Effects of Exercise on Coronary Risk Factors in Obese, Middle-Aged Subjects

TOSHIKI OHTA, M.D., TASKASHI KAWAMURA, M.D., KIYOSHI HATANO, M.D. 
MASASHI YOKOI, M.D., ZENICHIRO UOZUMI, M.D., NOBORU OKAMOTO, M.D. 
YOSHIKO MIZUNO, M.D., TORU IWATSUKA, M.D. 
AND SHUJI HASHIMOTO, Ph.D.*

The effects of exercise (10000 walk steps/day) and diet (1500 kcal/day) for 4 months on coronary risk factors (obesity, hypertension, serum lipid and lipoprotein abnormalities) were studied in 332 obese, middle-aged subjects.

Body weight, skinfold thickness, systolic and diastolic blood pressures, serum lipid and lipoproteins (total cholesterol, triglyceride, and β-lipoprotein) improved significantly (p<0.05) during the program. The degree of improvement in blood pressures, serum lipids and lipoproteins was greater in abnormal blood pressure (greater than 140/90 mmHg) or abnormal serum lipid group than in normal group. A significant correlation was observed between daily number of walk steps and the improvement of body weight, diastolic blood pressure and HDL-cholesterol. Increase of daily steps during the program showed a significant (p<0.05) correlation to the change in HDL-cholesterol.

It was suggested that mild exercise characterized by brisk walking was effective in the treatment of obesity, hypertension and low HDL-cholesterolemia in obese, middle-aged subjects.

Coronary artery disease is thought to be caused by many risk factors, including cigarette smoking, hypertension, hyperlipidemia, physical inactivity, electrocardiographic abnormalities, oral contraceptives, type A behavior, diabetes and gout, and obesity.

The role of physical training as well as diet in primary prevention of coronary artery disease can be demonstrated by a favorable influence on the major coronary risk factors. The purpose of this study was to investigate the effect of physical exercise and diet on obesity, hypertension and serum lipid abnormalities in obese, middle-aged subjects.

Key words: 
Exercise 
Obesity 
Coronary risk factors 
Hypertension

METHOD

Experimental design

From the patients who underwent a weight reduction program at Aichi Prefectural Center for Health Care, 332 obese subjects (male 65, female 297, age 47.2±8.3) with a relative body weight greater than 120% were included in this study. Most of the patients were housewives, employees and owners of a store.

The patients were placed in a 5-month weight reduction program consisting of diet (1500 kcal/day) and exercise (10000 walk steps/day). Energy consumption was calculated using a description of 7 days of daily intake, and walk steps were obtained with a pedometer. Medical data including body weight, triceps and subscapular skinfold

Aichi Prefectural Center for Health Care, Nagoya; *The Institute of Public Health, Tokyo, Japan
Mailing address: Toshiki Ohta, M.D., National Institute of Health and Nutrition, 1-23-1; Toyama, Shinjuku-ku, Tokyo 162, Japan

Japanese Circulation Journal Vol. 54, November 1990 1459
TABLE 1 CHANGES IN BODY WEIGHT, SKINFOLD THICKNESS, BLOOD PRESSURES, SERUM LIPIDS AND LIPOPROTEINS DURING WEIGHT REDUCTION PROGRAM

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight (kg)</td>
<td>N=264</td>
<td>64.7±9.6</td>
</tr>
<tr>
<td>Relative weight (%)</td>
<td>N=264</td>
<td>131.2±11.1</td>
</tr>
<tr>
<td>Triceps skinfold (mm)</td>
<td>N=160</td>
<td>15.5±4.4</td>
</tr>
<tr>
<td>Subscapular skinfold (mm)</td>
<td>N=148</td>
<td>27.3±6.1</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>N=251</td>
<td>129.3±18.2</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>N=251</td>
<td>79.0±12.0</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>N=246</td>
<td>199.1±38.2</td>
</tr>
<tr>
<td>HDL-cholesterol (mg/dl)</td>
<td>N=137</td>
<td>53.7±13.3</td>
</tr>
<tr>
<td>Triglyceride (mg/dl)</td>
<td>N=226</td>
<td>129.0±69.6</td>
</tr>
<tr>
<td>β-lipoprotein (mg/dl)</td>
<td>N=139</td>
<td>540.3±134.5</td>
</tr>
</tbody>
</table>

*p<0.05

Exercise Therapy in the Field of Circulation

*Relative weight was defined as 20% greater than the ideal weight derived by the following modified Broca's method:

\[
\text{Ideal Weight} = (\text{Height} - 100) \times 0.9
\]

A modification was required for Japanese, who are not as tall as western people. Triceps and subscapular skinfold thickness were measured with a caliper.

