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The analysis of old person's blood pressure and blood lipid according to exercise frequency of combination exercise

Park Jin-Seoung, Lee Su-Kyoung, Lee Kwang-Jun

ABSTRACT

Aims: This study to analyze the effect of combination exercise program on blood pressure and blood lipid by exercise frequency on the elderly. Methods: Subject aged 65–70 years. Subjects divided into three groups: control group, exercise three times per week and excercise five times per week group. Each group performed combination exercise for eight weeks. Results: Systolic blood pressure increased in control group, but decreased in exercise three times (p<0 0.05) and exercise five times per week group. Diastolic blood pressure decreased with all groups. Triglyceride did not significantly increase in the control group, but decreased both exercise group. Total cholesterol decreased in control group, exercise three times (p<0 0.05) per week group and exercise five times (p<0 0.05) per week group. HDL-cholesterol decreased in control group, exercise three times (p < 0.05) per week group and exercise five times (p < 0.05) per week group. LDL-cholesterol significantly decrease in exercise three times (p < 0.05) per week group and exercise five times (p<0 0.05) per week group. Exercise three times per week decrease more systolic blood pressure and total cholesterol, and LDL-C decrease more with exercise five times per week. Conclusion: High frequency exercise is not always effective to the elderly people that optimal exercise frequency design to the each elderly may be helpful.

Keywords: Blood pressure, Lipid, Exercise frequency, Elderly person

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INTRODUCTION

It has been reported that the elasticity of arteries decreases as people get older, such that blood pressure gradually increases from the 20s to the 60s and rapidly increases thereafter. In particular, systolic blood pressure increases remarkably with age [1]. Methods of treatment of hypertension can be divided into drug and drug-free treatments. Exercise has been receiving attention as a good alternative among representative drug-free treatments for hypertension, and many previous studies have been conducted on exercise therapy. Cowley [2]

stated that exercise reduces blood pressure regardless of whether body fat is reduced and recommended VO_2max 50%, which represents the stage immediately before the blood lactic acid value increases, as the appropriate exercise intensity. One researcher advised that aerobic exercise was effective for the improvement of the systolic blood pressure and diastolic blood pressure of elderly persons with hypertension [3], while Han [4] reported that aqua-aerobics exercise was effective for drops in blood pressure.

Blood lipid and cholesterol levels, which are related to hypercholesterolemia due to excessive accumulation of abdominal visceral fat among the causes of death of elderly persons aged 65 years or more [5], act as extremely important factors in evaluating individuals' risk of cardiovascular disease. The improvement of blood lipid levels is helpful for maintaining a low risk of onset of cardiovascular diseases and various adult diseases [6]. Blood lipid and cholesterol levels are known to be effectively improved through regular exercise, and according to a study conducted by Katzmarzyk et al., regular aerobic exercise is effective in the improvement of blood lipid, as it reduces neutral fats, total cholesterol, and low-density lipoprotein (LDL) cholesterol while increasing high-density lipoprotein (HDL) cholesterol, and regular complex exercise programs help to improve aged women's body composition and serum lipid components. Moreover, such programs enhance these patients' self-reliance fitness, thereby enabling aged persons to continue to live on their own [7, 8].

Kim and Kim presented the frequency of exercise along with exercise time and periods as quantitative factors. They indicated that performing exercise twice per week could not provide sufficient effects, although the effects of exercise are subjectively felt, and performing exercise three times per week would gradually reduce fatigue and muscle pain and provide more effects of exercise [9]. However, a study conducted by Lee demonstrated that in the case of beginner swimmers, exercise performed three times per week showed more effective improvement in the reduction of blood lipid than exercise performed six times per week; this indicates that large amounts of exercise are not necessarily helpful for the body in a physiological sense [10].

Although regular exercise is definitely a way to maintain health and longevity among elderly persons, It has been reported that 77.9% of elderly women aged 60–69 years and 86.7% of those aged 70 years or more do not perform exercise at all [11], and exercises involving special difficulties or those restricted by equipment or place sometimes become a cause of low rates of practice or avoidance in elderly persons exhibiting low rates of participation in exercise. Therefore, many factors, such as the intensity, time, method, and types of exercises, should be carefully addressed when setting exercise prescriptions for elderly persons. In the present study, complex exercise programs comprising exercise items that are suitable for elderly persons are applied to elderly persons at different frequencies to examine the effects of the exercises on participants' blood pressure and blood lipid concentrations.

