal Muscle Mass Index Measured by Bioelectric Impedance Analysis in Sarcopenic Elderly Women

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Abstract

Background: Aging is an inevitable physiological process leading to a progressive decrease in muscle mass and function, which is called sarcopenia. Correspondingly, this study aimed to investigate the effect of High-Intensity Interval Resistance Training (HIIRT) on certain sarcopenia-related factors in elderly women.
Methods: This was a quasi-experimental study in which thirty elderly women aged 60 to 70 years, from April to September 2020, volunteered to participate and were randomly assigned to the experimental (n=15) and control (n=15) groups. Body Mass Index (BMI), Appendicular Skeletal Muscle Mass (ASM), Appendicular Skeletal Muscle Mass Index (ASMI), and body fat percentage were measured using bioelectric impedance analysis; handgrip strength was measured via Jamar dynamometer; walking speed was measured employing six-meter walking test (6MWT); IGF-1 level (μg/L) was measured with Mediagnost kit (Germany) and serum myostatin level (ng/L) was measured using ELISA kit from R&D Company (USA) via Enzyme-Linked Immuno Sorbent Assay (ELISA) method in two stages: pre-test (week 0) and post-test (end of week 8). Independent t-test was subsequently utilized to assess the research variables through SPSS software version 23 at 0.05 level of significance.
Results: The results indicated a significant decrease in body fat percentage (1.05±0.79, P<0.001) and Myostatin (MSTN) (87.25±82.38, P<0.01) and a significant increase in handgrip strength (-08.58±4.50, P<0.001), ASM (-4.91±0.28, P<0.001), ASMI (-0.19±0.11, P<0.001), and 6MWT (-0.42±0.26, P<0.001) in the experimental group compared to the control. There was also an increase in IGF-1 (-0.83±2.90, P=0.88), yet it was not significant.
Conclusion: The major components indicative of sarcopenia were improved through High-Intensity Interval Resistance Training. Therefore, HIIRT appeared to be one of the most important coping strategies for reduction of muscle mass and strength in older women. We could thus conclude that it is necessary for the elderly to do this type of training.

Keywords: Resistance training, Aging, strength, Sarcopenia, Insulin-like growth factor-1, Myostatin

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1. Introduction

Aging is a physiological process in which changing strength, power, and perception of emotion are prominent features, leading to the reduction in functional efficiency of the whole body (1). The world's population is rapidly aging and in Iran, the proportion of the elderly population is rising rapidly given the decreasing birth rate and increasing life expectancy. With aging, a number of physiological and psychosocial functions are gradually lost, which can increase vulnerability and dependence of the individual (2) and in turn, elevate health care costs. It is noteworthy that a high percentage of these expenses are due to the adverse effects of losing lean muscle mass (3). The ability to maintain muscle homeostasis is impaired with aging, which in turn progressively reduces muscle mass and function, a phenomenon known as sarcopenia associated with imbalance, increased likelihood of falls and fractures, decreased independence, and death (4, 5). Therefore, maintaining muscle mass, function and strength is a vital issue (6). Progressive age-related changes in skeletal muscle are a function of the interaction between internal aging processes (for example, DNA damage, insulin resistance, low-level inflammation, cellular stress, mitochondrial dysfunction, cellular aging, and stem cell fatigue) and environmental factors (for example, disease, metabolic disorders, lack of access to nutrients, and physical inactivity) (7, 8). According to research results, reduced physical activity is the main factor of muscle mass loss in sarcopenic individuals (9). There are no appropriate and definitive treatments for sarcopenia

