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The Relation between Body Composition of the Aged and the Change of Physical Fitness Level through Complex Exercise Training for 12 weeks

The purpose of this study is to investigate and reveal the effects that the complex exercise training consisting of aerobic exercise and strength training(sit up, push up) that everyone can easily practice regardless of a time and a place in order to manage practically the physical strength of the aged affects the difference on their body composition and the change of physical fitness level.

Looking into the change of body composition of an experimental group, the weight of 2.5kg was reduced after applying complex training for 12 weeks and the body fat mass of 2.65kg was reduced. Also, the abdominal fat of 0.13% was decreased and the muscle mass of 1.56kg was increased.

For the change factors of physical fitness, cardiovascular endurance, muscular strength, muscular endurance, balance and flexibility excluding agility showed significant improvement after applying complex exercise training. The improvement of health fitness of the aged under this study was significantly effective to improve specified body functions which had been lowered by aging and insufficient physical activities. So, it is regarded that their health fitness is the important factor to improve the activity competence required for daily life and to lead healthy living by the improved activity competence. Henceforth, it needs to study more the complex composition of several sports, exercise intensity and the frequency based on the previous researches and studies. In addition, it needs to develop the complex exercise training in accordance with various characteristics such as a sex of the aged, an age, a physical fitness level, environment, a disease and the program in consideration of the efficacy and safety during training.

Key words: *Complex Exercise Training; Physical Fitness; Fitness Level*

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INTRODUCTION

The development of science and technology due to the advent of advanced industrial society has led to the development of the medical industry, and the development of the medical industry makes a mean life span longer by overcoming a disease and increasing living standards and an aging society has emerged(1).

The increase of the aged population causes several problems such as an economic, physical, social, psychological problem, etc., but the most serious problem may be a health problem because of the weakening of physical functions and a disease, and such weakening of physical functions suddenly lowers physical strength(2). The physical degradation by the progress of aging in an aging society lowers tasking ability and motor ability and is restricted in selecting a sport, promotes the pace of aging and affects internal tissues and organs(3).

Many researchers have planned and applied several training in order to investigate the delay of aging. However, they have known that complex training has been more effective than one kind of training for the aged who all fitness components are simultaneously reduced.

Complex exercise means what practices complexly two exercises for the purpose of getting the effects of resistance exercise and aerobic exercise at the same time, McCarthy et al. reported that the complex exercise including endurance exercise and resistance exercise three times a week increased a maximal oxygen consumption and a muscular function. If two contrary exercises like this are complexly applied, exercise performance increases(4). And according to the study of Berger et al., complex exercise is more effective in practicing two exercises on the same day(5).

Looking into the previous studies regarding the effects of complex exercise for the aged up to recently, it has been reported that it has had effect on hormonal change, dementia, abdominal fat, diabetes, blood pressure(BP), fall injury of the aged and etc. Park et al. investigated and revealed the improvement of muscular endurance, body composition and VO_2max which are factors of health fitness via the complex exercise which consists of calisthenics, strength training(sit up, push up), weight-bearing aerobic exercise and yoga(6), its effects have been investigated by a large number of results of studies such as the effect that the complex exercise of rope jumping and walking affects the body composition of the middle aged women in the study for health status of the aged(7) and the study of Han(8), the effect that it affects the physical strength of the aged in the study of Lee and so on(9). Such previous studies were suitable for indexing of complex exercise according to results of measurement. But, they have never discussed about the quantitative change via the comparative study between a participating group and a non-participating group. So, it needs to study the quantitative change.

Accordingly, the purpose of this study is to investigate and reveal the effects that the complex exercise consisting of aerobic exercise and strength training(sit up, push up) that everyone can easily practice regardless of a time and a place in order to manage practically the physical strength of the aged affects the difference on their body composition and the change of physical fitness level.

MATERIALS AND METHODS

Subjects of the Study and Experimental Design

This study selected 60 men and women who have nothing wrong in a physical examination, a basic medical examination and a laboratory test among members of welfare centers located in Seoul and the Metropolitan area as subjects of this study and then classified them into a training group(T-group) who had been trained complex exercise training including resistance exercise and aerobic exercise about muscular strength, endurance and etc. for 12 weeks and a control group.

