



Exercise training decreases body mass index in subjects aged 50 years and over

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ABSTRACT

Exercise training can improve blood pressure in normotensive, prehypertensive, and hypertensive subjects. One of the mechanisms of blood pressure reduction in hypertensive patients with obesity is through weight loss. This study aimed to examine the effect of exercise training on bodyweight and the relationship between weight loss and reduction of blood pressure. An experimental pre-post test design without controls was used to evaluate the effect of exercise training on weight loss. The study involved 89 elderly aged 50 years or more, consisting of 40 men and 49 women, who were members of Senayan Sport Fitness Club and had been exercising for at least three months. Exercise training was programmed and performed three times a week, consisting of aerobic (walking, jogging, static cycling), and resistance exercise. All exercise was performed for one to two hours with mild to moderate intensity. Blood pressure and body weight were obtained from medical records. Paired t-test showed that systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), pulse pressure (PP), and body mass index (BMI) were significantly lower after training [(systolic, 126.3 ± 2.9 vs 122.3 ± 2.7 , $p=0.02$), (diastolic, 80.2 ± 3.1 vs 77.2 ± 2.4 , $p=0.00$), (MAP, 95.6 ± 4.6 vs 92.2 ± 3.4 , $p=0.00$), (PP, 46.1 ± 4.2 vs 45.1 ± 3.6 , $p=0.04$), (BMI, 24.5 ± 2.9 vs 23.6 ± 2.9 , $p=0.04$)]. Duration of training was the most influential factor affecting Δ BMI, (Beta = 0.38; $p=0.00$). Exercise training could lower BMI and the reduction in diastolic blood pressure was higher for the subjects aged 70 years and over.

Keywords: Exercise, body mass index, blood pressure, pulse pressure, elderly

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INTRODUCTION

The effect of exercise training on blood pressure is obvious. This is the reason why exercise has been be a part of protocol based therapy in people with prehypertension and hypertension. A study by Pinto et al. showed that fast walking reduced ambulatory systolic

blood pressure (SBP) and diastolic blood pressure (DBP) by 7.6 and 6.3 mmHg in hypertensive subjects.⁽¹⁾ Hayashi et al. found that the decrease in SBP could even reach up to 10 mmHg.⁽²⁾ The decrease in blood pressure is usually greater in hypertensive than in normotensive persons.⁽³⁾

The decrease in blood pressure due to

exercise training can occur in several ways. One of the mechanisms of blood pressure reduction in hypertensive patients with obesity is through weight loss. SBP and DBP will decrease about 3 mmHg for a 3-9% decrease in body weight.⁽⁴⁾ A study by Engeli et al. showed that in obese women 5% weight loss reduced levels of angiotensinogen by 27%, renin by 43%, aldosterone by 31%, and angiotensin-converting enzyme (ACE) by 12%.⁽⁵⁾

SBP and DBP, mean arterial pressure (MAP), and pulse pressure (PP) are risk factors of cardiovascular diseases. The study by Sesso showed that increased SBP, DBP, MAP, and PP in men increases the risk of cardiovascular disease by 1.43 to 2.52 times.⁽⁶⁾ Systolic pressure tends to increase, while diastolic pressure rises until 60 years of age and then declines or stabilizes as increasing age.⁽⁷⁾ The difference between the pattern of increase in systolic pressure and that in diastolic pressure with increasing age causes the MAP and PP to be important factors for assessment of the risk of cardiovascular disease.^(8,9) A study in Japan on 246 healthy middle-aged and older adults (44-78 years) showed that after moderate and high-intensity interval walking training body weight and body mass index (BMI) decreased significantly in women.⁽¹⁰⁾ The objective of the present study was to investigate the effect of exercise training on weight loss, SBP, DBP, MAP, and PP.

METHODS

Research design

An experimental pre-post test design without controls was used to evaluate the effect of exercise training on weight loss, SBP, DBP, MAP, and PP. This study was carried out in Senayan Sport Fitness Club (SSFC), from August to October 2010.