(5, 10). However, several interventions have been applied to control muscle atrophy due to sarcopenia, including pharmacological and nutritional interventions, most of which have had limited efficacy. Training programs is among the clinical interventions that could be beneficial for sarcopenic elderly at both molecular and functional levels; however, the relationship between training programs and sarcopenia-related symptoms is not clear (4, 9), which was investigated in this research. An important point is that protein synthesis does not depend solely on daily protein intake and the signals of anabolic molecules also play a role in it. Insulin is a crucial anabolic hormone that stimulates hypertrophy through the secretion of Insulin-like growth factor-1 (IGF-1). In the elderly, protein synthesis and skeletal muscle mass decrease compared to those in young people due to anabolic signaling disorder and reduced IGF-1 secretion. Meanwhile, some catabolic factors, such as Myostatin (MSTN), are elevated, which in turn diminish the muscle volume and indicate the importance of these changes in sarcopenia (9, 11, 12). Nevertheless, the role of systemic IGF-1 in the compensatory growth process still remains controversial and it is not known whether the systemic isoform of IGF-1 performs other hypertrophic functions in response to resistance training (11). Research on the effect of resistance training or endurance training on IGF-1 levels of older people has indicated increase, decrease, or no changes in this factor (13, 14). Investigations in the field of MSTN have also shown contradictory results. Negaresh and colleagues (10) and Shanazari and colleagues (13) observed that MSTN levels decreased significantly after eight weeks of resistance training whereas Willoughby (15) stated that 12 weeks of resistance training increased MSTN mRNA expression. The methodology of this study is of particular importance from two aspects; primarily, MRI, CT scan, and DEXA have been used in several studies for muscle thickness measurement and calculation of the total mass of upper and lower body muscles (Appendicular Skeletal Muscle Mass=ASM). Moreover, Appendicular Skeletal Muscle Mass Index (ASMI) has been utilized for assessing and diagnosing sarcopenic people. It should be noted that Bioelectrical Impedance Analysis (BIA) was used in this study to calculate ASMI and detect sarcopenic individuals due to the feasibility, reasonable price, speed, non-invasiveness nor use of radiation, as well as safety, reliability, and strong correlation with DEXA and MRI methods (16-18). Certain studies have shown that resistance training in the elderly enhances muscle strength by increasing the cross-sectional area of type I and II fibers and lean tissue mass of the whole body (12). On the other hand, the results of other investigations have indicated that resistance training has no effects on muscle mass (19). The second aspect is the exercise design approach and the latest method was used in this research. Owing to the greater effect of periodized training on increasing strength and hypertrophy as well as the greater effect of high intensity training on these factors (11), a resistance training program was periodized for this study, including two hypertrophy mesocycles and a strength mesocycle with High-Intensity Interval Resistance Training (HIIRT) that has been less studied in older people. For note, different exercises create various adaptations; however, the issue of training efficiency is discussed these days and High-Intensity Interval Training (HIIT) protocol has been considered by researchers. The effect of HIIT has been investigated on different groups (both healthy and diseased) with various outcomes (20), but its effect on the elderly has not been completely investigated. HIIRT protocol is a new version of HIIT, which is similar to HIIT since it includes short periods of high-intensity exercise as well as maximum effort and heart rate. HIIRT emphasizes multi-joint muscle groups and considers both aerobic and anaerobic aspects of exercise, enhancing muscle strength, endurance, and power, in addition to increasing cardiorespiratory fitness. However, research into the health benefits of HIIRT in the elderly has been restricted (21). Hence, we conducted the present study for the first time in Iran to investigate the effect of HIIRT on lean body mass, arm and leg muscle mass, ASM Index, IGF-1, MSTN, and muscle strength.

2. Methods

2.1. Participants and Design of the Study

The statistical population of this quasi-experimental study included all the old women aged 60 to 70 years referred to Elderly Soroush Day Care Center (Shiraz, Iran) from April to September 2020. The sample size estimation was carried out using G*Power (version 3.1.9.2). Assuming an effect size of 0.95, with an alpha level of 0.05, the total sample size was estimated to be 30 (15 per group). Therefore, 30 subjects participated in this work with 80% power.

Thirty volunteer elderly sarcopenic subjects were identified and randomly divided into the experimental (n=15) and control (n=15) groups. Random allocation was done via balanced block randomization method. Thus, four blocks were used. Having two groups of A and B with four blocks, the block modelling was randomly rotated as follows: AABB, ABAB, ABBA, BAAB, BBAA, BABA.