MATERIALS AND METHODS

The subject recruited from an elderly collage program consisted of 24 healthy, injury-free, no medical history of cardiac disorder, and no special exercise in daily living. The general characteristic of the subjects are explained in Table 1. The subjects received explanation about the purpose and risk of the study. Those elders voluntarily participated subject were divided into three groups as control group (no exercise), exercise three times per week group and five times per week group.

In the present study, to examine the pattern of changes in the blood pressure and blood lipid concentrations of elderly persons according to the frequencies of exercise per week, prior measurements were conducted for each group before the beginning of the complex exercise program. In addition, post hoc tests were conducted after the eight weeks of implementation of the complex exercise program.

Composition of the Complex Exercise Program

The complex exercise program consisted of 10 minutes of mild stretching before exercising, 40 minutes of the main exercises, and stretching for 10 minutes as cooling down exercise. Thus, the total exercising time was 60 minutes. The complex exercise program is as given in Table 2, and those activities that may occur in the daily living of the elderly persons participating in the present study were not included as exercise and dietary intakes were not considered.

Variable Analysis

To eliminate last-bout exercise effects from all variables, strenuous exercise was prohibit within 24 hours before measurement. Blood pressure was measured and blood was collected after fasting for at least 12 hours.

Blood pressure analysis: Systolic and diastolic blood pressures were measured on the brachial artery of the right arm by auscultation using a mercury sphygmomanometer.

Blood lipid concentration analysis: To analyze blood lipid, 10 ml of blood was collected from the antecubital vein of each participant using a blood collection tube and heparin to transport the blood to the exercise prescription room at D University in Gyeongbuk. The transported blood was separated into serum and plasma by centrifugation for 15 minutes at 3000 rpm using an HA

Table 1: General characteristics of subjects

	Control group (n=8)	Three times per week (n=8)	Five times per week (n=8)
Age (in years)	68.67±1.35	68.45±1.60	68.78±1.29
Height (cm)	154.91±5.23	155.85±3.51	155.01±3.21
Weight (kg)	57.41±4.32	57.37±3.74	56.32±4.66

Table 2: The complex exercise program

Strategy		Exercise		Intensity	Minutes
Before exercise		Stretching			10
Main exercise	Aerobic exercise	Walking		THR 50% (0~4 weeks) THR 60% (5~8 weeks)	25
	Resistance exercise	Upper	pushing wall curl	Each set 8~15 RM/ 2 sets	15
		Lower	squat lunge		
Cooling down exercise		Stretching			10

1000-3 from Hannil Sci Co. (Korea); using the separated serum, neutral fats, total cholesterol, HDL cholesterol, and LDL cholesterol were analyzed using an automatic blood analyzer (BTS-370PLUS) from Biosystem Co. (Spain).

The data processing method: The means and deviations of all measured variables from the experiment were obtained using SPSS 12.0 for Windows, and one-way analyses of variance (ANOVAs) were conducted to examine the rates of changes in the time of measurement between the groups. In addition, paired sample *t*-tests were conducted to compare intragroup changes before and after the complex exercise program. The statistical significance level of the measured values was set to $\alpha < 0.05$.

RESULTS

Comparison of variables among the groups before the complex exercise program according to frequencies per week

