International Journal of Advanced Smart Convergence Vol.12 No.1 184-192 (2023)
http://dx.doi.org/10.7236/IJASC.2023.12.1.184

IJASC 23-1-22

Effects of Resistance Exercise for 12-weeks on Body Composition, Circumference and Muscle Activity by Age

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Abstract

The purpose of this study was to compare and analyze the body composition, muscle circumference, and muscle activity of men in their 30s and 50s when the resistance exercise program was applied for 12 weeks, and to provide basic data for the preparation of the resistance exercise program for middle-aged men before entering old age. Nine men in their 30s and eleven 11 men in their 50s participated in the moderate intensity resistance exercise program for 12 weeks. Two weeks before the experiment, body composition, muscle circumference, and EMG were pre-tested, and then body composition and muscle circumference were additionally measured at the 8th week. Body composition, muscle circumference, and EMG were measured within 2 weeks after the 12 week exercise program. The measured data were compared and analyzed by Mixed design two-way ANOVA, and the following results were obtained. The body composition showed a significant difference only in the skeletal muscle mass, and it increased in the 30s group at 8 weeks. Muscle circumference did not show significant difference according to group and time. Muscle activity showed a significant difference according to group and time, and pectoralis major and triceps brachii showed a significant decrease to 30s group. The pectoralis major was higher in the 30s group at all times. In summary, when applying a 12-week resistance exercise program for young men and middle-aged men, the effect of improving muscle strength may appear similar, but they are not consistent, and it is thought that gradual changes in training variables are needed to improve muscle mass.

Keywords: *Middle-Aged Men, 12-weeks Resistance Exercise, Muscle Mass, Circumference, Muscle Activity*

1. Introduction

As humans grow older, they enter adulthood − middle age − old age. In particular, about 40% of the elderly experience a rapid decrease in muscle mass, which begins to gradually decrease by 1-2% starting at the age of 40[1]. The decline in muscle function due to the decrease in muscle strength and muscle mass due to aging affects physical fitness factors such as flexibility, balance, and agility, and causes abnormal physical activities [2], increasing the risk of falls and impairment in daily life, and cardiovascular disease. Since metabolic diseases such as hypertension, diabetes, and dyslipidemia are caused by functional decline [3-4], maintaining

Manuscript Received: February. 17, 2023 / Revised: February. 20, 2023 / Accepted: February. 22, 2023
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muscle strength and skeletal muscle mass is important for a healthy quality of life in aging. It is an essential element [5].

The decline in muscle strength, which affects exercise performance, is due to living patterns due to the surrounding environment and social changes as you get older [6]. Changes in muscle functional needs due to reduced physical activity [7], reformation of motor units due to changes in neuromuscular activity [8] and reduction in maximum motor unit discharge rates [9], and increase in the proportion of slow contractile fibers [10]. In the study of muscle contraction according to age, it was reported that the higher the age, the greater the difference in the expression of muscle strength through maximum voluntary contraction [11], and the decrease in muscle strength due to changes in neuromuscular structure is known to be more pronounced in the lower body than in the upper body and in the muscles of the flexor. This change in muscle strength leads to changes in lifelong life functions such as a decrease in ground reaction and a decrease in walking speed [12].

Resistance exercise can improve muscle function (muscle strength and power) and structural (muscle hypertrophy), preventing sarcopenia because it causes increased myofascial hypertrophy in fast contraction fibers (type IIa and type IIx) compared to slow contraction fibers (type I) among muscle contraction types. In particular, resistance exercise is effective in increasing muscle mass and muscle strength, increasing hormones related to muscle protein synthesis, and reducing inflammatory factors, and increasing the transverse region of muscle fibers, so it is considered desirable to prescribe resistance exercise to prevent muscle loss [14]. On the other hand, since the decrease in muscle strength and muscle mass due to aging does not occur only in the elderly, middle-aged men with reduced physical function may also have ambivalence in the effect of resistance exercise [15]. In one study report, when an 8-week resistance exercise program was applied to men in their 40s and men in their 20s, there was a difference in the concentration of growth hormone, and the GH response was weakened in men in their 40s. The plasticity of the system raised the possibility of change or damage [16]. In addition, another study reported that when resistance exercise was applied to men in their 20s and men in their 40s for 8 weeks, muscle strength increased significantly in both groups, but the decrease in body fat was more pronounced in men in their 40s [17]. It was reported that the two groups showed similar resilience when the muscle injury protocol was applied to males at 60% of 1RM intensity, suggesting the need for additional research [18].