Finally, 22 subjects (12 in the experimental and 10 in the control group) completed the study. In this research, loss of skeletal muscle mass was measured using bioelectric impedance analysis (BIA) with InBody 470 device (Tokyo, Japan). Appendicular Skeletal Muscle Mass (ASM) was assessed by summing up the muscle mass of both hands and legs and ASM index (ASMI) was calculated by dividing ASM by square of height in terms of square meters (4, 22). In this study, loss of skeletal muscle mass was analyzed according to the instructions of a European Working Group on Sarcopenia in Older People (EWGSOP). Accordingly, those with ASMI <6.76 kg/m^2 and poor physical function (grip strength <20 kg and 6MWT <0.8 m/s) were considered sarcopenic. To distinguish sarcopenic people, three factors of muscle mass, grip strength, and 6MWT should be evaluated, which are the main components of sarcopenia detection. Therefore, according to the costs and time required to perform BIA test, 6MWT was performed first since it is easy to perform, not requiring special equipment, and could be performed in a straight path over a distance of 10 meters (two meters at the beginning and end of this path are not included in the time estimate), and also is one of the most reliable measurement methods. Herein, 6MWT was calculated in terms of meters per second by dividing distance (6 meters) by time (18, 22, 23). Given that the subjects' speed in this study was >0.8 m/s, handgrip strength and muscle mass were also evaluated and finally, those with ASMI< 6.76 kg/m^2 and handgrip strength <20 kg were recruited as sarcopenic subjects of this study. Handgrip strength was measured with Jamar dynamometer (manufactured by JLW INSTRUMENT Company in Chicago, USA) while the subjects held the dynamometer in their right hand, their elbow firmly leaning on the side and pelvis forming a 90-degree angle, and pressing the dynamometer with the maximum force to calculate the isometric power in kilograms (21). It is noteworthy that the subjects with any abnormalities or muscle problems preventing their participation in the protocol as well as those with Alzheimer's disease, Parkinson's, or severe brain disease (22, 24) were excluded from this study. To ensure that the subjects were able to participate in this exercise plan, they completed Physical Activity Readiness Questionnaire (PAR-Q) prior to taking part in the study. The questionnaire includes seven yes or no questions and if the subjects answer yes to one of these seven questions, they have to be examined by a physician before starting the exercise and obtain permission to do the activity (24). The study steps were explained to all the subjects and the potential risks were fully described. Additionally, all the subjects signed the informed consent form of the study before the start of the training period.

2.2 Experimental Design and Exercise Protocols

Before starting the training protocol, the subjects performed one-Repetition Maximum 1(RM) test with different exercises to determine the appropriate load in training protocol. Prior to the test, the subjects warmed up with a minimum weight of their choice (very light weights). They then selected a weight according to their estimation so that they could lift completely and correctly up to 10 times. The 1RM of the subjects was calculated by inserting the amount of weight and the number of repetitions in Brzezinski formula as follows (10):

$$1RM=Weight\div 1.0278\ (0.0278\times repetitions)$$

Before performing the training protocol, one week (three sessions) of weightless training sessions were performed to familiarize the subjects with the bodybuilding devices so that they learn the correct way of doing exercises with the devices. This was also done to prevent possible injuries due to incorrect performance of exercises. Subsequently, the research variables were measured in pre-test and also 48 hours after the last training session from 7 to 9 A.M. The blood samples (5 ml) were drawn from brachial vein, the serums were separated through centrifugation at 3000 rpm, frozen at -20°C, and stored in a tube at -80°C following 10 hours of fasting. Measurement of serum IGF-1 level (µg/L) was done using Mediagnost kit for human hormones (Germany) via ELISA method and serum myostatin level (ng/L) was measured with a special ELISA kit from R&D Company in the USA at the mentioned hour.

