

Effects of a Social Welfare Program for Health Promotion on Cardiovascular Risk Factors

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Background: Socioeconomic status is closely associated with an individual's health status. However, there are few studies examining the role of exercise-training as part of a community-based social welfare program in socially vulnerable groups. Given this, our aim was to measure whether long-term exercise training as a social welfare program affects the prevalence of depressive symptoms, metabolic syndrome and peripheral blood vessel condition among participants with low household income.

Methods: Twenty-nine adults and twenty-two older adults were recruited into this study with non-randomized, pre/post-test design. The subjects underwent a combined training consisting of aerobic and muscle strengthening exercises for 6 months or more. Depressive symptoms were evaluated using the Beck Depression Inventory and the Korean version of Geriatric Depression Scale. Metabolic syndrome was defined according to the International Diabetes Federation criteria. Blood vessel condition was assessed using non-invasive accelerated photoplethysmograph.

Results: Mean skeletal muscle mass increased after exercise-training, but body mass index and percent body fat were unchanged. Overall age-specific physical fitness and performance increased markedly among both adult and elderly subjects, respectively. The proportion of depressive symptoms was significantly reduced by 33% after exercise-training among all participants. The prevalence of individuals having metabolic syndrome was significantly reduced by 19.6% and the number of individual components of metabolic syndrome decreased after the exercise intervention. Among components of metabolic syndrome, waist circumference, HDL cholesterol and systolic blood pressure significantly improved. In addition, the proportions of moderate and severe arteriosclerotic progression significantly decreased.

Conclusion: Long-term exercise-training as a social welfare program is beneficial for health promotion and effective in simultaneously improving psychological and physiological health status in a low income population. This suggests that the development and expansion of an exercise intervention as a health-promoting welfare program are needed to address the inequality of exercise participation among socially vulnerable groups.

Key Words: Social welfare program, Exercise training, Socioeconomic status, Depressive symptoms, Metabolic syndrome, Peripheral blood vessel condition

INTRODUCTION

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An individual socioeconomic status is one of the major factors that determine his or her health status, and is depends on an individual's level of education and income [1,2]. The differences in health status corresponding to socioeconomic conditions attributes to health-related lifestyle

and behaviors, or how individuals perform activities to manage and promote their own health [3]. In fact, socioeconomic status is not only inversely associated with depressive symptoms, but inversely associated with the prevalence of metabolic syndrome as well, and is also a risk factor for cardiovascular disease [4-7]. Regular exercise, which is one of the major components of lifestyle interventions (along with adequate nutrition intake, smoking cessation, stress management and other non-drug modalities) can prevent and improve depressive and psychological symptoms, as well as improve metabolic disorders and cardiovascular diseases, which have recently been labeled lifestyle-related diseases [8]. According to epidemiological studies, household income is positively associated with participation in regular exercise and leisure-time physical activities, even as education level showed inconsistent associations with physical activity [9,10]. This indicates that participation in recreational sports and exercise programs is dependent on household income. Given this, there are currently discussions about equal opportunities to participate in physical activities and exercise programs that are important to health promotion. Social welfare services are attempting to develop sports welfare environments that are accessible and easy to utilize for anyone, particularly low income families [11-14]. However, no data are available regarding the effects of long-term exercise training as a social welfare program on psychological and physiological health status for community-dwelling Koreans with low household income. Therefore, the aim of this study was to assess the changes in the prevalence of depressive symptoms and metabolic syndrome and its components, as well as changes in the prevalence of peripheral blood vessel condition among subjects enrolling in a social welfare program incorporating therapeutic lifestyle changes and undergoing long-term (≥ 6 months) exercise training.

