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Effects of walking training on health-related fitness in healthy middle-aged adults – a randomized controlled study

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The effects of walking training on $\dot{V}O_2$max, serum lipoproteins and plasma fibrinogen were studied in 119 healthy middle-aged persons. Training prescription was 65–75% of $\dot{V}O_2$max, 50 min/session, four times a week for 15 weeks. The net difference (between pre-posttraining changes in the walking and control group) was statistically significant for $\dot{V}O_2$max (0.14 $l \cdot min^{-1}$, 95% CI 0.04, 0.23), total cholesterol (−0.20 $mmol \cdot l^{-1}$, CI −0.34, −0.06), LDL cholesterol (−0.17 $mmol \cdot l^{-1}$, CI −0.29, −0.05), ratio of HDL cholesterol to total cholesterol (0.014, CI 0.005, 0.023), and triglycerides (−0.15 $mmol \cdot l^{-1}$, CI −0.26, −0.04). No statistically significant changes occurred in fibrinogen. The findings indicate that walking training of moderate intensity resulted in a modest increase in $\dot{V}O_2$max and minor but consistently favorable changes in serum lipoproteins.

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Key words: maximal aerobic power; serum lipoproteins; HDL cholesterol subfractions; plasma fibrinogen; randomized controlled trial; moderate intensity exercise; walking

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Physical inactivity is a risk factor for many cardiovascular diseases. Health-related fitness encompasses cardiorespiratory, metabolic, morphological, muscular and motor components, deficiencies in which are risk factors for disease and can be modified by various modes of physical training (1). Walking has been recommended as an effective and safe way to increase health-related fitness (2–4). Despite the suitability of walking as an exercise mode for the general public, however, few studies have been conducted on the physiological effects of walking training on health-related fitness in sedentary persons (5–10).

Low concentrations of serum high-density lipoprotein (HDL) cholesterol and increased plasma fibrinogen are coronary risk factors which can be improved by physical training (11, 12). At present the minimal amount of exercise and the duration of training required to induce favorable changes in serum lipids are unknown. Although high-intensity exercise over several months has been shown to increase HDL cholesterol, the effects of moderate to low intensity training, for instance walking, are inconsistent, especially in premenopausal women (13).

The aim of the current investigation was to study the effects of walking training on maximal aerobic power, serum lipoproteins, and plasma fibrinogen as indicators of health-related fitness in healthy middle-aged men and women.

Material and methods

Subject selection. Volunteers were recruited through an announcement in the local newspaper. To be included, subjects were required to be 30–55 years old, non-smokers, premenopausal (women), and clinically healthy with no disabilities precluding exercise training. Regular medication (except for hormonal contraception in women) and physical exercise more than twice weekly were exclusion criteria, as was a body mass index (BMI) >33 $kg \cdot m^{-2}$. The study was approved by the ethics committee of the UKK Institute.

Medical screening examinations included submaximal exercise testing. Three persons were excluded because of ECG irregularities, and two because of elevated blood pressure.

After signing an informed consent, 117 people (55 men, 62 women) were randomized into an exercise and a control group. Randomization was stratified according to sex and submaximal oxygen consumption (divided into thirds). After randomization one

woman in the exercise group was excluded because of arrhythmia during maximal exercise testing. In all, 58 subjects (28 men, 30 women) initiated training, and 58 (27 men, 31 women) were in the control group. Measurements of maximal aerobic power ($\dot{V}O_2max$) and body composition, determinations of serum lipoproteins and plasma fibrinogen, and diaries of food intake were obtained before and after the 15-week intervention.

Anthropometry. Body weight and height were measured in light clothing without shoes. BMI was calculated by dividing weight (kg) by the square of height (m). Fat proportion of the body weight was estimated using bioelectrical impedance analysis (BIA) (BIA-106, RJL Systems Inc., Detroit, MI, USA). Waist circumference was measured halfway between the lowest rib and the iliac crest, and hip circumference at the level of the greater trochanters.

