Effects of combined exercise on appendicular muscle mass, self-reliance fitness and arteriosclerosis adhesion molecules in elderly women

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
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E Funds Collection

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Abstract

Background and Study Aims: Pathophysiological studies have shown that elevated circulating concentrations of soluble inflammatory markers, including monocyte chemoattractant protein-1 (MCP-1), soluble E-selectin and soluble vascular cell adhesion molecule-1 (sVCAM-1) may be independent risk factors for arteriosclerosis adhesion molecules. The aim of this study, is the effects of combined exercise on the arteriosclerosis adhesion molecules of self-reliance health fitness and appendicular muscle mass in elderly women.

Material and Methods: The participants were 21 elderly women (exercise group, n = 11; control group, n = 10). The combined exercise consisted of walking and resistance exercise 80 minutes/session, 4 days each week for 12 weeks. Body composition, a dual-energy X-ray absorptiometry , and arteriosclerosis adhesion molecules were measured.

Results: After combined exercise, significant group time interactions for body weight ($p<0.01$) and body fat percentage ($p<0.01$) were found. In AMM and HDL-C(r = 0.830, $p<0.01$), there was positive relationship while MCP-1 (r = −0.685, $p<0.01$), sE-selectin (r = −0.643, $p<0.01$), and sVCAM-1(r = −0.625, $p<0.01$) showed a negative correlation.

Conclusions: The long-term combined exercises appeared to prevent the risks of arteriosclerosis by improving arteriosclerosis adhesion molecules through enhancing self-reliance health fitness and increasing muscle mass of the elderly women.

Keywords: body composition • cardiovascular endurance • flexibility • muscular endurance • muscular strength • physical activity

Conflict of interest: Authors have declared that no competing interest exists

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Cardiovascular – *adjective* relating to the heart and the blood circulation system [53].

Cardiovascular disease – *noun* reduced function of the heart and arteries caused by excessive intake of saturated fats. Abbreviation **CVD** [53].

Coronary – *adjective* used for describing the arteries that supply blood to the heart muscles [53].

Hypertension – *noun* arterial blood pressure that is higher than the usual range for gender and age. Also called **high blood pressure**, **hyperpiesia**. Compare **hypotension** [53].

Body composition – a component of physical fitness; absolute and relative amounts of muscle, bone, and fat tissues composing body mass [54].

Obesity – *noun* the condition of being seriously overweight [53].

Overweight – *adjective* having a body weight greater than that considered ideal or health [53].

Physical activity – *noun* exercise and general movement that a person carries out as part of their day [53].

Exercise – *noun* **1.** physical or mental activity, especially the active use of the muscles as a way of keeping fit, correcting a deformity or strengthening a part **2.** a particular movement or action designed to use and strengthen the muscles ■ *verb* **1.** to undertake physical exercise in order to keep fit and healthy **2.** to subject the body, or part of it, to repetitive physical exertion or energetic movement in order to strengthen it or improve its condition [53].

Resistance training –*noun* training that increases muscle strength by working against resistance such as a weighted dumbbell or barbell [53].

Kinematics – *noun* the scientific study of motion [53].

Flexibility – *noun* **1.** the amount or extent to which something can be bent **2.** the extent to which something can change or respond to a variety of conditions or situations [3].

Flexibility – ability to move joints fluidly through complete range of motion without injury [54].

INTRODUCTION

Due to the rapid aging of South Korea, it has been reported that the old population over the age of 65 amounts to 14.3% of the total population in 2018, and it will reach 41.0% in 2065 [1]. With the rapid aging of the population, chronic diseases in the elderly have become a major social problem worldwide [2], and cardiovascular diseases (CVD) represent the main cause of death in the world [3, 4]. Being diagnosed for the 30% of the world population (exceeding 1.4 billion people) [5] and the 70% of the population above the age of 60, hypertension works as a high risk factor to CVD [6]. A primary cause of CVD is hypertension incurred from obesity and overweight due to physical inactivity [7]. Conversely, a regular physical activity at a moderate intensity can prevent or delay the onset of type 2 diabetes, lower BP (blood pressure) or reduce the risk for heart attack and stroke [8]. Regular exercise contributes to a reduction in CVD mortality [9].