In the comparison of variables among the groups before the complex exercise program according to frequencies per week, the systolic/diastolic blood pressures were 155.62±8.31/91.12±6.08 mmHg in the control group, 157.75±7.57/86.62±5.28 mmHg in the three times per week group, and 153.00±6.81/86.37±8.46 mmHg in the five times per week group; there was no statistically significant difference between them. The neutral fats were 171.25±15.99 mg/dl in the control group, 187.25±37.44 mg/dl in the three times per week group, and 146.62±21.72 mg/dl in the five times per week group; there was no statistically significant difference between them. The total cholesterol levels were 211.37±11.66 mg/dl in the control group, 211.37±11.66 mg/dl in the three times per week group, and 224.25±11.89 mg/dl, and no statistically significant difference was observed. The HDL cholesterol levels were 60.40±3.23 mg/dl in the control group, 53.07±3.58 mg/dl in the three times per week group, and 62.87±4.02 mg/dl in the five times per week group; no statistically significant difference was found. Finally, the LDL cholesterol levels were 105.65±10.98 mg/dl in the control group, 100.43±11.29 mg/dl in the three times per week group, and 113.96±6.71 mg/dl in the five times per week group; there was no statistically significant difference between them (Table 3).

Comparison of variables among the groups after the complex exercise program according to frequencies per week

In the comparison of variables among the groups after the complex exercise program according to frequencies per week, systolic/diastolic blood pressures were 158.87±7.36/88.75±2.95 mmHg in the control group,

130.62±4.96/83.37±2.34 mmHg in the three times per week group, and 138.75±4.33/85.50±1.88 mmHg in the five times per week group; while the systolic blood pressures were statistically different ($p < 0.05$), diastolic blood pressures were not. Neutral fats were 184.87±9.92 mg/dl in the control group, 128.62±17.54 mg/dl in the three times per week group, and 110.00±68.88 mg/dl in the five times per week group, and the differences were statistically significant ($p < 0.05$). Total cholesterol levels were 189.62±15.86 mg/dl in the control group, 121.37±13.39 mg/dl in the three times per week group, and 143.50±15.68 mg/dl in the five times per week group; the differences were statistically significant ($p < 0.05$). The HDL cholesterol levels were 56.55±4.31 mg/dl in the control group, 37.78±4.69 mg/dl in the three times per week group, and 41.52±5.31 mg/dl in the five times per week group; the differences were statistically significant ($p < 0.05$). Finally, the LDL cholesterol levels were 102.87±5.20 mg/dl in the control group, 75.50±7.00 mg/dl in the three times per week group, and 80.25±7.59 mg/dl in the five times per week group; the differences were statistically significant ($p < 0.05$) (Table 4).

Changes in blood pressure and blood lipid according to the time of the day of the complex exercise program

As for changes in systolic blood pressure according to the time of the complex exercise program in the control group, systolic blood pressure increased from 155.62±8.31 mmHg immediately before the complex exercise program began to 8.87±7.36 mmHg at eighth weeks, but the difference was not statistically significant. In the three times per week group, systolic blood pressure was shown to have statistically significantly improved from 157.75±7.57 mmHg before the program to 130.62±4.96 mmHg eight weeks later ($p < 0.05$). In the five times per week group, systolic blood pressure was shown to have improved from 153.00±6.81 mmHg before the program to 110.00±68.88 mmHg eight weeks later, but the difference was not statistically significant.

In terms of changes in the diastolic blood pressure, this parameter showed improvement from 91.12±6.08 mmHg before the program to 88.75±2.95 mmHg eight weeks later in the control group, 86.62±5.28 mmHg before the program to 83.37±2.34 mmHg eight weeks later in the three times per week group, and 86.37±8.46 mmHg before the program to 85.50±1.88 mmHg eight weeks later in the five times per week group. However, the differences were not statistically significant.

Blood neutral fats increased from 171.25±15.99 mg/dl before the program to 184.87±9.92 mg/dl eight weeks later in the control group, from 187.25±37.44 mg/dl before the program to 128.62±17.54 mg/dl eight weeks later in the three times per week group, and from 46.62±21.72 mg/dl before the program to 110.00±68.88 mg/dl eight weeks later in the five times per week group. However, the differences were not statistically significant.

In terms of blood total cholesterol, this parameter improved from 211.37±11.66 mg/dl before the program to 189.62±15.86 mg/dl eight weeks later in the control group. However, the difference was not statistically significant. In the three times per week group, blood total cholesterol statistically significantly improved from 193.50±8.09 mg/dl before the program to 121.37±13.39 mg/dl eight weeks later, while in the five times per week group, it statistically significantly improved from 224.25±11.89 mg/dl before the program to 143.50±15.68 mg/dl eight weeks later ($p < 0.05$).