30 old persons over 60 years old were determined to be suitable for an examinee by a pre-survey. And all 30 persons had been trained a complex training program three times a week for total 60 minutes per day stretching for 10 minutes, main complex exercise program for 40 minutes and wrap up for 10 minutes. Also, the data which is a measuring tool of a baseline(beforehand), physical strength, motor behaviors, health perception for 12 weeks(post-exercise) was collected by a questionnaire. Meanwhile, this study minimized the error by getting rid of an outlier from the selected examinee(subjects) via a pre-test about a moto behavior and health perception.

The selected examinee were the public who had not been prescribed a drug in the past 3 months and complex exercise had been practiced three times a week and 60 minutes per day for 12 weeks.

Body Composition Measurement

Body composition is measured by bio-electrical impedance analysis: Inbody 4.0. To measure it, the examinee should remove all kinds of accessories with the minimum clothes and conform to the measurement methods and the postures requested by Inbody 4.0. Unnecessary actions to be interfered with the measurement were controlled, and for the results, body fat was measured as a unit of 0.01% and muscle mass and body fat mass were done as one of 0.01kg.

Physical Fitness Test

For a physical fitness test, Senior Fitness Test(SFT) suggested by Rita et al. was supplemented and used in accordance with the purpose of this study, and the test was composed as shown in Table 1(10). Physical strength was measured by the measurement methods of national fitness survey(8).

Running of six minutes: cardiovascular endurance

It measures a pulse rate for 1 minute after running of 6 minutes at a rate of 10km/h on a treadmill. And then it qualitatively measures cardiovascular endurance through a pulse rate per minute using FT-6175 wireless meter.

Table 1. Items for fitness test

Division	Taekwondo
Cardiovascular endurance	Measurement of the pulse after running of 6 minutes
Muscular strength	Grip strength
Muscular endurance	Sit up
Flexibility	Trunk flextion in sitting position test : trunk flextion forward
Agility	10m shuttle run
Balance	One leg standing with eye-closed

Grip strength: muscular strength

An examinee stands with his/her feet at shoulder width, easily controls the handle of a hand(grip) dynamometer(Takei, Japan) in accordance with a size of hand. An examinee lowers his/her arms comfortably and grips a hand dynamometer as strong as possible without movement with standing upright. Grip strength is respectively measured 2 times for a right and left arm, and the higher value among the measurement results is recorded as a unit of 0.01kg.

Sit up: muscular endurance

An examinee draws up his/her knees at 90° with lying on a mat and laces fingers behind his/her head as a starting position. And then if his/her both cubitus reach both knees by sitting up simultaneously with a signal 'start' and then returns to the starting position, it is regarded as 1 time of sit up and the repeat count of sit up for 1 minute is recorded.

Trunk flextion forward: flexibility

It is measured when an examinee pushes a measuring plate with his/her fingertips sitting on a measuring instrument with stretching out knees less than 5cm of the distance between both legs. If an examinee bends his/her knees, pushes the plate with rebounce or does not push it with both hands when measuring flexibility, it becomes null. If the plate gets away from the tip of the toes, it is measured as '-', and if it gets near it, it is done as '+'. And the higher value after measuring 2 times is recorded as a unit of 0.01cm.

10m shuttle run: agility

An examinee presses a buzzer placed 10m ahead if a starting signal rings and then returns to the starting point. It measures the time when an examinee repeats 2 times this process as a unit of a second. It calculates a mean after measuring the time 2 times, and if an examinee does not press a buzzer, it becomes null.

One leg standing with eye-closed: balance

It is measured when an examinee closes his/her eyes after bending back one leg standing upright with spreading both arms and shoulder out horizontally. If an examinee loses the balance of body, reaches one leg to the floor or opens eyes in measuring, immediately the measurement has to be stopped. The higher value after measuring 2 times is recorded as a unit of 0.01 second.

Complex Exercise Training Program

The measurement and test for all items were made 2 times before and after complex exercise(Table 2). In order to reduce an error of measurement before and after applying it, they were measured from 8 am under the same conditions to the maximum, and examiners inform examinees of matters to be attended so that they seriously participate into this program and maintain the test environment calmly and quietly.

Data Analysis

The results of this study were processed by SPSS Win 15.0 version, and at this time, 2×2 repeated measure factorial design was used that the group factor among examinees was set up as an independent variable and a time of measurement was done as a repeated measurement factor. Repeated measures ANOVA was used before and after applying a complex exercise program for the purpose of understanding the changes on physical fitness of the aged in accordance with their participation or non-participation into complex training.