Although the effect of resistance exercise on the human body may vary depending on the life cycle, most studies on the effect of exercise due to aging are conducted on the elderly [19-21]. Although it is clear that changes in body composition and motor function are clear even in middle age, which is the stage before entering old age[22-23], there is a lack of comparative analysis of body composition and performance with other age groups targeting the domestic population, and changes in appendicular skeletal muscle (ASM), skeleton muscle index (SMI) and EMG, an indicator of neuromuscular activity, are rarely investigated. Therefore, this study attempted to investigate changes and differences in body composition, muscle circumference, and muscle activity that may appear when the same 12-weeks resistance exercise program is applied to young and middle-aged men.

2. Experiment Materials and Methods

2.1 Experimental Approach

Subjects in their 30s and 50s conducted a preliminary test for body composition, circumference, and EMG two weeks before the experiment, and then conducted a resistance exercise program three times a week for 12 weeks. Body composition and circumference were additionally measured at week 8, and body composition, circumference, and EMG were measured in the same manner as the pre-examination within two weeks after the end of the program.

2.2 Subject

The subjects of this study were 11 men in their 30s and 50s with less than 6 months of experience in resistance exercise, and the significance, purpose, and procedure of the study were fully explained based on the bioethics and safety Act, and the expected benefits and inherent risks and inconveniences were fully notified. During the study, two people in their 30s were dropped out of the group, and the data of nine men in their 30s and 11 men in their 50s were analyzed. The physical characteristics of the subject are shown in Table 1.

Table 1. The physical characteristics of the subject

Group	Age	Height (cm)	Weight (kg)	BMI	Bodyfat (%)
30s(n=9)	33.99±3.10	173.00±5.52	69.32±10.52	23.17±3.31	21.59±6.24
50s(n=9)	53.44±2.79	170.89±4.26	70.23±8.17	24.03±2.44	22.22±4.59

Mean±SD

2.3 Research procedure

2.3.1 Resistance exercise

In this study, the 12-week resistance exercise program was conducted in the fitness room of D University in Chungcheongnam-do and was conducted for one hour three times a week. There are a total of eight sports events, and all the large muscle groups (chest, back, and leg) can be used. The weight strength of the whole-body resistance exercise was 70 to 85% (8 to 12RM) of 1RM, and three sets of each event were performed while resting for 60 to 90 seconds. To prevent injuries and accidents during the resistance exercise program, one exercise leader per three was conducted in the presence. In addition, to prevent a rapid increase in blood pressure during exercise, it was instructed that the valsalva breathing generated at the stitching point did not exceed 2 seconds.

2.3.2 Bioelectrical Impedance Analysis measurement

To evaluate body composition, a body composition analyzer (Inbody 430, Korea) was used. To minimize the variables of the test results, the subjects fasted 8 hours before the measurement, were required to wear the same clothes for all tests, and all metals worn on the body were removed. When measuring, the inspector took off his socks, adjusted the sole of the foot to the footrest sensor, and lightly held both handles, and did not move or speak during the inspection. After the measurement was completed, data on the body fat, and muscle mass were analyzed using the analysis result paper. Appendicular skeletal mass (ASM) and skeletal muscle index (SMI) were calculated to evaluate the index of sarcopenia following the 12-week muscle resistance exercise program. ASM was calculated by dividing the value of the total limb skeletal muscle mass (arms and legs) by the square of the height. SMI was calculated by dividing the limb skeletal muscle mass by weight [24].