MATERIALS AND METHODS

1. Subjects and study protocol

Twenty nine adults (five males and twenty four females, average age, 48.6 ± 10.4 years) and twenty two older adults (two males and twenty females, average age, 67.5 ± 3.7 years), participants in a social welfare program for health promotion among community-dwelling low income

families (the average monthly household income corresponding to 100-120% of the minimum cost of living) were recruited into this study. An interventional exercise-training program with non-randomized pre- and post-test designs was used for this study, which was conducted from May 2013 to August 2015. All subjects provided informed consent to participate in this study, which was approved by the Ethical Committee of Yonsei University Wonju College of Medicine, Korea (YWMR-09-0-033) and was in compliance with the Helsinki Declaration. The subjects underwent combined training consisting of aerobic exercises (running, bicycling and swimming) at an intensity corresponding to a Borg scale rating of approximately 12-16 (somewhat light to hard) and muscle strengthening exercises with 40-70% of 1 RM, including a warm-up and cool down of 5 minutes, respectively. Exercise prescription and intensity were gradually increased during the program according to each subject's progress. All subjects were enrolled in 60-minute supervised exercise training sessions 3 or more days per week, and participated in a long-term exercise training lasting at least 6 months.

2. Measurement of anthropometry and body composition

Body weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively, from which BMI and bovine serum albumin (BSA) were calculated as body weight/height in meters squared (kg/m^2). Waist circumference (WC), expressed in centimeters, was measured at the mid-point between the lower rib margin and the iliac crest. Percentage of total body fat mass (%) and muscle mass (kg) were acquired from total body scans using multi-frequency bioelectrical impedance analysis (Inbody 720, Biospace, Seoul, Korea).

3. Measurement of health-related fitness

Subjects' physical fitness was assessed by appropriate parameters/variables according to age groups. Adults performed sit-ups, sit and reach, multi-stage 20 meter shuttle runs, 10 meter agility shuttles and long jumps; older adults performed chair-stands, 6 minute walks, 2 minute stationary walking, timed up and go, and figure-eight walks. Both groups received handgrip strength assessments.

4. Determination of depressive symptoms

Symptoms of depression were evaluated using the revised version of the 21-item Beck Depression Inventory (BDI-II) and the Korean version of the 30-item Geriatric Depression Scale (KGDS) among adults and older adults, respectively [15,16]. Subjects with a BDI score of 10 or more among adults and a KGDS score of 14 or more among older adults were assigned to the group with depression. Those with a BDI score under 10 or a KGDS score under 14 were placed in the group without depression.

5. Evaluation of metabolic syndrome

Metabolic syndrome was defined according to the International Diabetes Federation criteria (IDF) [17]. Components of the IDF criteria for metabolic syndrome included: blood pressure $\geq 130/85$ mmHg, HDL cholesterol level < 40 mg/dL in men and < 50 mg/dL in women, total triglyceride level > 150 mg/dL, or fasting plasma glucose ≥ 100 mg/dL. Abdominal obesity was defined as a waist circumference ≥ 90 cm in men and ≥ 80 in women. The criteria for having metabolic syndrome were defined as the presence of abdominal obesity with two or more of the other metabolic syndrome components. Blood samples from all subjects were obtained through the antecubital vein after at least an 8 hour fast, both before and after exercise training. Blood samples were centrifuged at 3,000 rpm for 10 min, and metabolic profiles, including fasting glucose, HDL cholesterol and triglycerides, were measured with an automatic chemical blood analyzer (IVD-A10A, Samsung, Korea). Blood pressure was measured by automated equipment (BPbio 320, Biospace, Korea) in a sitting position after a 5-minute rest.

6. Blood vessel condition

Blood vessel condition was assessed using non-invasive accelerated photoplethysmograph (APG; SA6000, Medicare, Korea) which automatically analyzed the peripheral blood circulation through double-differentiation of the APG record on the fingertip [18]. This study analyzed six indices obtained from the APG, including differential pulse wave index (DPI), blood vessel output power (BVOP), blood vessel tension (BVT), blood vessel status score (BVSS) and

blood vessel aging level (BVAL). The progression of arteriosclerosis was defined according to BVAL (normal, 1-2; mild, 3-4; moderate, 5; severe, 6-7) [19].

7. Statistical analysis

All data were analyzed using SPSS version 21 (SPSS, Chicago, IL, USA) for Windows with the significance level set to $p < 0.05$. Values were expressed as the mean (*SD*) and the number of subjects (proportion, %) for continuous and nominal variables, respectively. Continuous variables were tested for a normal distribution using the Kolmogorov-Smirnov test. Paired t-tests were used to compare normally distributed variables and Wilcoxon signed-ranks tests were used to compare non-normally distributed variables. Chi-square tests were used to determine changes from before and after exercise training in prevalence data and the distribution of subjects across categorical variables.