Table 2. Complex exercise training program

Composition	Exercise program		Expected effect
Warming-up exercise	Calisthenics, stretching (10 minutes)		Muscle relaxation by warm-up
Complex exercise	Aerobic exercise	Treadmill & cycling(20 minutes)	Improvement of cardiopul-monay function
	Anaerobic exercise	Weight training(20 minutes) (40~50% of 1RM:10~12times×2times)	Improvement of muscular strength & agility
Wrap-up exercise	Wrap-up & stretching(10 minutes)		Relaxation

RESULTS

The Changes on Body Composition of the Aged who Participation into Complex Exercise Training(Table 3)

The change on weight

The change of weight did not show the significant difference among groups, but there was meaningful difference on the times applying complex exercise($p<.05$). So, a complex exercise program was effective to change a weight. Meanwhile, the interaction between an experimental group and the applied exercise time was effective because of $F=2.24$ and $p<.05$.

The change on body fat mass

The change of body fat mass showed significant difference among groups($p<.05$), but there was no meaningful difference among the times applying complex exercise. As a result of a post-test, an exercise group showed significant difference($p<.001$), and the body fat mass was reduced as about 20.5% from 31.66% to 29.01% on average. So, a complex exercise program was effective to reduce body fat. In the mean time, the interaction between an experimental group and a time was ineffective because of $F=.021$.

The change on abdominal fat

The change of abdominal fat showed significant difference($p<.05$) between an experimental group and a time. As a result of a post-test, an exercise group showed meaningful difference($p<.01$), and the abdominal fat was reduced from 1.34kg to 1.21kg on average. But, a control group did not show the meaningful difference. On the one hand, the interaction between a group and a time was effective because of $F=7.01$.

The change on muscle mass

The change on muscle mass before and after applying complex exercise showed significant difference($p<.01$) between groups, and did not show it between times. As a result of a post-test, the muscle mass was increased from 16.45kg to 18.01kg on average but there was no meaningful difference between an exercise group and a control group. Meanwhile, the interaction between a group and a time was effective because of $F=6.71$ and $p<.05$.

The Changes on Physical Fitness Level of the Aged applying Complex Exercise(Table 4)

The change on cardiovascular endurance

The change of cardiovascular endurance before and after applying complex exercise did not show the significant difference among groups but showed it($p<.01$) among times. As a result of a post-test, the pulse count of an exercise group was reduced and showed meaningful difference($p<.01$). Meanwhile, the interaction between a group and a time was ineffective because of $F=1.23$.

The change on muscular strength

The change of muscular strength before and after applying complex exercise was not significant between groups but was significant between times($p<.01$). As a result of a post-test, an exercise group showed significant difference($p<.001$) and the muscular strength was increased from 21.30kg to 24.11kg on average. In the mean time, the interaction between a group and a time was effective because of $F=18.87$ and $p<.001$.

Table 3. Results of two-way ANOVA for each items before and after complex exercise among groups

Item	Group	Pre	Post	p	Repeated ANOVA(F-value)	
Weight	Experimental	71.26±8.64	68.76±6.01	.001***	Group	1.32
					Time	5.37
	Control	74.88±5.2	74.01±1.23	.450	Group×Time	2.38†
Body fat mass	Experimental	31.66±4.21	29.01±3.30	.000***	Group	4.77
					Time	1.02
	Control	74.88±5.2	74.01±1.23	.450	Group×Time	.02
Abdominal fat	Experimental	1.34±5.26	1.21±1.053	.024*	Group	4.42
					Time	3.86
	Control	1.67±2.09	1.71±1.234	.160	Group×Time	7.01††
Muscle mass	Experimental	16.45±2.28	18.01±3.30	.634	Group	8.51
					Time	.16
	Control	17.72±1.09	16.09±5.56	.632	Group×Time	6.71†

* : p<.05, *** : p<.001(Comparison between a time)/†p<.05, ††p<.01(Interaction Effect)

The change of muscular endurance

The change of muscular endurance before and after applying complex exercise was insignificant between groups, but it showed significant difference between times(p<.01). As a result of a post-test, there was significant difference on exercise groups(p<.001) and the muscular endurance was increased after 12 weeks. Meanwhile, the interaction between a group and a time was ineffective because of F=.09.

The change of agility

The change of agility before and after applying complex exercise showed meaningful difference (p<.05) between groups and it did so between times(p<.05). As a result of a post-test, agility of both an exercise group and a control group was increased but it was not significant. In the mean time, the interaction between a group and a time was ineffective because of F=.24.