The training protocol of the present study was performed with two mesocycles of training for basic physical fitness and hypertrophy (Table 1). The first one included two weeks with six sessions (3 sessions per week) and the second mesocycle (strength protocol or HIIRT) comprised six weeks (18 sessions) of High-Intensity Interval Resistance Training to increase strength (Table 2). At the beginning and end of the sessions, 5 minutes of warming up and 5 minutes of cooling down were performed using movements, such as walking, jogging, and light stretching (24, 25). The training session consisted of eight movements for the whole-body muscle groups, namely, shoulder fly, Lat Pull, chest press, elbow flexion and extension, knee flexion and extension, and abdominal crunch. The

Table 1: The first mesocycle of the training program in the experimental and control groups

Week	Rest between set	Rest interval (minute)	Repetitions	Sets	1RM(%)
1	"90-"30	1	8-15	2-4	50%
2	"90-"30	1	8-15	2-4	55%

Table 2: The second mesocycle of the training program in the experimental and control groups

Weeks	Sets	Rest interval (minutes)	First repetitions	Rest between repetition	Second repetition	Rest between repetition	Thirth repetition	1RM(%)
1	2-3	2	4-6	20"	2-3	20"	1-2	60%
2	2-3	2	4-6	20"	2-3	20"	1-2	65%
3	2-3	2	4-6	20"	2-3	20"	1-2	70%
4	2-3	2	4-6	20"	2-3	20"	1-2	75%
5	2-3	2	4-6	20"	2-3	20"	1-2	80%
6	2-3	2	4-6	20"	2-3	20"	1-2	85%

sessions lasted 35 minutes (25). The exercises were performed with 50-85% intensity of 1RM and the workload increased by 5-10% on a weekly basis in proportion to the ability of the subjects according to overload principle (14). The control group did not have any specific sports activities during the study and only did daily life activities. The participants were urged not to change their diet during the exercise weeks and not to engage in other types of physical activities.

2.3 Statistical Analysis

Research data were analyzed employing SPSS version 21. After confirming the normality of data distribution and homogeneity of data with Kolmogorov-Smirnov test, independent t-test was used to compare the variables between the two groups at P≤0.05 significance level. It should be noted that because of the significant differences among the dependent variables (between the two groups in the pre-test) to compare the variables in pre-test and post-test, the mean difference was initially calculated and comparison was then performed; for example, to compare body fat percentage, the difference in body fat percentages was calculated at the beginning and end of the study (Δ% FM=% FMt-% FM0) and were then compared. The same procedure was carried out for the other variables (26).

Results

22 sarcopenic subjects (12 in experimental and 10 in control group) with ASMI<6.76 kg/m^2 and poor physical function (grip strength <20 kg) and with no abnormalities or muscle problems preventing their participation in the protocol completed the study. Table 3 represents the demographic characteristics of the participants. The results of independent t-test showed no significant differences between the experimental (n=12) and control (n=10) groups regarding age (P=0.57), High (P=0.73), Weight (P=0.55), and BMI (P=0.56) in the pre-test.

Table 4 represents that weight (0.83±1.02, P<0.001), body mass index (0.34±0.41, P<0.001), and body fat percentage (1.05±0.79, P<0.001) significantly decreased in the experimental group compared to the control group. Meanwhile, net body mass (-0.98±0.57, P<0.001), ASM (-4.91±0.28, P<0.001), ASMI (-0.19±0.11, P<0.001), right handgrip (-08.58±4.50, P<0.001), and 6MWT (-0.42±0.26, P<0.001) had a significant increase in the experimental group compared to the control after eight weeks of activity. IGF-1 (-0.83±2.90, P=0.88) did

Table 3: Characteristics of the study participants (Mean±SD)

Variables	Group	Pre- test (Mean±SD)	Post- test (Mean±SD)
Age (years)	Experiment	65.50±3.28	----------
	Control	65.40±2.27	----------
High (cm)	Experiment	156.41±6..24	----------
	Control	156.20±4.91	----------
Weight (kg)	Experiment	70.08±8.33	69.25±8.60
	Control	63.40±5.64	64.30±5.05
Body Mass Index (kg/ m2)	Experiment	28.65±3.21	28.31±3.35
	Control	26.10±3.43	26.47±3.24

Table 4: Pre-test and post-test of the dependent variables (mean difference±SD) of the groups