Blood pressures were taken by an automated mercury manometer after 5 min rest in the supine position. Serum cholesterol, triglyceride, HDL-cholesterol and β-lipoprotein were obtained with an automatic analyzer after 14 h of overnight fasting.

Progressive multi-stage treadmill test was carried out to the voluntary maximum before and after the training program in 25 subjects. Oxygen consumption and ventilation were measured every 30 sec with an automated analyzer (Anima R1500A), and the anaerobic threshold was determined.

Laboratory procedure

Statistical analysis

Student's paired t test was used to assess the difference in mean values before and after the intervention. Correlation coefficient

**Japanese Circulation Journal** Vol. 54, November 1990
Fig. 2. Relation between number of daily walk steps and changes in body weight, blood pressure, serum lipids and lipoproteins.
HDL-C: HDL-cholesterol; TC: total cholesterol; TG: tryglyceride

RESULTS

Sequential changes in daily walk steps and energy consumption were examined. Daily steps changed from 8100±2600 steps at the beginning to 9800±2600 steps at the end of the program. Energy consumption changed from 1928±411 kcal to 1555±321 kcal.

Changes in body weight, skinfold thickness, blood pressures, serum lipids and lipoproteins were compared before and after the program (Table I). Body weight, relative body weight, triceps and subscapular skinfold thickness decreased significantly (p<0.05) during the program. Systolic and diastolic blood pressure, total cholesterol, triglyceride and β-lipoprotein showed significant (p<0.05) improvement. HDL-cholesterol increased, but the improvement was not significant.

The subjects were divided arbitrarily into normal and abnormal groups with respect to blood pressures or serum lipids and lipoproteins. Changes in blood pressures or serum lipids and lipoproteins were compared be-
between the 2 groups (Fig. 1). Abnormal blood pressure was defined as 140/90 mmHg or greater and normal as less than 140/90 mmHg. Abnormal serum lipid was defined as the presence of abnormalities in any serum lipids and lipoproteins examined in this study.

Significant ($p<0.05$) improvement of systolic and diastolic blood pressure was observed in the abnormal blood pressure group (systolic: $150 \pm 14 \rightarrow 137 \pm 13$ mmHg, diastolic: $90 \pm 10 \rightarrow 84 \pm 11$ mmHg), but no significant change was observed in the normal group (systolic: $120 \pm 11 \rightarrow 121 \pm 12$, diastolic: $74 \pm 8 \rightarrow 74 \pm 9$). Serum lipids and lipoproteins improved significantly in both normal and abnormal groups except for HDL-cholesterol in normal group. The improvement was greater in abnormal group (total cholesterol: $232 \pm 49 \rightarrow 219 \pm 46$ mg/dl, triglyceride: $191 \pm 85 \rightarrow 128 \pm 75$ mg/dl, HDL-cholesterol: $51 \pm 13 \rightarrow 55 \pm 16$ mg/dl, $\beta$-lipoprotein: $626 \pm 164 \rightarrow 565 \pm 147$ mg/dl) than in normal group (total cholesterol: $188 \pm 26 \rightarrow 184 \pm 30$ mg/dl, triglyceride: $97 \pm 35 \rightarrow 80 \pm 32$ mg/dl, HDL-cholesterol: $59 \pm 12 \rightarrow 56 \pm 11$ mg/dl, $\beta$-lipoprotein: $473 \pm 69 \rightarrow 441 \pm 88$ mg/dl).

Correlation was ascertained between the number of steps of daily walk and changes in body weight, relative weight, blood pressures, serum lipids, and lipoproteins (Fig. 2). Reduction in body weight and relative weight exhibited a significant ($p<0.05$) correlation with the number of steps of daily walk. Significant ($p<0.05$) association was observed between steps of walk and changes in diastolic blood pressure in females. Systolic and diastolic blood pressure improved in subjects who walked more than 7000 steps per day. HDL-cholesterol showed a significant ($p<0.05$) correlation to the number of steps in males. However, other serum lipids and lipoproteins exhibited no such association.

On the other hand, daily energy consumption showed a significant ($p<0.05$) correlation to the improvement of body weight, relative body weight, triglyceride and $\beta$-lipoprotein.

Changes in the number of steps of daily walk were compared with the improvement of coronary risk factors. This change also showed a significant correlation to the improvement of HDL-cholesterol in males (Fig. 3).

Cardiorespiratory function was measured in 25 subjects before and after the program (Table II). In spite of weight reduction, the absolute value of oxygen uptake and ventilation at 80% of maximum HR (max HR was calculated by $220-\text{age}$) improved. The anaerobic threshold also improved after the program.