The change on balance

The change of balance before and after applying complex exercise did not show meaningful difference between groups, but it showed the difference between times(p<.05). As a result of a post-test, significant difference(p<.05) was shown in an exercise group. Though the balance was increased in a control group, but it was insignificant. In the mean time, the interaction between a group and a time was effective because of F=10.00 and p<.001.

The change on flexibility

The change of flexibility before and after applying complex exercise was insignificant between times but it showed meaningful difference between groups(p<.05). As a result of a post-test, meaningful difference(p<.001) was shown in an exercise group and post-flexibility after applying an exercise program was increased from 5.34cm to 6.81cm. Meanwhile, the interaction between a group and a time was ineffective because of F=1.27.

DISCUSSION

Through complex training for 12 weeks under this study, an experimental group showed significant results of reduction of body fat 2.65% and increase of muscle mass 1.56kg by participating into the complex exercise consisting of aerobic exercise, cycling, stretching and weight training. As a result of applying several kinds of rhythmic exercises during 11 weeks to the women aged over 70 years old who had the body fat more than 30%, even in the study of Kim, their body fat was reduced as 1.11%(11). Such

Table 4. Results of two-way ANOVA for each item before and after complex exercise among groups

Item	Group	Pre	Post	p	Repeated ANOVA(F-value)	
Running of 6 minutes	Experimental	114.89±10.02	106.17±6.45	004**	Group	.168
					Time	7.610
	Control	108.34±8.34	106.99±3.04	.532	Group×Time	1.230
Measurement of grip strength	Experimental	21.30±3.53	24.11±2.09	.000***	Group	2.002
					Time	11.231
	Control	22.33±8.91	22.30±5.21	.433	Group×Time	18.876†††
Sit-ups	Experimental	17.12±7.29	19.45±7.89	000***	Group	2.090
					Time	8.674
	Control	16.20±3.30	17.32±6.54	.231	Group×Time	.092
10m shuttle run	Experimental	11.01±6.34	10.09±3.12	376	Group	2.974
					Time	3.169
	Control	10.56±3.50	11.23±1.39	.190	Group×Time	.242
One leg standing with eye-closed	Experimental	9.23±6.78	14.34±3.62	.031*	Group	.567
					Time	8.453
	Control	9.08±4.31	10.44±5.09	.260	Group×Time	10.002††
Trunk flexion forward	Experimental	5.34±1.90	6.81±2.23	.000***	Group	8.031
					Time	.169
	Control	1.83±2.23	4.12±5.89	.042	Group×Time	1.269

* : p<.05, **p<.01, *** : p<.001(Comparison between a time)/††p<.01, †††p<.001(Interaction Effect)

result is very similar to the one of the study of Park et al.(6), and it could be believed that complex exercise caused very significant improvement of the change of their body composition. In the mean time, Choi insisted that the regular aerobic exercise for 16 weeks led the reduction of a weight and a body fat %(12), and this study showed the meaningful difference of a weight under complex training, too. However, it was regarded that there was no significant difference on the change of muscle mass because weight training among complex training practiced not high-intensive training but low-intensive training. And aerobic exercise is very effective to reduce the weight of fat people(13), but the exercise time should be long because the energy consumption of aerobic exercise is small. Especially, he pointed out that it is difficult for fat people to participate into high-intensive exercise for a long time because of their low physical fitness level and mentioned that appropriate resistance exercise is effective to control weight(14).

A control group did now show significant differences for each item and the difference on change of their abdominal fat mass was small. Like the experimental group of complex training, however, regular strength training(sit up, push up) increases their muscle mass, and such increased muscle mass makes them consume a calorie more than before by increasing a basal metabolic rate. Therefore, it is possible to suggest that complex training can be helpful for reducing body fat.

If aging starts once, generally, all physical functions go down at the same time. In case of body composition, especially, the characteristic is that the increase of body fat and the decrease of muscle happen simultaneously(15). Body fat increases according to an age and is gradually re-dispersed. And in case of the aged, their abdominal fat has a tendency to

increase and subcutaneous fat of legs and arms tends to decrease(16). The increase of fat is concerned with obesity, high blood pressure(BP), hyperlipidemia, diabetes and a cardiovascular disease. So, it is desirable not to escape the recommended % body fat for the sake of healthy life of old age. Accordingly, complex exercise which consists of several kinds of exercise like the example of this study rather than one kind of exercise can be very effective to improve the lowering of multi-functions of the aged.