Variables	Groups	Mean ±SD	MD [a]	t	df	P
Δ Weight (kg)	Experiment	0.83±1.02	1.73	4.44	20	<0.001*
	Control	-0.90±0.73				
Δ BMI (kg/m²)	Experiment	0.34±0.41	0.70	4.47	20	<0.001*
	Control	0.36±0.30				
Δ lean Body Mass (kg)	Experiment	-0.98±0.57	-1.50	-7.20	20	<0.001*
	Control	0.52±0.34				
Δ Body Fat Percent (%)	Experiment	1.05±0.79	1.34	4.46	20	<0.001*
	Control	-0.29±0.56				
Δ ASM (kg)	Experiment	-4.91±0.28	-0.75	-7.20	20	<0.001*
	Control	0.26±0.17				
Δ ASMI (kg/m²)	Experiment	-0.19±0.11	-0.30	-7.49	20	<0.001*
	Control	0.10±0.07				
Δ Right hand grip (kg)	Experiment	-08.58±4.50	-8.78	-6.32	14.003	<0.001*
	Control	0.20±1.54				
Δ Walking Speed (m/s)	Experiment	-0.42±0.26	-0.47	-5.96	11.77	<0.001*
	Control	0.04±0.04				
Δ IGF-1 (μg/l)	Experiment	-0.83±2.90	0.15	0.14	20	0.88
	Control	-0.99±1.83				
Δ MSTN (ng/l)	Experiment	87.25±82.38	161.18	3.84	20	<0.01*
	Control	-73.92±114.25				

Δ=Difference between pre-test and post-test variables, a= Mean Difference, *Significant difference (P<0.05), BMI= Body Mass Index, ASM= Appendicular Skeletal Muscle Mass, ASMI= Appendicular Skeletal Muscle Mass Index, IGF-1= Insulin-Like Growth Factor-1, MSTN= Myostatin

not significantly increase, but MSTN (87.25±82.38, P<0.01) significantly reduced in the experimental group compared to the control group. Therefore, High-Intensity Interval Resistance Training enhanced body composition, strength, and walking speed of sarcopenic elderly women. It also improved the body mass and reduced the process of sarcopenia by reduction of the MSTN.