Subjects

The study subjects consisted of 89 participants, namely 40 men and 49 women,

who were members of the Senayan Sport Fitness Club (SSFC), Jakarta. The sample size was calculated for numeric in paired sample ($\alpha=0.05\%$, $\beta=0.20\%$, $SD=10$, significant mean difference=4). Inclusion criteria were members aged 50 years or more, with normal or above normal blood pressure, who had practiced three times a week continuously in the last three months (checked from the daily presence list) and underwent regular blood pressure examination at the SSFC. The sole exclusion criterion was members who did not practice for the last three months or more.

Exercise training

The intensity of the training was in accordance with the individual training programs that had been designed based on the member's level of fitness and health (50-60% VO_{2max}) for exercise for at least 30 minutes. Aerobic training was done either outdoors (walking, jogging) or indoors (static cycling), whereas weight training was done indoors. Exercise was performed three times a week.

Data collection

Data of the subjects included age, gender, and exercise test variables (SBP, DBP, BMI, and weight, MAP), which were obtained from patient fitness and medical records. Pre-exercise values of blood pressure, height, and body weight were mean values taken before exercise bouts in the first 10 days, whereas post-exercise values were mean values taken before exercise bouts in the last 10 days of exercise training. Blood pressure was measured by trained nurses using a sphygmomanometer (Nova). Body weight was measured using Camry scales to the nearest 0.1 kg, and height was measured using a stature meter to the nearest 0.1 cm. BMI was calculated as the weight (kg) divided by the square of the height (m^2).

Ethical clearance

Ethical clearance was approved by the Ethical Commission of Atma Jaya Catholic

University. The participants were requested to give written consent, with attached signature. Identify of all participants was kept confidential and used for research purposes only.

Statistical analysis

The data obtained were processed and analyzed using SPSS version 16.0, and normality of distribution of the data was checked using Kolmogorov-Smirnov test. Paired t-test was performed to confirm the difference of mean SBP, DBP, MAP, and PP before and after training, whereas ANOVA was used to compare the same variables between age groups. The Pearson or Spearman correlation test was conducted to determine the relationship between the above variables. Significance of the results was set at $p < 0.05$.

RESULTS

Of the participants enrolled in the study, 40 were male (44.9%) and 49 (55.1%) were female. Mean age of the subjects was 61.3 ± 11.5 years and most of the subjects, both male and female, were aged 60 to 69 years (47.2%) (Table 1). There were more female than male subjects in all age groups.

Exercise test variables consisting of duration of training, BMI, SBP, DBP, MAP, and PP, are shown by age group in Table 2, for comparison of the between-group means. The

Table 1. Subject distribution according to the gender and age group

Age group	Gender		Total (%)
	Male	Female	
50-59 y	6	8	14 (15.7)
60-69 y	19	23	42 (47.2)
70-79 y	8	10	18 (20.2)
≥ 80 y	7	8	15 (16.9)
Total	40	49	89 (100)

mean duration of training was 6.3 years. The longest duration of training was 7.1 years, occurring the age group of 70-79 years, and differed significantly from the duration of training in the age group of ≥ 80 years. The mean body weight above normal was found in the age group of 70-79 years, but there was no difference in BMI between groups. The mean SBP and mean DBP of all groups were higher than normal. Mean SBP of age groups 60-69, 70-79, and ≥ 80 years were significantly higher than that of the group of 50-59 years, whereas for mean DBP no significant between-group difference was found. The mean MAP of all groups were within the normal range (70-110 mm Hg). Mean MAP in the age group of 70-79 years was higher than that in the age group of 50-59 years. Similarly, the mean PP of all groups were above normal (30-40 mmHg), and mean PP of the age group of 60-69 years was also significantly higher than that of age group of 50-59 years.