Blood pressure measurements were taken after the subjects had been resting in a sitting position for 5 min, using a random zero sphygmomanometer (Hawksley & Sons Ltd, Lancing, Sussex, England). The blood pressure was measured twice each time and the mean values were used in the data analysis.

Exercise test. $\dot{V}O_2max$ was determined during an uphill walk on a treadmill (Telineyhtymä Oy, Kotka, Finland), which was continued up to the symptom-free volitional maximum. The test protocol was modified after that of Pennsylvania State University (14), starting with a warm-up walk at a speed of 5 km $\cdot$ h^{-1} on a 5% incline. The incline was increased by 2.5% every 3 min (except during the second stage), and the speed was increased by 0.5 km $\cdot$ h^{-1} during the third, sixth and ninth stage of the test.

A metabolic analyzer (Metabolic Measurement Cart 2900Z, Sensor Medics Corp., Anaheim, CA, USA) was used to collect and analyze expired air. ECG was monitored (Case 12, Marquette Electronics Inc., Milwaukee, WI, USA) continuously. Perceived exertion was rated using the Borg scale (15) during each exercise stage. A fingertip blood sample was taken for lactate analysis within 2 min after cessation of exercise.

Maximum effort was defined as the plateau of $\dot{V}O_2$ (increase less than 2 ml $\cdot$ min^{-1} $\cdot$ kg^{-1} between consecutive gas analyses every minute), and/or at least two of the following parameters: heart rate (HR) more than 85% of the age-predicted maximum, respiratory quotient >1.05, and post exercise capillary lactate >4 mmol $\cdot$ l^{-1}.

Training prescription. The training sessions, lasting an hour four times a week, ran for 15 weeks from February to July. The subjects were instructed to start with a 5–10 min warm-up and finish with stretching. The target intensity of exercise for 50 min was 74–81% of HRmax, which is equivalent to 65–75% of $\dot{V}O_2max$ (14). HR was monitored continuously with an HR monitor (Polar Edge, Polar Electro Oy, Kempele, Finland). Subjects used a pedometer (Fitty-3, Kasper & Richter, Uttenreuth, Germany) during all exercise sessions to count the number of steps they took, and based on individual stride length, to calculate the distance walked. HRs were also recorded (Polar Sport Tester PE 3000) during once weekly supervised sessions.

Food intake. Current dietary intake was estimated on the basis of complete three-day (including one weekend day) food diaries at the beginning and the end of the study. The subjects were given oral and written instructions for calculating their food intake with household measures. The food composition data was calculated with MicroNutrica software (16).

The subjects were told not to change their eating or physical activity habits (except for prescribed exercise). The subjects also kept a log of physical activity during leisure and trips to and from work. All subjects refrained from smoking during the study. Nine of the women used hormonal contraceptive medication at the beginning and seven at the end of the training.

Biochemical analyses. Blood samples were taken after an overnight fast before and after training. Subjects were told to refrain from physical exercise and alcohol consumption for 48 h before the sampling. Samples for lipoproteins were taken twice (one week interval), and the mean values were used in the data analysis. All analyses were made from frozen (−70°C) samples. HDL cholesterol and the HDL_3 fraction were determined by means of selective precipitations (Dextralip (50 Sochibo, Meudon-La-Foret, France) and $MgCl_2 \cdot 6\ H_2O$) (17). The remaining cholesterol in the supernatant as well as total cholesterol were measured using an enzymatic cholesterol oxidase method (CHOD-PAP, Boehringer Mannheim, Mannheim, Germany). The analytical variations calculated from three human serum-based quality control materials were 0.7–1.0% for total cholesterol at 3.8–7.9 mmol $\cdot$ l^{-1}; 0.98–1.53% for HDL at 0.78–2.11 mmol $\cdot$ l^{-1}; and 1.84–3.42 % for the HDL_3 fraction at 0.51–1.04 mmol $\cdot$ l^{-1}. Cholesterol levels in low-density lipoprotein (LDL) (18) and in the HDL_2 fraction were also calculated. Triglycerides were measured with the enzymatic method (GPO-PAP, Boehringer Mannheim). For this assay, the analytical variation was found to be 1.09–2.19% for the concentration range 0.69–2.57 mmol $\cdot$ l^{-1}.