2.3.3 Circumference measurement

The circumference of the upper arm was measured horizontally using a flexible and non-stretchable tape measure with the arm naturally placed on the side of the thigh and the hand touching the side of the thigh. The circumference of the thigh was measured horizontally using a flexible and non-stretchable tape measure after placing the foot on the step box in a 90° bent position between the knee and the hip joint [14]. All measurements were performed on the dominant side, and were performed twice each and recorded when the repeated measurement value was within 5 mm.

2.3.4 EMG measurement

EMG was measured during 10RM chest press exercise, and a wired four-channel electromyograph (Laxtha, Korea) was used. The surface electrodes were attached to the pectoris major and triceps brachii, the pectoris major was attached to the anterior axial mold, and the triceps brachii was attached to the posterior axial mold at a point separated by four fingers width. For EMG signal analysis, the original signal up to the initial three times was converted to RMS, an indicator of muscle activity, and for this purpose, Offset Control was set to 0 and Bandpass FFT-Filtering was set to 10-400 Hz. Then, Root Mean Squared was applied to use the average value.

2.4 Statistical Analysis

All the data collected in this study were calculated using the IBM SPSS statistics 22 statistical program to calculate the mean and standard deviation of all variables, and the differences between groups and periods were analyzed using the Mixed design two-way ANOVA method. If a significant difference occurs, post-verification was performed with bonferroni.

3. Result

3.1. Changes in body composition

Body composition according to 12 weeks resistance exercise showed significant difference according to time in Skeletal muscle mass. As a result of post-hoc analysis, there was a significant increase between pre-8week in the 30s group. The results of the two-way ANOVA of the body composition according to the 12-week resistance exercise are shown in Table 2.

Table 2. Changes in body composition

Variable factor	Age	Pre	8-week	12-week		F	*p*
Skeletal muscle mass(kg)	30s	30.32±2.87	31.04±2.99ʃ	30.96±2.85	Group	.009	.926
	50s	30.37±2.98	30.89±2.88	30.68±3.20	Time	7.025	.003
					(G) x (S)	.441	.647
body fat (%)	30s	21.59±6.24	20.62±6.29	21.44±6.31	Group	.056	.815
	50s	22.22±4.59	21.43±5.21	21.91±5.78	Time	2.597	.090
					(G) x (S)	.093	.912
BMI	30s	23.17±3.31	23.26±3.18	23.43±3.32	Group	.275	.607
	50s	24.03±2.44	24.00±2.57	23.98±2.53	Time	.701	.504

					(G) x (S)	1.548	.228
ASM (kg)	30s	7.72±0.57	7.80±0.61	7.79±0.61	Group	1.304	.270
	50s	8.01±0.47	8.10±0.47	8.06±0.50	Time	1.923	.163
					(G) x (S)	.077	.926
SMI (%)	30s	33.60±2.88	33.66±2.86	33.39±2.92	Group	.002	.962
	50s	33.46±2.34	33.77±2.67	33.61±2.93	Time	.598	.556
					(G) x (S)	.402	.673

Mean±SD, ʃSignificant difference to time.

3.2. Changes in Circumference

Circumference according to 12 weeks resistance exercise did not significant difference according to group and time. The results of the two-way ANOVA of the circumference according to the 12-week resistance exercise are shown in Table 3.

Table 3. Changes in circumference (cm)

Variable factor	Age	Pre	8-week	12-week		F	*p*
Upper arm	30s	31.70±1.32	31.17±2.08	31.49±2.48	Group	1.210	.288
	50s	29.96±3.00	29.72±3.47	30.79±2.85	Time	2.297	.117
					(G) x (S)	1.373	.268
Thigh	30s	51.78±3.68	51.64±3.64	51.98±3.20	Group	.154	.700
	50s	50.88±3.34	51.27±2.19	51.53±3.49	Time	.499	.612
					(G) x (S)	.216	.807

Mean±SD

3.3. Changes in Muscle activity

Muscle activity according to 12 weeks resistance exercise showed significant difference according to group and time. As a result of post hoc test, pectoralis major showed a difference between groups in all periods, and only in the 30s group showed a significant decrease according to the period. The triceps brachii showed a significant decrease with time only in the 30s group. The results of the two-way ANOVA of the muscle activity according to the 12-week resistance exercise are shown in Table 4.