Table 2. Exercise test variables by age group at baseline

Age group	Training duration (years)	BMI (kg/m ²)	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)	PP (mmHg)
50-59 y	5.3	24.1	120.7	78.4	92.5	42.3
60-69 y	6.7	25.0	127.6*	79.9	95.8	47.7*
70-79 y	7.1*	25.9	128.7*	81.9	97.5*	46.8
≥ 80 y	4.2	23.0	128.2*	80.6	96.5	47.6
Overall	6.3	24.5	126.3	80.2	95.6	46.1

One-way ANOVA test

*Significant at $p < 0.05$, compared to lowest mean value

Table 3. Exercise variables before and after training, by age group

Age group	BMI			SBP			DBP			MAP			PP		
	Pre	Pos	p	Pre	Post	p	Pre	Post	p	Pre	Post	p	Pre	Post	p
50-59 y	24.1	22.7	0.01	120.7	118.1	0.04	78.4	75.9	0.01	92.5	89.9	0.05	42.3	42.2	0.68
60-69 y	25.0	24.0	0.04	127.6	120.8	0.00	79.9	76.0	0.00	95.8	90.9	0.29	47.7	44.8	0.00
70-79 y	25.9	24.8	0.04	128.7	122.5	0.01	81.9	78.1	0.03	97.5	92.9	0.02	46.8	44.4	0.02
≥80 y	23.0	22.9	0.74	128.2	127.8	0.62	80.6	78.8	0.06	96.5	95.1	0.62	47.6	49.0	0.07
Overall	24.5	23.6	0.04	126.3	122.3	0.02	80.2	77.2	0.00	95.6	92.2	0.00	46.1	45.1	0.04

One-way ANOVA test

A comparison of pre- and post-training values of the exercise test variables are shown in Table 3, where it is apparent that the values for body mass index and all other parameters decreased significantly into the normal category after exercise training. Mean post exercise values of BMI in the age groups of 60-69 and 70-79 years, post exercise SBP the age group of 50-59 years, and post exercise DBP of age groups 70-79 and ≥80 years, fell into the normal category. However, post exercise PP of all groups were still above normal.

Table 4 shows the results of multiple regression analysis demonstrating that training duration was the most influential factor affecting Δ BMI (Beta = 0.38; $p=0.00$). However, both age, gender, and training duration did not affect Δ SBP, Δ DBP, Δ MAP dan Δ PP.

DISCUSSION

This study was conducted in the elderly to confirm decrease in body weight after exercise training and its relationship to changes in cardiovascular parameters. The results showed there was significant reduction in BMI and all exercise test parameters. Overall, BMI, SBP, DBP decreased about 3.7%, 4 mmHg, and 3 mmHg, respectively. This could be interpreted as meaning that a decrease in BMI by 1% will decrease SBP and DBP by about 1 mmHg. This result was quite similar to that of other studies. The study by Steven et al. showed that the decrease in blood pressure after exercise training can occur even with a slight decrease in bodyweight.⁽¹²⁾ Mulrow et al. found a decrease in SBP and DBP of 3 mmHg for a 3-9% decrease in body weight.⁽⁴⁾

Table 4. Multiple regression analysis of age, gender and training duration on exercise variables

	Δ BMI		Δ SBP		Δ DBP		Δ MAP		Δ PP	
	β	p	β	p	β	p	β	p	β	p
Age	-0.14	0.18	-0.01	0.94	-0.04	0.75	-0.03	0.82	0.02	0.90
Gender	-0.24	0.03	-0.06	0.60	-0.03	0.78	-0.05	0.66	-0.06	0.63
Training duration	0.38	0.00	0.07	0.58	0.12	0.32	0.10	0.39	0.01	0.97

β = Standardized coefficients

* Significance at $p<0.05$

A meta-analysis by Cornelissen and Fagard showed that exercise can lower SBP and DBP in the normotensive by 3.3 and 3.5 mmHg, respectively, whereas in patients with hypertension SBP and DBP decreased by 6.9 and 4.9 mmHg.⁽¹³⁾ Our subjects consisted of both normotensive and hypertensive individuals, who were however not divided into normotensive and hypertensive groups, because our study emphasized the association between weight loss and reduced blood pressure. Therefore, the overall mean decrease in blood pressure was the combined result of the decreases in both types of subjects, so that the mean reduction in SBP and DBP was less, being only 4 and 3 mmHg, respectively.