In addition, the physical inactivity followed by aging induces sarcopenia in tandem with obesity, and forges an inflammatory of TNF-α (tumor necrosis factor-α), C-reactive protein (CRP), IL-6 (Interleukin-6), and IL-1 (Interleukin-1), rapidly processing sarcopenia [10]. Osborn et al. [11], reported that when the inflammatory in vascular and endothelial cell-cell adhesion within the vessel wall occurs, the surface of inflammatory cell and vascular endothelial cell induces soluble Vascular Cell Adhesion Molecule-1 (sVCAM-1) called adhesion molecules and soluble E-Selectin (sE-Selectin), which sticks to vessel wall [12]. Due to the irritations of inflammatory cytokines such as TNF-α and IL-1, these molecules appear on endotheliocyte [13]. In addition, it increases the manifestation of chemokine, which incurs arteriosclerosis and blood inflammation concentration [14], ultimately increasing the prevalence of the CVD. For the most prevailing inflammatory chemokine, there is monocyte chemotactic protein–1 (MCP-1), and it triggers the exercise of monocyte and moves blood lipoprotein into vessel wall, which are all related to inflammation aging, obesity and cardiovascular factors [15, 16].

The increase in blood inflammation works as a catalyst to plaque rupture and contributes to the outbreak of a coronary syndrome [17]. Studies on reducing inflammation through exercise intervention have been continuously receiving attention for several years [18], and appeared to reduce visceral fat [19], noticeably along with MCP-1, sE-Selectin and sVCAM-1 [20] when exercise intensity and physical activity increased. As mentioned above, the roles and mechanisms of vascular endothelial cell, MCP-1, sE-Selectin and sVCAM-1 have been revealed; however, the exercise for the elderly or the scientific studies through physical activity is rarely being found [21].

Considering that only 37.0% of the total elderly population above the age of 65 assesses themselves as being healthy [1], it is necessary to develop kinematic measures to improve the health-related quality of life of the elderly [22].

Therefore, the aim of this study, is the effects of combined exercise on the arteriosclerosis adhesion molecules of self-reliance health fitness and appendicular muscle mass in elderly women.

MATERIAL AND METHODS

Study participation

The study was approved by the Ethics Committee of Dong-A University (2-1040709-AB-N-01-201901-HR-013-04). Research subjects were selected who participated in senior citizens' center at the Yang-san City in Gyeongsangnam-do, South Korea.

Inclusion criteria were as follows: women aged at 65 or older who had no experience in regular exercise on the voluntary after conducting a medical check of specialist's. Primary, total 30 subjects were selected but 4 subjects were excluded – because of taking other drugs; they were randomly allocated into a exercise group (13 subjects) and the other 13 subjects were control group. But 5 subjects quit in the middle (personal reasons: 5), finally 21 subjects were leaved in total 11 in the exercise group, and 10 in the control group. For the safety, the subjects (n = 21) who taking antihypertensive drug were directed to keep taking continuously during the experiment. All of the participants were managed to maintain their normal life style. Their characteristics of the subject are shown in Table 1.

Measurement of body composition

Physical and anthropometric variables were measured at baseline and after 12 weeks in both groups. Body mass and height were measured to the nearest 0.1 kg and 0.1 cm, respectively, using a Venus 5.5 body composition analyzer

(Inbody 720, Biospace, Seoul, Korea). Body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in meters.

Using DEXA (DPX-L, Lunar Radiation Corp., Madisom, WI, USA), AMM measured the muscle mass in the respective parts of lean body mass except for the bone mass. The arm muscle mass (ARM) and leg muscle mass (LMM) were measured by adding the right and left sides of the upper and lower parts of the muscle mass.

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using a mercury sphygmomanometer (KENCO, CK-E301, TAIWAN) after the subjects had rested for 10 minutes.

Self-reliance fitness

According to the ACSM guidelines [23] to health-related physical fitness, body composition, muscular strength, muscular endurance, cardiorespiratory endurance, flexibility are the factors defining the healthy status of physical strength. And for the elderly, agility is included. For muscular strength test; 2kg-dumbbell curl and chair sit-and-down; for cardiorespiratory endurance, 2-minutes\ walk; for flexibility, sit-and-reach; and for agility, Timed Up and Go (TUG) were conducted.