RESULTS

Mean skeletal muscle mass ($p < 0.001$) increased after participating a social welfare program for health promotion; however, total body weight, BMI and % body fat were unchanged (Table 1). In age-specific physical fitness, muscular endurance and flexibility markedly increased among adults. Further, physical performance, including mobility, dynamic balance and agility, meaningfully improved among older adults. Muscle strength also significantly increased among all subjects (Table 1). The portion and categorical variables of depression were significantly improved after exercise training (Table 2). The prevalence of individuals with metabolic syndrome was significantly reduced by 19.6% and the number of individual components of metabolic syndrome decreased after the exercise intervention (Table 3). In each component of metabolic syndrome, waist circumference ($p < 0.001$), HDL cholesterol ($p = 0.032$) and systolic blood pressure ($p = 0.041$) significantly improved, while fasting blood glucose, triglyceride and diastolic blood pressure were unchanged after the exercise intervention (Table 3). The results of the APG for the blood vessel condition showed that after exercise training, the proportions of moderate and severe arteriosclerotic progression significantly decreased, while those of healthy individuals increased ($p < 0.0001$).

Table 1. Effects of a social welfare program for health promotion on anthropometric, bodycomposition and health-related fitness variables

Variable	Pre-training		Post-training		p-value*
	Mean (SD)		Mean (SD)		
Anthropometry and body composition					
Height (cm)	156.3 (6.3)		156.2 (6.1)		0.935
Weight (kg)	59.5 (7.7)		59.3 (7.3)		0.782
Body mass index (kg/m ²)	24.3 (2.8)		24.3 (2.8)		0.844
% Body fat	33.6 (5.8)		32.8 (5.7)		0.178
Muscle mass (kg)	19.3 (4.2)		21.4 (3.5)		<0.001
Health-related fitness					
Handgrip strength (kg) ^b	25.9 (6.3)		27.1 (6.1)		0.002 [†]
Sit-up (n) ^a	12.1 (8.9)		20.4 (12.9)		<0.001
Sit and reach (cm) ^a	12.0 (9.5)		14.6 (7.4)		0.001
Multi-stage 20 meter shuttle run (n) ^a	13.2 (6.5)		14.1 (9.6)		0.057 [†]
10 meter agility shuttle (sec) ^a	17.0 (4.4)		15.9 (3.1)		0.678 [†]
Long jump (cm) ^a	122.7 (37.0)		134.4 (22.1)		0.112
Chair-stand (n) ^o	15.5 (3.7)		18.0 (4.9)		0.072
6 minute walk (m) ^o	428.9 (95.9)		426.7 (87.1)		0.022
2 minute stationary march (n) ^o	109.1 (16.0)		118.8 (23.3)		0.002
Timed up and go (sec) ^o	6.8 (1.1)		6.2 (1.4)		0.034 [†]
Figure-eight walk (sec) ^o	27.7 (5.2)		24.9 (5.7)		0.030

*obtained from the paired t-test or [†]Wilcoxon signed rank test.

^a, adults (n = 29); ^o, older adults (n = 22); ^b, both adults and older adults (n = 51).

Table 2. Effects of a social welfare program for health promotion on depression levels in middle-aged and older participants

Variable	Depression level (Score)	Pre-training		Post-training		p-value
		n	(%)	n	(%)	
BDI and KGDS	Non-depressed	23	(45.1)	40	(78.4)	<0.001*
	Depressed	28	(54.9)	11	(21.6)	
BDI	Minimal (0-9)	12	(41.4)	22	(75.8)	0.024 [†]
	Mild (10-15)	12	(41.4)	6	(20.7)	
	Moderate (16-23)	5	(17.2)	1	(3.5)	
	Severe (>23)	-	-	-	-	
KGDS	Good (0-13)	11	(50.0)	18	(81.8)	0.039 [†]
	Mild (14-18)	11	(50.0)	4	(18.2)	
	Moderate and Severe (>18)	-	-	-	-	

BDI: Beck depression inventory, KGDS: Korean Form of Geriatric Depression Scale.