**DISCUSSION**

Coronary risk factors include cigarette smoking, hypertension, hyperlipidemia, physical inactivity, electrocardiographic abnormalities, oral contraceptives, type A behavior, diabetes mellitus, hyperuricemia, and obesity! Physical activity is expected to be effective in the improvement of hypertension, hyperlipidemia, physical inactivity, diabetes mellitus, hyperuricemia and obesity.

There is considerable information regarding excessive body fat and a number of health risks. The risks are impairment of cardiac function, hypertension, diabetes, re-

---

**TABLE II  CHANGES IN CARDIORESPIRATORY FUNCTION DURING WEIGHT Reduction Program**

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight (kg)</td>
<td>65.0±9.4</td>
<td>61.1±9.2*</td>
</tr>
<tr>
<td>VE (80% HRmax) (l/min)</td>
<td>41.9±10.7</td>
<td>45.1±9.6*</td>
</tr>
<tr>
<td>$\dot{V}O_2$ (80% HRmax) (ml/min)</td>
<td>1371±213</td>
<td>1476±233*</td>
</tr>
<tr>
<td>$\dot{V}O_2$/W (80% HRmax) (ml/min/kg)</td>
<td>22.0±3.3</td>
<td>25.4±3.8*</td>
</tr>
<tr>
<td>$\dot{V}O_2$ (AT) (ml/min/kg)</td>
<td>18.0±2.5</td>
<td>23.1±3.6*</td>
</tr>
</tbody>
</table>

VE: ventilation; $\dot{V}O_2$: oxygen consumption; AT: anaerobic threshold

* $p<0.05$; N=25
nal disease, gallbladder disease, pulmonary disease, osteoarthritis, gout, abnormal blood lipid and lipoprotein concentration. Thus, obesity is associated with multiple atherogenic traits and excessive fat accumulation contributes to an increased risk of coronary artery disease.

In the treatment of obesity, the major emphasis is placed on decreasing energy intake and little is given to increasing energy expenditure. However, the effect of exercise alone as a weight reduction tool has been reported. Exercise therapy is more effective in preserving lean body mass in weight reduction programs as compared with diet therapy.

In the present study, body weight and skinfold thickness decreased significantly during the program and the reduction of body weight correlated with the number of walk steps, whereas inversely with daily energy intake.

Effect of physical training on hypertension has been examined in well-controlled studies. Most of these studies have shown a significant reduction in systolic and diastolic blood pressure in the hypertensive subjects, but not in control subjects. Studies of effects of physical activity on overweight, hypertensive patients showed a significant reduction in blood pressure. Tuck et al and Reisin et al reported that weight reduction contributed to a decline in blood pressure in obese subjects.

In the present study, systolic and diastolic blood pressure decreased significantly after the weight reduction program, and the reduction was greater in the hypertensive group than in normotensive group. These results showed the effectiveness of exercise therapy in hypertensive patients. Patients who walked more than 7000 steps per day showed a consistent reduction of systolic and diastolic blood pressure as compared with patients who walked less. The result indicates that at least 7000 steps per day may be necessary for exercise therapy of hypertension.

The effects of physical activity on serum lipids and lipoproteins have been reported. HDL-cholesterol is indicated to increase, total cholesterol and triglyceride to decrease or remain unchanged. Tran reported that exercise induced the greatest reduction of total cholesterol and HDL-cholesterol when accompanied by weight reduction.

In the present study, improvement or HDL-cholesterol showed a significant correlation with the number of steps. The finding is in accordance with previous papers. However, changes in total cholesterol and triglyceride did not show a correlation to the number of steps. The lack of association may be caused by the energy intake reduction program undergone at the same time.

Effects of physical activity on cardiorespiratory function have been examined. Bonanno et al and Pacy et al showed that maximum oxygen consumption, oxygen pulse and ventilation increased after training. However, previous studies utilized training at a relatively high intensity and the training was monitored.

In the present study, a brisk walk of more than 10000 steps per day showed similar results as previous reports. This suggests that exercise of mild to moderate intensity characterized by a brisk walk is effective for the improvement of cardiorespiratory function.

In conclusion, a brisk walk proved safe and effective for exercise therapy for hypertension, lipid metabolic disorders and impaired cardiopulmonary function associated with obese, middle-aged subjects.

REFERENCES

5. Nonpharmacological approach to the control of high blood pressure. Final report of the subcommittee of nonpharmacological therapy of the 1984 joint national committee on detection, evaluation, and treatment of high blood pressure. Hypertension 8: 444, 1986
7. LEWIS S, HASKELL WL, WOOD PD, MAN-OGIAN N, BAILEY JE, PEREIRA MB:


11. TUCK ML., SOWERS JR., DORNFELD L.,


*Japanese Circulation Journal* Vol. 54, November 1990