Combined exercise program

Referring the subjects of recommendation of F.I.T.T. (Frequency, Intensity, Time, Type) for hypertensive [24, 25] to control the target intensity of the different training programs, all participants at all training sessions recorded the values of perceived exertion using the Borg scale [26]. Using 0.5~2kg dumbbell and thera band's band [yellow (thin) to red (medium) or green (heavy) bands], resistance training was conducted to be fit to individual's exercise level. According to the individuals' level of exercise, aerobic exercise was conducted for 30 minutes by using LEXCO brand's LST9920 treadmill. The control group had no exercise intervention, and was instructed to pursue their habitual daily life activities. The exercise program workout for 80 minutes a round, 4 times (i.e., Monday, Tuesday, Thursday and Friday) a week for 12 weeks (Table 2).

Blood collection and laboratory assays

Fasting venous blood samples was collected from all participants at baseline and at 12 weeks. All samples were taken at 9:00 AM from an antecubital vein. The concentrations of serum total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were analyzed using an automatic chemical analyzer (Hitachi-7600-110/7170 analyzer, Tokyo, Japan). Serum samples were obtained after centrifugation and stored at −80 °C. Serum interleukin-1 (IL-1), monocyte chemotactic

Cardiovascular endurance – *noun* the ability of the cardiovascular system to deliver sufficient blood to the muscles to sustain intense activity for any period of time [53] – in this paper **cardiorespiratory endurance**.

Agility – *noun* a combination of physical speed, suppleness and sill [53].

Warm-up – *noun* an exercise or a period spent exercising before a contest or event [53].

Muscular strength – maximal force or tension level produced by a muscle or muscle group [54].

Muscular endurance – ability of muscle to maintain submaximal force levels for extended periods [54].

Cardiorespiratory endurance – ability of heart, lungs, and circulatory system to supply oxygen to working muscles efficiently [54].

1RM – individual's maximal strength or 1 repetition maximum [55].

Table 1. The characteristics of the subject – values are mean & SD (±).

Variable	Group		p-values (by unpaired t-test)
	Exercise (n = 11)	Control (n = 10)	
Age (years)	69.6 ±2.07	69.6 ±2.20	0.969
Weight (kg)	53.0 ±2.45	53.0 ±1.39	0.917
BMI (kg/m^2)	23.2 ±1.54	21.1 ±0.82	0.001
Fat mass percent (%)	23.5 ±2.59	23.5 ±2.46	0.964
SBP (mmHg)	128.7 ±6.65	121.0 ±8.58	0.036
DBP (mmHg)	74.1 ± 5.63	69.8 ±6.11	0.112
HD (years)	10.91 ±2.55	11.1 ±2.33	0.860
HDD (years)	9.0 ±2.32	9.1 ±2.02	0.918
ARM (kg)	4.0 ±0.31	3.6 ±0.33	0.010
LMM (kg)	11.2 ±1.35	9.6 ±0.64	0.002
AMM (kg)	15.3 ±1.56	13.2 ±0.82	0.001

BMI body mass index; **SBP** systolic blood pressure; **DBP** diastolic blood pressure; **HD** hypertension duration; **HDD** hypertension drug duration; **ARM** arm muscle mass, **LMM** leg muscle mass; **AMM** appendicular muscle mass

Table 2. Combined exercise program.

Item	Contents			Time (min)
Warm-up	walking, flexibility, stretching			10
Resistance exercise	Front pushing Front raise Side raise Flexor Extensor Pronation Supination	Thera-band yellow, red, green	10-12 reps 3set 1 to 6 week; reps 7~11 6 to 12 week; reps 11~13	30
	Arm curl Shoulder press Triceps extension	Dumbbell 0.5~2kg		
	Squat Wide squat	Dumbbell 0.5~2kg		
	Cross crunch On one´s knees push-up			
Aerobic exercise	Walking		1 to 6 week; reps 7~11 6 to 12 week; reps 11~13	30
Cool-down	walking, flexibility, stretching			10

reps – *plural noun* movements that are repeated exactly, usually a particular number of times. Also called **repetitions** [53].

protein–1 (MCP-1), tumor necrosis factor-α (TNF-α), soluble E-selectin (sE-selectin), and soluble vascular cell adhesion molecule-1 (sVCAM-1), were determined enzymatically using standard laboratory procedures. We determined blood sample levels in the serum using a sandwich-type enzyme-linked immunosorbent assay (ELISA) Due Set kit from R&D Systems (Minneapolis, MN, USA) according to the manufacturer's instructions as described previously. In each subject, the degree of insulin resistance was assessed from the fasting glucose and insulin concentrations according to homeostasis model assessment (HOMA), the following formula: HOMA-IR = fasting glucose (mg/dl)/18 × fasting insulin (μU/ml)/22.5.(HOMA), the following formula: HOMA-IR = fasting glucose (mg/dl)/18 × fasting insulin (μU/ml)/22.5.