*obtained from *McNemar's and [†]Mantel-Haenszel chi-square tests for binary and ordinal variables, respectively

In addition, the proportion of lowest BVAL increased by 13.7% ($p < 0.0001$). Comparison of each index from APG found significant differences in DPI ($p = 0.004$), BVOP ($p = 0.002$) and BVSS ($p = 0.005$); there were no significant differences in BVT or RBV between the pre-and post-exercise training (Table 4).

DISCUSSION

The results of this study demonstrated that a six-month exercise program for health promotion was successful in significantly reducing the prevalence of depressive symptoms and metabolic syndrome, and also lead to an improvement in peripheral blood vessel circulation among subjects with low household income. In particular, we noted improvements in health-related fitness based on the increase of mus-

Table 3. Effects of a social welfare program for health promotion on the prevalence of metabolic syndrome and its components

Variable	Pre-training		Post-training		p-value
	N or mean	(%) (SD)	N or mean	(%) (SD)	
Metabolic syndrome	No	20 (39.2)	30 (58.8)		0.021*
	Yes	31 (60.8)	21 (41.2)		
Number of metabolic syndrome components	0	4 (7.8)	9 (17.6)		<0.001 [†]
	1	16 (31.4)	21 (41.2)		
	2	16 (31.4)	14 (27.4)		
	3	11 (21.6)	3 (5.9)		
	4	4 (7.8)	3 (5.9)		
	5	-	1 (2.0)		
Waist circumference (cm)	84.4	(7.7)	81.6	(7.1)	<0.001 [‡]
Systolic blood pressure (mmHg)	124.9	(15.2)	121.7	(13.2)	0.041 [§]
Diastolic blood pressure (mmHg)	78.3	(10.7)	79.0	(7.4)	0.520 [§]
Fasting blood glucose (mg/dL)	97.7	(19.6)	95.6	(13.2)	0.284 [‡]
Triglyceride (mg/dL)	115.5	(75.5)	115.9	(63.5)	0.929 [§]
High density lipoprotein (mg/dL)	54.4	(15.6)	58.2	(13.2)	0.032 [§]

*obtained from McNemar's or [†]Mantel-Haenszel chi-square tests for nominal variables, and [‡]paired t-test or [§]Wilcoxon signed-ranks test for continuous variables.

Table 4. Effects of a social welfare program for health promotion on vascular status results from accelerated photoplethysmograph analysis

Variable	Pre-training		Post-training		p-value
	N or mean	(%) (SD)	N or mean	(%) (SD)	
Arteriosclerosis progress	Normal	28 (54.9)	31 (60.8)		<0.0001 [†]
	Mild	15 (29.4)	15 (29.4)		
	Moderate	7 (13.7)	5 (9.8)		
	Severe	1 (2.0)	-		
Blood vessel aging level	1	7 (13.7)	14 (27.4)		<0.0001 [†]
	2	21 (41.1)	17 (33.3)		
	3	14 (27.4)	13 (25.5)		
	4	1 (2.0)	2 (4.0)		
	5	7 (13.8)	5 (9.8)		
	6	-	-		
	7	1 (2.0)	-		
DPI	-28.4	(38.6)	-41.0	(38.2)	0.004 [‡]
BVOP	-63.4	(17.1)	-69.1	(15.1)	0.002 [‡]
BVT	-10.7	(16.5)	-8.2	(14.5)	0.470 [‡]
RBV	-43.0	(16.6)	-39.4	(16.8)	0.089 [‡]
BVSS	39.2	(15.8)	44.3	(16.6)	0.005 [‡]

DPI: differential pulse wave index, BVOP: blood vessel output power, BVT: blood vessel tension, RBV: remained blood volume, BVSS: blood vessel status score.

*obtained from [†]Mantel-Haenszel chi-square tests for nominal variables and the [‡]paired t-test for continuous variables, respectively.

cle mass and its performance. The improvement of depressive symptoms and cardio-metabolic indicators through exercise training might be involved in these increases in health-related fitness.