4. Discussion

In this study, for the first time, the changes in sarcopenia-related parameters were investigated using a HIIRT-periodized protocol in elderly women. The findings of the current study indicated that the HIIRT protocol significantly affected and improved the main sarcopenia-related parameters, such as ASMI, handgrip strength, walking speed, and serum MSTN in this group. The results of this research revealed that eight weeks of periodized resistance training protocol, including six weeks of HIIRT, improved body composition; hence, a significant increase was observed in lean body mass, appendicular muscle mass, and appendicular muscle mass index. Furthermore, there was a significant decrease in weight, BMI, and body fat percentage, which has been confirmed in previous studies, indicating that resistance training can improve the body composition in older people (22, 24, 26, 27). Marcos-Pardo and co-workers (26) showed that 12 weeks of resistance training increased muscle mass, yet decreased weight, BMI, and body fat percentage. Makizako and co-workers (22) also reported that 12 weeks of moderate-intensity combined resistance, balance, flexibility, and aerobic exercise training prevented muscle wasting in older women. The interesting point is the length of the training period; although the results of all these studies confirm the positive effect of resistance training on body composition and muscle mass in the elderly, the advantage of the present study is that we achieved these favorable effects in a shorter period (eight weeks) owing to the type and the special design of training protocol, taking into account the short rest periods and high intensity of exercises. According to research results, the less the rest between the sets, the greater the improvement in body composition (24). However, Steele and colleagues (19) and Bao and co-workers (4) reported conflicting results and stated that resistance training does not significantly change ASM and ASMI. The study by Steele and colleagues (19) also implied that one year of moderate-intensity progressive resistance training (two sessions per week, one set of 15 Rep) does not change muscle and body mass in the elderly after one year. However, in spite of the shorter training period (eight weeks) in the present research, a significant increase and decrease of muscle mass and body weight were observed, respectively. This was probably on account of the high intensity of the exercise in HIIRT protocol because higher intensity of exercise could contribute to a greater reduction in the total body fat mass (28) while increasing the percentage of lean muscle tissue in the body (29). Fat loss is not always associated with an increase in lean body mass since acute fat loss is a function of increasing energy consumption while chronic one is due to the cost of energy for protein synthesis, repair, and adaptation after applying a heavy load on muscles. In addition, increased resting metabolism, which is highly dependent on muscle mass, is another reason for fat loss. Therefore, the differences in protocol components (three sessions versus two sessions per week; two sets with four to six repetitions; short-term, high-intensity, and low-rest intervals versus one set of 15 moderate-intensity repetitions) are likely to explain the inconsistency of the results. It should be noted that the training protocol of this study was performed for the first time in Iran for sarcopenic elderly women and was a periodized protocol. Its first mesocycle is hypertrophy and the second one (HIIRT protocol) is a strength mesocycle performed through three sets of rest pause. Rest pause is a training method involving intense workouts. Each set performed with this technique includes four to six repetitions, 20” recovery, two repetitions in fatigue, 20” recovery, and one or two repetitions until exhaustion (25). An important point is that although several studies have been conducted on the effect of training on body composition, the majority of them have focused on long-term exercise (more than 12 weeks) and the effect of high-intensity exercise in a short time on the elderly community has received less attention, which is the new approach of this study. HIIRT may seem to be risky for older people, but we do not agree with this view for the following reasons and believe that the present research protocol is safe, effective, attractive, and applicable for older people: 1) The positive effect of High-Intensity Resistance Training and its tolerability by the elderly have been reported and confirmed in previous research (30); 2) Accuracy and focus on exercises; 3) Continuous care by professional sport sciences coaches in all the stages of the protocol; 4) Use of periodized training and allocation of sufficient time for familiarization (one week/three sessions); training session and justification of correct implementation of techniques by a bodybuilding instructor through mentioning possible mistakes in performing movements and the possibility of resulting injuries as well as gaining basic physical fitness and preparation to participate in HIIRT protocol (two weeks/six sessions), according to American College of Sports Medicine (ACSM) recommendations; 5) Intimate and close relationship between the instructor and participants during the study.

The obtained results herein indicated that handgrip strength and physical function (6MWT) increased in the experimental group relative to the control. It should be noted that these two tests are important in the field of sarcopenia in terms of both clinic and research and are a good predictor of mobility limitations and mortality in the general population (17, 18). The study of Steel and colleagues (19) showed that six months of moderate-intensity progressive resistance training enhanced the strength of elderly. Makizako and colleagues (22) also stated that 12 weeks (three sessions per week, 60 minutes per session) of moderate-intensity combined resistance, balance, flexibility, and aerobic exercise improved the physical performance of sarcopenic older women. As already mentioned, despite the similarity of the results, an advantage of the present work was the increase in strength and physical performance owing to the type of training protocol performed over a shorter period of time (eight weeks). One of the physiological reasons behind this change is the relationship between muscle mass and strength. Physical function and strength are improved concomitant with the increase in muscle mass; therefore, the increase in handgrip strength and 6MWT is likely to be the result of improved body muscle mass (5). Nevertheless, Madden (21) reported that eight weeks of moderate-intensity continuous training (MICE) did not change the performance of elderly people and the type of exercise program is probably the reason behind the difference between this finding and that of the present study (High-Intensity Resistance Training versus MICE). According to the research results, the HIIRT protocol, while being safe, contributes to a greater increase in the performance of the elderly than other protocols (21).

Another factor studied in this research was IGF-1, which increased in the experimental group compared to the control, yet the difference was not statistically significant. Negharesh and colleagues (10) also demonstrated that eight weeks of resistance training did not change IGF-1 levels in older men. On the other hand, de Souza Vale and co-workers (31) stated that 12 weeks of resistance training with 50-85% 1RM elevated IGF-1 levels of older women. The trend of IGF-1 increase is likely to slow down given the higher levels of chronic inflammation in the elderly and considering the theory of inflammation and its inhibitory effects on GH/IGF-1 axis. Therefore, it appears that the longer the training period (more than 12 weeks) and the higher its intensity, the greater the increase in IGF-1 levels (32). In this study, a significant decrease in myostatin was observed in the experimental group compared to the control, which has been confirmed in a number of studies (13, 33, 34).