Statistical analysis

All results were reported as the mean and standard deviation (±). All data were analyzed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). The unpaired participations t-test was used to assess group differences in baseline variables. A two-way analysis of variance (ANOVA) was used to determine interaction (group × time) effects for all outcome variables. Statistical significance was accepted at the 0.05 level.

RESULTS

Self-reliance fitness

In the exercise group, there were a valid decline in weight ($p<0.01$), fat mass percent ($p<0.01$), TUG ($p<0.05$), and a valid increase in left·right dumbbell curl ($p<0.001$; $p<0.001$), 2-minute walk ($p<0.001$), chair sit-and-down ($p<0.001$), ARM ($p<0.001$), LMM ($p<0.001$), and AMM ($p<0.001$). In the control group, fat mass percent ($p<0.05$) showed a valid increase while left dumbbell curl ($p<0.05$), 2-minute walk ($p<0.05$), LMM ($p<0.05$), AMM ($p<0.05$) showed a reduction. In between the groups and time, weight ($p<0.01$), fat mass percent ($p<0.001$), left·right dumbbell curl ($p<0.001$; $p<0.05$), 2-minute walk ($p<0.001$), chair sit-and-down ($p<0.001$), TUG ($p<0.05$), ARM, LMM, AMM ($p<0.001$; $p<0.001$; $p<0.001$) showed a valid correlation (Table 3).

Serum lipid and arteriosclerosis adhesion molecules

In the exercise group, there appeared a valid decline in SBP ($p<0.05$), TC ($p<0.001$), TG ($p<0.05$), LDL-C ($p<0.05$), glucose ($p<0.001$), insulin ($p<0.001$), HOMA-IR ($p<0.001$), IL-1 ($p<0.01$), TNF-α ($p<0.01$), sE-selectin ($p<0.001$) and sVCAM-1 ($p<0.001$), while HDL-C ($p<0.001$) showed a valid increase. In the control group, LDL-C ($p<0.05$), glucose ($p<0.05$), MCP-1 ($p<0.05$) showed a valid increase. Among SBP ($p<0.05$),

Table 3. The changes of self- reliance fitness between the groups (exercise n = 11; control n = 10) at baseline and after 12 weeks – values are mean & SD (±).

Variables	Group	Baseline	12 weeks	%diff	p–value (group × time)
Weight (kg)	Exercise	53.09 ±1.39	52.36 ±1.62	−0.73[aa]	0.002
	Control	53.00 ±2.45	53.33 ±2.41	0.33	
Fat mass percent (%)	Exercise	23.51 ±2.46	22.80 ±2.21	−0.70[aa]	0.000
	Control	23.56 ±2.59	23.82 ±2.66	0.27[a]	
Left dumbbell curl (frequency)	Exercise	23.55 ±4.13	26.45 ±3.17	12.36[aaa]	0.000
	Control	22.70 ±2.71	21.90 ±2.08	−3.52[a]	
Right dumbbell cur (frequency)	Exercise	26.91 ±4.78	29.09 ±4.23	8.11[aaa]	0.002
	Control	23.30 ±3.37	23.20 ±2.66	−0.43	
2-minutes' walk (frequency)	Exercise	103.64 ±6.20	107.91 ±7.26	4.12[aaa]	0.000
	Control	104.00 ±5.37	102.10 ±4.33	−1.83[a]	
Chair sit-and-down (frequency)	Exercise	14.91 ±2.47	18.27 ±3.61	22.56[aaa]	0.000
	Control	15.80 ±2.15	15.90 ±2.56	0.63	
Sit-and-reach(cm)	Exercise	7.55 ±1.70	7.84 ±1.48	3.86	0.063
	Control	7.04 ±1.79	6.94 ±1.60	−1.42	
TUG (sec)	Exercise	6.09 ±1.14	5.55 ±0.93	−8.96[a]	0.011
	Control	6.40 ±0.84	6.80 ±0.92	6.25	
Arm muscle mass (kg)	Exercise	4.00 ±0.31	4.21 ±0.33	0.21 [aaa]	0.000
	Control	3.61 ±0.33	3.56 ±0.29	−0.05	
Leg muscle mass (kg)	Exercise	11.29 ±1.35	11.85 ±1.26	0.56[aaa]	0.000
	Control	9.63 ±0.64	9.55 ±0.61	−0.08[a]	
Appendicular muscle mass (kg)	Exercise	15.30 ±1.56	16.06 ±1.40	0.77[aaa]	0.000
	Control	13.24 ±0.82	13.11 ±0.75	−0.13[a]	