For changes in HDL cholesterol, this decreased in the control group from 60.40±3.23 mg/dl before the program to 56.55±4.31 mg/dl eight weeks later, but the difference was not statistically significant. In the three times per week group, HDL cholesterol statistically significantly decreased from 53.07±3.58 mg/dl before the program to 37.78±4.69 mg/dl eight weeks later; that in the five times per week group also statistically significantly decreased from 62.87±4.02 mg/dl before the program to 41.52±5.31 mg/dl eight weeks later.

Finally, in the control group, LDL cholesterol decreased from 105.65±10.98 mg/dl before the program to 102.87±5.20 mg/dl eight weeks later, but the difference was not statistically significant. In the three times per week group, it improved statistically significantly from 100.43±11.29 mg/dl before the program to 75.50±7.00 mg/dl eight weeks later, and in the five times per week group, it also statistically significantly improved from 113.96±6.71 mg/dl before the program to 80.25±7.59 mg/dl eight weeks later ($p < 0.05$) (Table 5).

DISCUSSION

According to the American Heart Association [12], systolic blood pressure of 120–130 mmHg and diastolic blood pressure of 80–85 mmHg are considered normal, while systolic blood pressure of 130–139 mmHg and diastolic blood pressure of 85–89 mmHg are considered higher than normal, and individuals with systolic blood pressure exceeding 140 mmHg and diastolic blood pressure exceeding 90 mmHg are diagnosed with hypertension. Extensive studies intended to prevent and treat hypertension have been conducted, and in particular, diverse exercise treatment–related studies have been conducted. Motoyama et al. [13] reported that when an aerobic exercise program was implemented with elderly hypertension patients aged 64–84 years for nine months, their systolic blood pressure significantly improved by –17 mmHg, and the diastolic blood pressure was significantly improved by –9 mmHg. Moreover, Mughal, Alvi, and Ansari [14] reported that when aerobic exercises with an intensity level reaching 50% of maximal oxygen

Table 3: Comparison of variables among the group before the complex exercise (mean±SE)

Group	Control Group	Three times per week	Five times per week	F	p
Systolic blood pressure (mmHg)	155.62 ±8.31	157.75 ±7.57	153.00 ±6.81	0.098	0.907
Diastolic blood	91.12 ±6.08	86.62 ±5.28	86.37 ±8.46	0.433	0.654
Pressure (mmHg)	171.25 ±15.99	187.25 ±37.44	146.62 21.72	0.590	0.563
TG (mg/dl)	211.37 ±11.66	193.50 ±8.09	224.25 ±11.89	2.085	0.149
TC (mg/dl)	60.40 ±3.23	53.07 ±3.58	62.87 ±4.02	1.973	0.164
HDL-C (mg/dl)	105.65 ±10.98	100.43 ±11.29	113.96 ±6.71	3.218	0.060

Table 4: Comparison of variable among the groups after the complex exercise (mean±SE)

Group	Control Group	Three times per week	Five times per week	F	p
Systolic blood pressure (mmHg)	158.87 ±7.36	130.62 ±4.96	138.75 ±4.33	6.494	0.006*
Diastolic blood Pressure (mmHg)	88.75 ±2.95	83.37 ±2.34	85.50 ±1.88	1.237	0.311
TG (mg/dl)	184.87 ±9.92	128.62 ±17.54	110.00 ±68.88	4.561	0.023*
TC (mg/dl)	189.62 ±15.86	121.37 ±13.39	143.50 ±15.68	5.372	0.013*
HDL-C (mg/dl)	56.55 ±4.31	37.78 ±4.69	41.52 ±5.31	4.294	0.027*
LDL-C (mg/dl)	102.87 ±5.20	75.50 ±7.00	80.25 ±7.59	4.794	0.019*