Negaresh and co-workers (33) stated that eight weeks of strength training reduced serum myostatin levels while Willoughby (15) reported that 12 weeks of resistance training (three times a week and three sets of six repetitions each with 85-90% 1RM) elevated myostatin levels. Considering the differences in the length of the training program and the type of protocols, resistance training appears to raise the expression of myostatin mRNA via increasing glucocorticoid expression. Nonetheless, downregulation of myostatin receptors, including activin IIb, by follistatin does not affect the strength and muscle mass resulting from resistance training (15). Resistance training causes muscle hypertrophy and increases muscle mass in the elderly by enhancing muscle protein synthesis, activating the proliferation of satellite cells, producing anabolic hormones, and reducing catabolic cytokine activity, which in turn augments the cross-sectional area of type I and II fibers, as well as the total lean muscle mass of older people. Moreover, it improves muscle strength, which is clinically significant. As a result, resistance training helps reverse the age-related decrease in muscle mass and strength (12). Notably, the signals of anabolic molecules play an essential role in protein synthesis. IGF-1 stimulates protein synthesis and satellite cell proliferation and hypertrophy by activating the PI3K-Akt-mTOR pathway while suppressing protein degradation; however, this anabolic pathway is impaired in elderly and leads to the reduced expression of Akt and mTOR. Overall, these data suggested that anabolic signaling disorder plays a crucial role in sarcopenia (11). Myostatin, on the other hand, is an important and effective factor limiting muscle size and negatively regulating skeletal muscle growth and development. Thus, myostatin is a negative regulator of satellite cells and its higher expression leads to muscle atrophy (35). Research has shown that MSTN expression increases in older people to reduce muscle protein production by inhibiting mTOR while resistance training decreases MSTN. Therefore, in this study, activation of anabolic signaling, such as PI3K-Akt-mTOR pathway, stimulation of growth factor secretion (like IGF-1), and reduced MSTN through high intensity interval resistance training, improved muscle mass, strength and physical function in elderly (25). Ultimately, a number of important limitations need to be considered; primarily, we did not evaluate the muscle tissue IGF-1 and MSTN via tissue biopsy. Secondly, the number of participants were small. Finally, only women comprised the participants herein and sex may affect the acute exercise response and/or long-term exercise adaptation, including the muscle hypertrophy. Hence, our results did not necessarily apply for both sexes of the elderly population and further investigation is required for more clarification in this regard. Furthermore, as sarcopenia is a multifactorial syndrome, the other variables not controlled in this study should be investigated in future research as possible confounders or interrelated components, such as frailty, nutrition, supplementation, and behavioral status. It could be accordingly recommended that future studies of sarcopenic elderly men as well as tissue biopsies and longer HIIRT periods be performed to accurately measure catabolic and anabolic factors.

5. Conclusion

In brief, the results of the present study shed light on the fact that HIIRT is a safe and applicable resistance training protocol for older people with the ability to make desirable changes in muscle strength, size, and performance by applying load on muscle group and inducing muscle contraction. The most important merit of this training program is that it creates metabolic adaptations by spending less time and volume, but high efficiency, which is suitable for weight control and fat reduction since the use of heavy loads and short recovery periods in this type of exercise result in stimulation and induction of mechanical effects on the muscles; this emphasizes the efficiency of the training. Another important point is that long-term training protocols are probably wearisome and time consuming for older people whereas HIIRT saves time and could be easily adapted given that it is performed with high intensity. Additionally, since many older people suffer from early fatigue, boredom, and impatience with traditional resistance training programs, this training method is believed to be a good option for these people.

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Ethical Approval

The Ethical Review Board of the Shiraz University of Medical Sciences approved the present study under the following number: IR.SUMS.REHAB.REC.1399.013. Also, all the subjects signed the informed consent form of the study before the start of the training period.

Conflict of interest: None declared.

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