The experimental group who had been prescribed complex training showed the increase of muscular strength as well as the decrease of pulse in measurement of cardiovascular endurance after running of 6 minutes. The group proved the effect of complex training for functional improvement before and after applying the training in the measurement of muscular endurance, flexibility and balance. But this hypothesis was rejected because agility did not show significant difference.

The exercise recommendations of specialized agencies such as ACSM(The American College of Sports Medicine) and AHA(American Heart Association) before 1990 have placed emphasis on aerobic exercise such as walking, swimming and cycling or endurance exercise without almost use of the terms in relation to muscular strength. However, their recent exercise recommendations have included resistance training for muscular strength like endurance exercise(17). Jeon et al. reported that there was a time when it was suggested that muscular strengthening exercise applied to the aged in order to maintain and strengthen muscular strength was inappropriate for them(18), but in recent years, strength training(sit-up, push-up) has been recommended as a necessary exercise for the aged and it is desirable for using the equipment of weight training as the exercise for their safety and convenience. Weight training increases muscular strength using weight resistance training and such increased muscular strength causes myohypertrophia(5). Choi revealed significant increases of abdominal curl 25%, back extension 23.4%, leg curl 32%, leg extension 23.4% and leg press 23.6% as a result of applying trunk & lower body weight training during 12 weeks for elderly women(19), and he also reported that even if an elderly woman who aging has been considerably progressed has regularly practiced weight training for a long time, muscular strength had been strengthened by the increases for the size of myofiber, the muscular cross-section, the density of a bone and mineral, etc. around the exercise region. As a result of complex exercise including weight training for 12 weeks under this study, the right grip strength of the experimental group had been strengthened, and the complex exercise is regarded that it strengthens the muscular connective tissue of elderly women, improves functionally body movement and protects their joints and muscles from an injury. It is difficult to strengthen muscular strength because physical fitness(strength) has a limit to enlarge skeletal muscle or performance muscle with only aerobic exercise(9). However, it was certified that skeletal or performance muscle is strengthened by practicing complexly weight training around global muscles like the results shown after applying complex training including resistance and aerobic exercise.

Additionally, the previous studies in relation to muscle strength has reported that both muscular strength and flexibility were increased at the same time. But so far, the relation between muscular strength and flexibility has not been clearly defined. Recently, one of Korean studies reported that both isometric weight training and PNF weight training positively affect the increase of hyperthropy and blood flow rate as well as the improvement of muscular strength and flexibility(19). Likewise the previous study, this study proved that both the flexibility and muscular strength of 30 subjects(examinees) who had participated into complex training had been significantly increased and there was significant difference for such increases between control groups. It seems that flexibility had been increased by stretching, resistance training and posture correction before and after applying complex exercise. Also, it is thought that the complex exercise is sufficient to stimulate a muscle tissue around a joint for the purpose of improving ROM of a joint and the improvement of ROM caused the strengthening of muscular strength. Also, the increased ROM is helpful for strengthening of muscular strength because it is able to use muscle more easily. So, it can be suggested that weight training gives a positive effect to the health fitness of the aged.

CONCLUSION

This study made a conclusion as followings in order to investigate and reveal the changes of body composition and physical fitness level of the aged through complex exercise training for 12 weeks.

Looking into the change of body composition of an experimental group, the weight of 2.5kg was reduced after applying complex exercise training for 12 weeks

and the body fat mass of 2.65kg was reduced. Also, the abdominal fat of 0.13% was decreased and the muscle mass of 1.56kg was increased.

For the change factors of physical fitness, cardiovascular endurance, muscular strength, muscular endurance, balance and flexibility excluding agility showed significant improvement after applying complex training. The improvement of health fitness of the aged under this study was significantly effective to improve specified body functions which had been lowered by aging and insufficient physical activities. So, it is regarded that their health fitness is the important factor to improve the activity competence required for daily life and to lead healthy living by the improved activity competence. Henceforth, it needs to study more the complex composition of several sports, exercise intensity and the frequency based on the previous researches and studies. In addition, it needs to develop the complex exercise in accordance with various characteristics such as a sex of the aged, an age, a physical fitness level, environment, a disease and so on and the program in consideration of the effecacy and safety during training.

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