uptake were performed 3–5 times per week, the systolic blood pressure improved by –5.7 mmHg and the diastolic blood pressure by –1.4 mmHg. In addition, Park and Sun [15] reported that when elastic band resistance exercises were applied to elderly female hypertension patients for 10 weeks, significant improvements in blood pressure appeared. The complex exercise program implemented in the present study includes walking exercises at intensities of 50–60% and low-intensity free resistance exercises. According to the results, systolic blood pressure increased in the control group, while it was improved by –27.14 mmHg ($p < 0.05$) in the three times per week group and –14.25 mmHg in the five times per week group. Meanwhile, diastolic blood pressure improved by –2.37 mmHg in the control group, –3.25 mmHg in the three times per week group, and –0.87 mmHg in the five times per week group; however, none of the differences were shown to be statistically significant. These findings were similar to the results of previous studies indicating that regular exercises have positive effects on elderly persons' blood pressure; in the present study, the complex exercise program implemented three times per week was shown to be more effective for improvement of elderly persons' blood pressure compared to the same program implemented five times per week.

In the present study, the effects of the complex exercise program implemented for eight weeks on elderly persons' blood lipid concentrations were also examined. Based on most studies, regular exercises are known to positively affect elderly persons' lipid concentrations, and Kim et al. [16] reported that complex exercise programs applied to obese elderly persons brought about a positive reduction in body fat and cholesterol, and Park et al. [17] stated that in the case of elderly women in their 60s with total serum cholesterol and neutral fats at the threshold level for hyperlipidemia, moderate aerobic exercises for eight weeks increased HDL cholesterol while reducing LDL cholesterol; this represents a factor

Table 5: Change in blood pressure and blood lipid according to the time of the day of the complex exercise program (mean±SE)

	Group	Pre-exercise	Post-exercise	t	*p*
Systolic blood pressure (mmHg)	Control Group	155.62 ±8.31	158.87 ±7.36	-0.254	0.807
	Three times per week	157.75 ±7.57	130.62 ±4.96	2.859	0.024*
	Five times per week	153.00 ±6.81	138.75 ±4.33	2.108	0.073
Diastolic blood pressure (mmHg)	Control Group	91.12 ±6.08	88.75 ±2.95	0.400	0.701
	Three times per week	86.62 ±5.28	83.37 ±2.34	1.356	0.217
	Five times per week	86.37 ±8.46	85.50 ±1.88	0.253	0.808
TG (mg/dl)	Control Group	171.25 ±15.99	184.87 ±9.92	-1.036	0.335
	Three times per week	187.25 ±37.44	128.62 ±17.54	2.044	0.080
	Five times per week	146.62 21.72	110.00 ±68.88	1.381	0.210
TC (mg/dl)	Control Group	211.37 ±11.66	189.62 ±15.86	1.669	0.139
	Three times per week	193.50 ±8.09	121.37 ±13.39	6.560	0.000*
	Five times per week	224.25 ±11.89	143.50 ±15.68	3.896	0.006*
HDL-C (mg/dl)	Control Group	60.40 ±3.23	56.55 ±4.31	1.414	0.200
	Three times per week	53.07 ±3.58	37.78 ±4.69	4.201	0.004*
	Five times per week	62.87 ±4.02	41.52 ±5.31	3.612	0.009*
LDL-C (mg/dl)	Control Group	105.65 ±10.98	102.87 ±5.20	0.367	0.724
	Three times per week	100.43 ±11.29	75.50 ±7.00	2.686	0.031*
	Five times per week	113.96 ±6.71	80.25 ±7.59	6.382	0.000*

related to arteriosclerosis that can positively act in preventing cardiovascular diseases. Based on the results of intragroup tests of changes in internal neutral fats over the duration of the complex exercise program, whereas such fats increased in the control group over time, those in the three times per week group showed improvement of neutral fats from the boundary level to the normal level. Internal neutral fats in the five times per week group were improved to the completely normal level through the complex exercise program, although the difference was not statistically significant. The total cholesterol levels of the three times per week group ($p < 0.05$) and the five times per week group were shown to be improved through the complex exercise program, and the internal LDL cholesterol levels of the three times per week group and the five times per week group were also shown to be effectively improved through the complex exercise program ($p < 0.05$). However, the internal HDL cholesterol levels of the control group, three times per week group, and five times per week group all showed

statistically significant decreases ($p < 0.05$), as seen with total cholesterol and LDL cholesterol; this result was different from the general results of previous studies, which indicated that HDL cholesterol increased.