[a]$p<0.05$, [aa] $p<0.01$, [aaa]$p<0.001$

TC ($p<0.001$), TG ($p<0.05$), LDL-C ($p<0.001$), HDL-C ($p<0.001$), glucose ($p<0.001$), HOMA-IR ($p<0.001$), IL-1 ($p<0.001$), TNF-α ($p<0.001$), MCP-1 ($p<0.05$), sE-selectin ($p<0.01$), sVCAM-1 ($p<0.001$), from time×group revealed significant main effects between interaction (Table 4).

Correlations coefficients

Positive relationship was shown in ARM and HDL-C (r = 0.653, $p<0.01$), while sVCAM-1 (r = −0.557, $p<0.01$) showed a negative correlation. In LMM and HDL-C (r = 0.794, $p<0.01$), there was a positive relationship, and a negative correlation appeared in MCP-1 (r = −0.720, $p<0.01$), sE-selectin (r = −0.656, $p<0.01$), and sVCAM-1 (r = −0.574, $p<0.01$). In AMM and HDL-C (r = 0.830, $p<0.01$), there was positive relationship while MCP-1 (r = −0.685, $p<0.01$), sE-selectin (r = −0.643, $p<0.01$), and sVCAM-1 (r= −0.625, $p<0.01$) showed a negative correlation (Table 5, Figure 1).

DISCUSSION

As aging has become a severe issue worldwide [27] , the decline in physical function and self-reliance health fitness has a negative impact on economy and society due to incidence rate of CD and mortality increase [28, 29]. As one gets aged, concerns on health management also increase; especially regular physical activity is thought to be highly important to the elderly [30]. Chad et al [31] reported that increasing muscle mass through exercise plays a significant role in improving physical function of the elderly women, and it is effective to prevent the fall and to improve quality of life and cognitive ability through the self-reliance health fitness [32].

Liao et al. [33] reported the result of their study on the 56 elderly women conducting elastic band exercise concerning muscle mass and physical function over 12 weeks, which is proved to have a valid effectiveness in muscle mass and physical function;

Table 4. The changes of serum lipid and arteriosclerosis adhesion molecules between the groups (exercise n = 11; control n = 10) at baseline and after 12 weeks – values are mean & SD (±).