Unfortunately we did not possess a control group in this

study due to its retrospective pre- and post-test design. However, previous studies of exercise training programs among individuals with depression or metabolic syndrome did not observe any changes in depressive symptoms or metabolic parameters in their control groups [20-22]. Exercise

participants exhibited improvement in the psychological indices measured by the BDI and KGDS among both adult and older adult subjects at the end of the 6 months or more of the exercise intervention in this study. These results are consistent with those found by several other investigators who reported improvements in depressive symptoms subsequent to significant increases in health-related fitness among subjects with and without chronic illness [22,23].

Meanwhile, there are well known bidirectional associations among depression, metabolic syndrome, cardiovascular diseases and their risk factors [24-26], crosstalk among them should be investigated in future study. Moreover, depression is thought to be an independent risk factor for cardiovascular disease and closely associated with several cardiovascular risk factors, including stroke and risk for cardiac mortality [27,28]. These deleterious co-morbidities of depressive symptoms with metabolic syndrome and cardiovascular risk factors were concurrently improved by long-term exercise training in this study. These results correspond with the findings of a previous epidemiologic study, where individuals with low levels of physical activity showed a higher prevalence of simultaneous metabolic syndrome and mild or greater depressive symptoms [29]. Thus, we suggest that long-term exercise training is an effective intervention for reducing both psychological and metabolic disorders and their risk factors.

In addition, we analyzed the changes in each component of measurement in order to clarify which aspects are responsible for reducing the prevalence of depressive symptoms and metabolic syndromes, and for the improvement of peripheral blood condition by long-term exercise training. Regarding the changes in each component of the depression index, long term-exercise training reduced depressive symptoms based on the improvements of cognitive-affective and somatic sub-scores in adult and older subjects, respectively (data not shown). These results are consistent with previous reports that indicated exercise lead to improved physical and mental function to promote quality of life, as well as enhanced health-related fitness [30-32]. Assessing the specific components of metabolic syndrome, waist circumference and systolic blood pressure decreased and HDL cholesterol increased through exercise training in this study, although fasting blood glucose, triglycerides and diastolic blood pres-

sure did not differ between pre- and post-test. It may be that the lack of changes in fasting blood glucose, triglycerides and diastolic blood pressure are because the mean values of those components were within normal range at both the pre- and post-test. Finally, regarding the results from APG, DPI is an index of age-related vascular aging and BVOP reflects the extensibility of peripheral blood vessels. RBV indicated the remaining blood volume after the contraction of blood vessels. The results of the test are more favorable when the negative value (absolute) increases in BVOP and decreases in RBV. According to aging blood vessels, BVOP becomes weak, but RBV increases. BVT indicates the elasticity (contraction and relaxation) of blood vessels, which has a positive value in normal waveform, whereas its value decreases and is observed as a negative value in aging blood vessels [18,19]. The overall improvement of arteriosclerotic progression and blood vessel aging level were mainly attributed to the increase (absolute value) in BVOP and the trend toward a decrease (absolute value) in RBV. These indicate that long-term exercise training increases the extensibility of peripheral blood vessels and partially improves peripheral blood flow, rather than elasticity, in contraction and relaxation.

There are several limitations in this study. First, this was a non-randomized observational study and did not include a pair matched control group. However, as noted above, prior studies evaluating the effectiveness of exercise intervention programs in both depressive symptoms and risk factors of cardiovascular disease, including metabolic syndrome, all failed to show meaningful changes in measured parameters in the control groups. On the other hand, our study represents the experience and evidence of community-based exercise training as part of a social welfare program for socially vulnerable groups, such as low household income families and economically inactive elders.

To our knowledge, this is the first study to document the effect of a social welfare program using supervised exercise training on psychological and physiological health indicators in a community-based social welfare project in Korea. The result of this study supports the notion that socioeconomic status may affect the inequality of participation to exercise program [11-14,33]. Although public health promotion through exercise is only reflected in social welfare policies

in some advanced nations, transcending race, culture and country, health promotion program base expansion can be expected to address socioeconomic imbalance in the future. Considering socioeconomic imbalance a result of health imbalance (which itself is the result of psychological and metabolic diseases), development and enlargement of exercise intervention programs as health-promoting welfare programs for vulnerable social groups and low income individuals must be considered.

In summary, long-term exercise-training as a social welfare program is beneficial for health promotion and effective in simultaneously improving psychological and physiological health status among individuals with a low household income.

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