In general, regular exercises reduce neutral fats concentrations through the rapid use of neutral fats as energy sources; the activation of the lipoprotein breakdown enzymes in the skeletal muscles and adipose tissues; stimulation by hormone secretion; the inhibition of hepatic triglyceride lipase (HTGLA), which induces neutral fat synthesis in the liver; the activation of oxidative enzymes in the mitochondria of muscles; and the promotion of metabolic control following the increases in the concentration of myoglobin resulting from aerobic exercises [18]. In addition, although changes in the body composition through resistant exercises were not examined in the present study, the resistant exercises included in the complex exercise program may have increased the internal muscle protein of the elderly persons that participated in the complex exercise program, thereby enhancing the activity of special enzymes necessary for aerobic metabolism. This may have resulted in the improvement of the oxidative energy metabolism capacity and an increase in the density of capillaries per muscle fiber to tentatively improve the aerobic capacity of the skeletal muscles [18].

The known reason why HDL cholesterol increases through exercise is that exercises increases the proteins in the body and activate the lipoprotein lipase activity (LPLA) in plasma, thereby not only transforming the chylomicrons, very LDL (VLDL), and the cholesterol existing in human bodies into HDL cholesterol but also suppressing the HTGLA, leading to inflows of HDL cholesterol into plasma [19]. However, Lee and Thomas et al. reported that whereas neutral fats and LDL cholesterol showed significant decreases through aerobic exercises, HDL cholesterol did not increase or decrease [20, 21]. Kim [22] reported that for the relationship between the frequency of participation in exercise and changes in HDL cholesterol concentrations, whereas males showed significant increases after exercise, in contrast, females showed decreases [22]. Boardley et al. reported that when male and female elderly persons underwent complex exercise training three times per week for 16 weeks, blood lipid variables, including neutral fats, HDL cholesterol, and LDL cholesterol did not significantly increase. The reason why the results of previous studies are not consistent with each other as such is that cholesterol can be affected not only by exercises but also by diverse other causes, such as the level of cholesterol before exercise, body fat, age, sex, dietary intakes, living habits, and personal physiological characteristics. In the present study, the participants' dietary intakes at normal times and living habits that were not controlled seem to have affected the results of the present study.

In the present study, exercises performed three times per week were shown to be more effective for the improvement of neutral fats and total cholesterol than exercises performed five times per week. This is similar to the results of the study conducted by Lee [10], which indicated that changes in lipid were larger in the group that performed swimming three times per week than in the group that performed swimming six times per week. In a study conducted with middle-aged women, Kim and Kim [9] reported that whereas the neutral fats of the group that performed exercises at least three times per week showed significant decreases, those of the group that performed exercises less than three times per week showed no change. Given the foregoing results, the effective frequency of exercises for improvement of blood lipid is considered to be at least three times per week, and in the case of elderly persons performing exercises, three times per week is considered to be more effective for improvement of neutral fats and total cholesterol than performing exercises five times per week. Therefore, in the case of elderly persons, higher frequencies of exercises cannot be concluded to be good, but personalized exercise prescriptions should be provided that take into consideration the frequency, intensity, and duration that fit individuals' characteristics and exercise capacity [23].

CONCLUSION

In the case of elderly persons, performing exercises three times per week was shown to be effective for the improvement of systolic blood pressure, internal neutral fats, and total cholesterol, and performing exercises five times per week was shown to be effective for improvement of internal LDL cholesterol. In the case of elderly persons, exercise prescriptions with high frequencies of exercises are not necessarily considered good for enhancement of positive effects, but personalized exercise prescriptions should be provided that take into account the frequency, intensity, and duration that fit individuals' characteristics and exercise capacity.

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Author Contributions

Park Jin-Seoung – Substantial contributions to conception and design, Acquisition of data, Drafting the article, Final approval of the version to be published
Lee Su-Kyoung – Substantial contributions to conception and design, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published
Lee Kwang-Jun – Substantial contributions to conception and design, Analysis and interpretation of data, Drafting the artic, Revising it critically for important intellectual content, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

Authors declare no conflict of interest.

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