Variable	Group	Baseline	12 weeks	%diff	p–value (group × time)
SBP (mmHg)	Exercise	121.09 ±8.58	118.91 ±6.83	−2.18[a]	0.033
	Control	128.70 ±6.65	129.20 ±5.31	0.50	
DBP (mmHg)	Exercise	69.82 ±6.11	69.36 ±4.97	−0.45	0.304
	Control	74.10 ±5.63	74.40 ±5.30	0.30	
TC (mg/dl)	Exercise	179.73 ±13.30	172.09 ±9.55	−7.64[aaa]	0.000
	Control	185.90 ±11.83	186.50 ±11.24	0.60	
TG (mg/dl)	Exercise	115.18 ±10.52	113.09 ±9.13	−2.09[a]	0.028
	Control	117.70 ±12.74	118.00 ±12.79	0.30	
LDL-C (mg/dl)	Exercise	96.27 ±12.39	94.55 ±10.68	−1.73[a]	0.001
	Control	106.40 ±13.99	108.70 ±12.95	2.30[a]	
HDL-C (mg/dl)	Exercise	54.42 ±7.68	56.72 ±7.34	2.3[aaa]	0.000
	Control	44.33 ±2.87	44.20 ±2.65	−0.13	
Insulin (μU/ml)	Exercise	8.57 ±1.38	8.18 ±1.29	−0.39[aaa]	0.085
	Control	9.70 ±1.50	9.80 ±1.24	0.11	
Glucose (mg/dl)	Exercise	86.36 ±8.57	81.18 ±6.74	−5.18[aaa]	0.000
	Control	87.80 ±6.25	89.40 ±6.22	1.60[a]	
HOMA-IR	Exercise	1.82 ±0.30	1.64 ±0.27	−0.19[aaa]	0.001
	Control	2.10 ±0.37	2.17 ±0.36	0.07	
IL-1 (pg/ml)	Exercise	3.37 ±0.25	3.21 ±0.18	−4.85[aa]	0.001
	Control	3.83 ±0.28	3.93 ±0.33	2.61	
TNF-α (pg/ml)	Exercise	3.52 ±0.24	3.31 ±0.23	−5.94[aa]	0.000
	Control	3.85 ±0.26	4.02 ±0.35	4.42	
MCP-1 (pg/ml)	Exercise	674.36 ±97.55	658.18 ±90.41	−2.40	0.025
	Control	651.60 ±73.93	657.60 ±73.12	0.92[a]	
sE-selectin (ng/ml)	Exercise	45.91 ±6.17	43.94 ± 566	−4.43[aaa]	0.002
	Control	47.29 ±4.24	47.14 ±3.67	-0.32	
sVCAM-1 (ng/ml)	Exercise	512.27 ±21.96	493.46 ±19.34	−3.67[aaa]	0.000
	Control	524.00 ±25.34	529.20 ±23.01	0.99	

[a]*p*<0.05, [aa]*p*<0.01, [aaa] *p*<0.001 **SBP** systolic blood pressure; **DBP** diastolic blood pressure; **TC** total cholesterol; **TG** triglyceride; **LDL-C** low density lipoprotein-cholesterol; **HDL-C** high density lipoprotein-cholesterol; **HOMA-IR** homeostasis model assessment for insulin resistance; **IL-1** interleukin-1; **TNF-α** tumor necrosis factor-α; **MCP-1** monocyte chemotactic protein-1; **sE-selectin** soluble E-selectin; **sVCAM-1** soluble vascular cell adhesion molecule-1

and after conducting the 6 months of cardiorespiratory training (70% of HRmax; maximum heart rate) and resistance training (one-repetition maximum; 65% of 1RM), all participants (n = 38, 65~80 aged women) experienced a positive improvement in weight, BMI and appendicular muscle [31].

As well, conducting 32-weeks combined exercise (resistance + aerobic) showed an improvement in the interaction of self-reliance health fitness of the elderly (71.3 ±4.6; n = 22) (Timed Up and Go Test: p<0.001; functional reach test: p = 0.002; 30-second chair stand: p = 0.001; 6-minute walk test: p<0.001) [34].

As a result of this study, conducting the combined exercise significantly improves weight, BMI, %fat, AMM and self-reliance health fitness. Therefore, it is noticeable that the combined exercise intervention can enhance aging-concerning muscle atrophy, self-reliance health fitness. In addition, the combined exercise of this

Table 5. Correlations coefficients between muscle and arteriosclerosis adhesion molecules in elderly women (n = 21).

Variable	HDL-C	MCP-1	sE-selectin	sVCAM-1
Arm muscle mass	0.653[aa]	−0.362	−0.396	−0.557[aa]
Leg muscle mass	0.794[aa]	−0.720[aa]	−0.656[aa]	−0.574[aa]
Appendicular muscle mass	0.830[aa]	−0.685[aa]	−0.643[aa]	−0.625[aa]

[aa]p<0.01; **HDL-C** high density lipoprotein-cholesterol; **MCP-1** monocyte Chemotactic Protein–1; **sE-selectin** soluble E-selectin; **sVCAM-1** soluble vascular cell adhesion molecule-1