In the present study the grouping of the subjects according to age was consistent with MacAuley's study which found that the relationship between blood pressure and physical activity was influenced more by age.⁽¹⁴⁾ However, although in the present study post-exercise values of SBP, DBP, MAP, and PP of the elderly were higher, age had no influence on the increase in the values of these exercise variables. This difference may be caused by the wider age range of the subjects (16-74 years) in the MacAuley study which impacted significantly on blood pressure.⁽¹⁴⁾

Although the decrease in SBP was statistically significant, mean SBP of all age groups after training, except in the age group of 50-59 years, was clinically less significant, because it was still in the prehypertension category.⁽¹⁵⁾ In contrast, the mean DBP of all age groups after training was clinically significant, as it reflected a beneficial change in category, from prehypertension to normotension. The clinically non-significant decrease in SBP may be the result of the considerably higher SBP values in a number of subjects, leading to no change in hypertensive category.

The decrease in blood pressure due to weight loss may occur by several mechanisms. Obesity, especially central obesity, is

associated with an increase in renin angiotensin aldosterone (RAA) system activity, sympathetic activity, endothelial dysfunction, and insulin resistance.^(16,17) Engeli et al. found that weight loss could reduce angiotensinogen, renin, aldosterone, and angiotensin-converting enzyme.⁽⁵⁾ The study by Dengel et al. of obese people showed that weight loss increased insulin sensitivity and brachial artery compliance.⁽¹⁸⁾ Furthermore, the study by Straznicky et al. found that weight loss in obese people lowered plasma norepinephrine spillover rate, muscle sympathetic activity, and increased baroreflex cardiac sensitivity.⁽¹⁹⁾ In our study, the decrease in blood pressure by exercise training-induced weight loss may have been caused by a similar effect on the RAA system, insulin sensitivity, sympathetic activity, and endothelial function.

MAP and PP, in addition to SBP and DBP, are also risk factors for cardiovascular disease, especially in the elderly.⁽⁶⁾ The MAP value is determined by the value of SBP and DBP. An increase in SBP and DBP would increase MAP, while a decrease in SBP and DBP would lower MAP. Mean arterial pressure is proportional to cardiac output (CO) and peripheral resistance. Increased CO and peripheral resistance will increase MAP and vice versa.⁽¹⁰⁾ In this study, mean pre- and post exercise MAP values were within normal range and decreased significantly due to reduction in SBP and DBP. The study by Seals et al. also found decreased SBP and DBP, with consequently decreased MAP, after three months of aerobic exercise.⁽²⁰⁾

The study by Garcia-Palmieria et al. examined the relationship between PP, stratified by quartiles, and cardiovascular mortality in men. They found that the highest quartile of PP (≥ 57 mmHg) had a 1.4 times higher cardiovascular mortality than the lowest quartile (< 38 mmHg).⁽⁹⁾ Mean pre-and post exercise PP of all age groups and overall in the present study were substantially below 57 mmHg and therefore did not lead to an increased risk of cardiovascular mortality.

Exercise has been proven to be beneficial in lowering the blood pressure, especially in patients with hypertension. Regularity of exercise training also reduces the risk of developing cardiovascular disease.⁽²¹⁾ Programmed and supervised physical activities are more efficient in sustaining blood pressure in the elderly with hypertension.⁽²²⁾ The American College of Sports Medicine (ACSM) recommends an optimal exercise program to optimize blood pressure improvement in hypertension. Exercise should be performed on most, preferably all days of the week, with moderate intensity (40-60% VO_{2max}), for 30 minutes of continuous or accumulated activity. Aerobic or endurance exercise should be the primary activity, supplemented by weight training or resistance exercise.⁽²³⁾ The exercise programs in the present study met the recommended ACSM criteria of exercise for hypertension.

This study has several limitations that led to bias and influenced the results. In the first place, the study did not record the amount of food consumed by the subjects, which is important for determining the actual cause of the loss in bodyweight and the decrease in blood pressure. Another limitation is that a number of subjects at times took antihypertensive medication before blood pressure examination. Therefore the mean blood pressure value did not purely reflect the effect of exercise training; however, this may be eliminated by taking the mean from 10 examinations.

CONCLUSIONS

Exercise training leads to a lower body mass index that is also influenced by gender. Moreover, the reduction in diastolic blood pressure is higher for persons aged 70 years and over. It is recommended to examine the effect of exercise on blood pressure in subjects on a controlled diet and taking no antihypertensive medication.

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