Table 4. Changes in muscle activity (%MVIC)

Variable factor	Age	Pre	12-week		F	*p*
Pectoralis major	30s	76.75±31.31	53.47±19.64ʃ	Group	7.616	.014
	50s	46.68±15.33†	35.16±11.21†	Time	15.877	.001
				(G) x (S)	1.812	.197
Triceps brachii	30s	28.52±9.28	16.85±5.38ʃ	Group	.084	.776
	50s	23.71±5.68	20.06±6.91	Time	18.251	.001
				(G) x (S)	4.997	.040

Mean±SD, †Significant difference to group. ʃSignificant difference to time.

4. Discussion

Resistance exercise is considered one of the ways to inhibit muscle loss due to aging [16], and regular and repetitive resistance exercise is known to increase protein synthesis and increase skeletal muscle mass regardless of age [25-26]. However, it is reported that the hormonal response to acute resistance exercise varies according to the life cycle [27], but many studies have been conducted on the elderly and young adults, and there are insufficient studies comparing the difference in exercise effects between middle age (40s and 50s), which is the preparation stage of old age.

In the results of this study, the skeletal muscle mass measured by bioelectric resistance method showed a significant increase only in the 30s at the 8th week, and the ASM and SMI indices used as indicators of sarcopenia showed no significant change. In previous study, when a gradual resistance exercise program was applied to 46-year-old men and 64-year-old men at an intensity of 50% to 80% of 1RM, blood testosterone increased up to 8 weeks in both groups [28]. Another study reported that the concentration of GH and testosterone in the blood increased significantly in men in their 20s and 40safter 8 weeks of 8-15RM resistance training in men in their 20s and 40s [16]. In this study, the increase in skeletal muscle mass, which appeared only in the 30s group, shows that the responses of factors mediating muscle growth may vary according to the life cycle, and this may lead to differences in exercise performance.

Upper arm and thigh circumferences did not show significant differences according to groups and time. The circumference of the upper arm and thigh is the result of measuring the circumference of the skin surface with a tape measure, and is influenced by skeletal muscle mass and adipose tissue [29]. When resistance training with a gradual increase in intensity from 15RM to 8RM was applied three times a week, both groups reported an increase in the circumference, suggesting that a longer training period and periodic training with varying intensity is needed do.

Electromyography analysis, which is used as an indicator of muscle activity, can change with training adaptation, and is known to increase activity as muscle activity increases [30]. Resistance training increases the efficiency of force generation, and muscle activity is maintained or decreased despite the increase in muscle strength as training continues [31], and it has been reported that lower muscle activity is observed during the same maximum load exercise after training [32]. In this study, the decrease in muscle activity as a result of training can be seen as a neuromuscular adaptation effect due to resistance training, and this training effect supports the results of studies reported to occur in all ages [33-34]. The improvement in muscle strength due to training is due to changes in the release rate of motor units [35] and the learning effect induced by decreased co-activation of antagonist muscles [34]. Since non-trained individuals cannot recruit a pool of large and fast motor units during submaximal exercise, firing rates must increase or additional motor units must be recruited to maintain motor performance [36].

As a result, the improvement in muscle strength due to training in aging subjects is mainly due to the improvement of neuromuscular efficiency rather than muscle hypertrophy [37], and in this study, muscle activity decreased even though body composition and circumference did not change. can be explained by showing. On the other hand, compared to those in their 30s, the group in their 50s did not show a significant increase according to the training period, suggesting that neuromuscular adaptation due to aging may decrease even in middle age.

5. Conclusion

Body composition of men in their 30s and 50s group after 12 weeks of resistance training showed a significant difference only in skeletal muscle mass and increased in the 30s group at 8 weeks. Circumference did not show significant differences according to groups and time. Muscle activity showed significant differences according to group and period, and significant decrease according to the period of only 30s group in the pectoralis major and triceps brachii. Pectoralis major was always in his 30s group.

In summary, when applying a 12-week resistance exercise program for young men and middle-aged men, the effect of improving muscle strength may appear similar, but they are not consistent, and it is thought that gradual changes in training variables are needed to improve muscle mass.

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