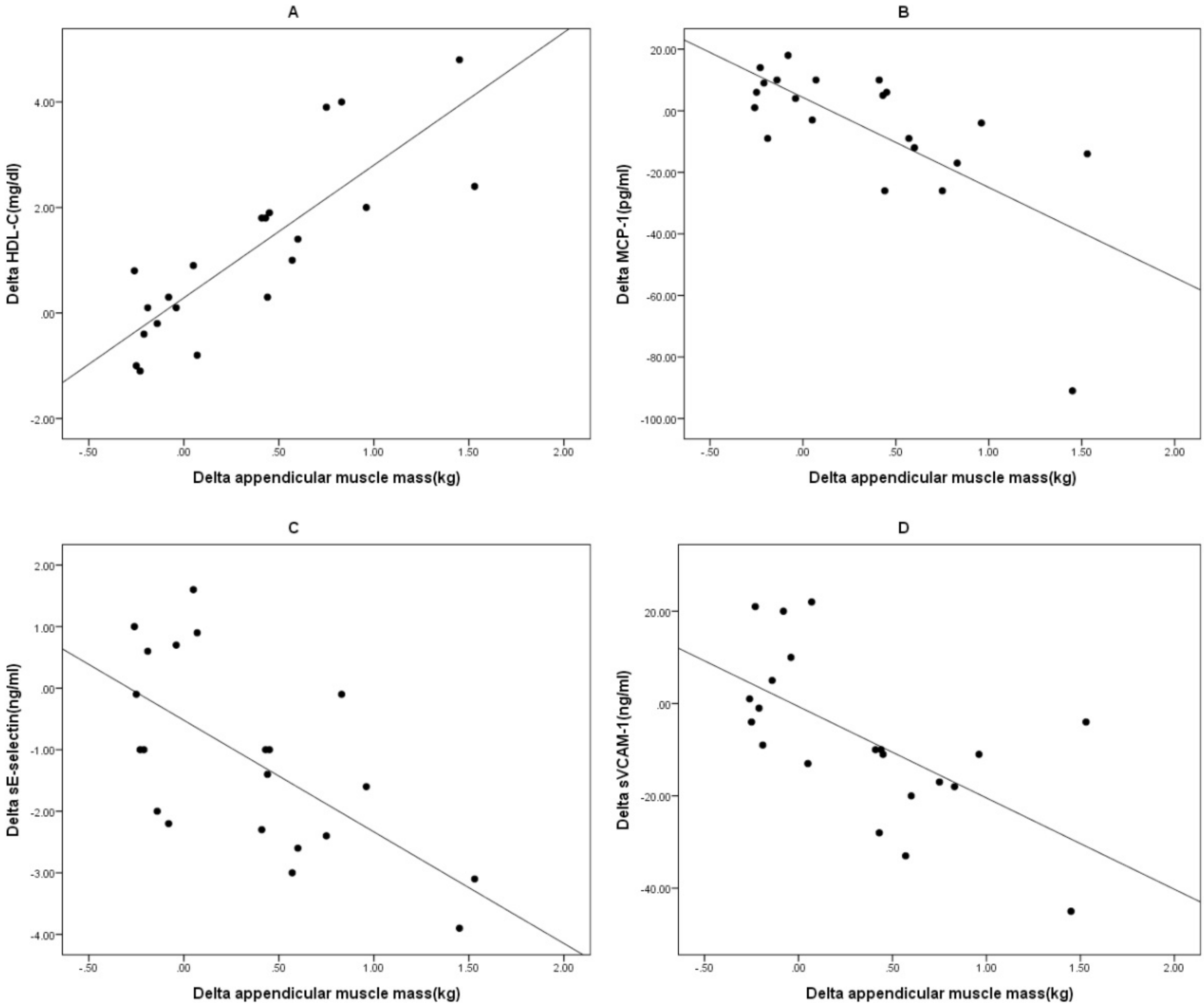

Figure 1. Correlation between delta appendicular muscle mass and arteriosclerosis adhesion molecules in elderly women(n = 21). A: HDL-C r = 0.830, p = 0.000; B: MCP-1 r = −0.685, p = 0.001;C: sE-selectin r = −0.643, p = 0.002; D: sVCAM-1 r = −0.625, p = 0.002 (**HDL-C** high density lipoprotein-cholesterol; **MCP-1** monocyte chemotactic protein–1; **sVCAM-1** soluble vascular cell adhesion molecule-1; **sE-selectin** soluble E-selectin).

study's exercise program conducted weight-bearing exercise and elastic band that the elderly can easily practice, which bore a lower risk of injuries to the elderly women; thus it can be considered as an exercise program that can prevent illness related to aging.

The CVD, ranking the second place of cause of death in the elderly order than 65 [1], is reported to be 20% more hazardous to women [35]; in order to alleviate CVD risk factor and hypertensive, improving life style and practicing regular exercise are known to be effective in reducing the CVD risk factor and improving hypertension [36].

The increase (1%) in endothelial function through Aerobic exercise effectively reduces the CVD risk factor by 13% [37], and resistance exercise is reported to have a positive impact on regulating BP to hypertension patients [9].

Concerning the study result, conducting the combined exercise can reduce SBP value significantly ($p<0.05$), which positively improves prevention of the CVD risk factor [9, 36, 38]. Martins et al. [39] conducted the high-intensity exercise (85% of HRmax) and combined exercise (70% of HRmax) to the elderly postmenopausal aged above 60, and sought a valid increase in the muscle mass index of the two groups and a valid time difference in IL-1ra, glucose, insulin, HOMA-IR; and when the 16 weeks of aerobic exercise (square dance + taijiquan) were conducted to 27 senior (70 ±3. 26), it showed a valid improvement in SBP, DBP, TC, and LDL-C [40].

In the preceding study of Ha et al. [41], it showed a valid improvement in Glucose (the main effect for a time: $F = 8.846$; $p<0.01$), insulin (interaction: $F = 7.810$; $p<0.05$), HOMA-IR (interaction: $F = 10.990$; $p<0.01$) when the 12 weeks of combined exercise (aerobic + elastic band) were conducted to the elderly women aged above 70.

This research had a valid improvement result in TC, TG, LDL-C, glucose, insulin, HOMA-IR and IL-1. Therefore, the regular combined exercise improves blood lipid and insulin resistance and plays a key role in preventing diabetes and improving the CVD risk factor [42, 43].

Atherosclerosis is one of the most prevailing types of the CVD [44] and is related closely to cell adhesion molecules (CAMs) and Inflammatory marker [45]. Therefore, for more effective improvements, more emphasis should be laid on the role of exercise [46].

In the 4-months study on life style intervention (dietary habits and exercise) of Gokulakrishnan et al. [47], TNF-α (35%), IL-6 (33.3%), MCP-1 (22.3%) showed an effective improvement ($p<0.001$), and in 8-weeks study that conducted the resistance exercise on 19 obesity elderly women (BMI; 27.7 ±0.9), there appeared a valid reduction ($p = 0.01$) in TNF-α and a valid interaction ($p = 0.05$) in between the groups and time [48].This research also saw a valid improvement in TNF-α and IL-1 after the combined exercise. Deriving from the increase in muscle mass due to the combined exercise, it is thought to reduce the inflammatory concentration of TNF-α and IL-1, which is effective to reduce insulin resistance, atherosclerotic and chronic inflammatory [49]. Moreover, practicing exercise is reported to be effectual in improving sE-selectin concentration [45], and low moderate aerobic exercise is said to be effective in alleviating cell adhesion molecules (CAMs) [46].

Gaining the data of a valid improvement in sE-selectin and sVCAM-1, this study is expected to improve health promotion and quality of life by preventing psychological and physical negative effects due to aging through vitalizing self-reliance health fitness and muscle mass of the elderly women and enhancing arteriosclerosis adhesion [50, 51].

Based on the aforementioned preceding research, this study conducted a Pearson product moment correlation to grasp the relationship between arteriosclerosis adhesion molecules and AMM in the elderly women. As a result, appendicular muscle mass had a valid positive correlation in HDL-C, and had a negative correlation in MCP-1, sE-selectin, sVCAM-1, which appeared that the increase of AMM had a relationship with the increase in HDL-C and the decline in MCP-1, sE-selectin, sVCAM-1. For the elderly women, these results indicate that the increase in AMM is independently related to the increase in HDL-C and the decrease in MCP-1, sE-selectin, sVCAM-1 concerning the long-term combined exercise. Thus, the improvement in self-reliance health fitness, AMM and arteriosclerosis adhesion aolecules found in the study has a meaning in kinematic sense.

However, there are some limitations in this study. The subjects of study were elderly women with hypertension, but not halting the antihypertensive drug intake for the subjects' safety. Therefore, it is necessary to examine the change in BP from holter-monitoring [52] and the effects of antihypertensive drug in the next research.

CONCLUSIONS

The long-term combined exercises appeared to prevent the risks of arteriosclerosis by improving arteriosclerosis adhesion molecules through enhancing self-reliance health fitness and increasing muscle mass of the elderly women.

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