Frozen (−70°C) citrate plasma was used as the sample for the fibrinogen test, which was based on a modified automated Clauss method (ACL 2000, Fibrinogen-C, Instrumentation Laboratory, Milan, Italy). In this technique, fibrinogen is transformed into fibrin in the presence of excess thrombin (19). Fibrinogen analyses showed a 2.7% variation.

A lactate assay with deproteinization was used for

Table 1. Pretraining status of the subjects. Means (SD) in the walking and control groups, range of all subjects

	Walking (n=58)	Control (n=58)	Range (n=116)
Age, years	42.1 (5.1)	40.3 (4.5)	31–52
BMI, kg · m^{-2}	25.0 (2.8)	25.5 (3.0)	18.5–32.7
$\dot{V}O_2$max, l · min^{-1}	2.96 (0.59)	3.03 (0.68)	1.90–4.49
BIA, %	23.6 (6.7)	24.8 (6.7)	11–38

BIA, bioimpedance analysis for fat proportion of body weight.

capillary samples during exercise testing. Blood samples were measured after precipitation with perchloric acid using an enzymatic method (Lactate MPR1, Boehringer Mannheim).

Statistical analysis. Calculations for the sample size were based on the assumption of a 10% difference in the pre-post training $\dot{V}O_2$max between the walking and the control group for each sex (type I error α=0.01). Eighty per cent was selected as the power of the test. Calculations yielded a minimal group size of 26 subjects for each sex, resulting in a total sample of 104 (4 · 26).

The results are given as means and standard deviations (SD). An analysis of covariance (ANCOVA) with pretraining measures as covariates was used to analyze the training effects, which were determined as net differences (differences between the changes in the walking and the control group). For the net differences, 95% confidence intervals (CI) were also calculated.

There was a balance between the sexes in the study groups. Because the training effects did not generally differ between the sexes, the results for both sexes have been combined. When the findings showed a sex difference, they are reported separately.

Results

Five walkers (three men, two women), and three subjects (one man and two women) in the control group dropped out during the study. Two severe injuries resulted from the training (one stress fracture and one knee injury leading to surgery). Other reasons for discontinuation were not related to training. The total drop-out rate (including the one randomized subject who was later excluded because of arrhythmia) was 7%.

Two walkers suffered muscle strains, while another had a prolonged respiratory infection. In all three cases their training participation was substantially reduced. Two subjects had motivational difficulties and discontinued training during the first two months. All five subjects, however, were included in the data analyses in keeping with the intention-to-treat principle.

The pretraining status of all the subjects (n=116) is presented in Table 1. The mean age of the subjects was 41.2 (SD 4.9) years (men 41.4, women 40.9). Their mean BMI was 25.3 (SD 2.9) kg · m^{-2} while their average $\dot{V}O_2$max was 3.00 (SD 0.64) l · min^{-1}. There were no substantive differences between the drop-outs (n=9) and those who completed the study (n=108).

On average, the walkers participated in 57 training sessions (92% of the prescribed number; total range 11–60) or in 3.8 sessions per week. Thirty (66%) people took part in all 60 exercise sessions. The mean length of one session (including warm-up and cool-down) was 61 (SD 3) min. On average, performance above the lower limit of the target HR accounted for 42 (SD 11) min of this time. The mean training HR (recorded during weekly supervised sessions) was 139 (SD 11) beats · min^{-1} or 75% (SD 4, range 66–86) of initial HRmax. The mean estimated distance walked

Table 2. Body weight, body mass index (BMI), and fat proportion of body weight measured by BIA (bioimpedance analysis) before and after training. Means (SD)

	Walking (n=53)		Control (n=55)	
	Before	After	Before	After
Weight, kg				
Men	80.8 (9.3)	79.3 (9.3)	84.0 (10.4)	84.4 (11.1)
Women	66.8 (8.9)	65.7 (8.2)	68.6 (8.6)	68.8 (9.3)
BMI, kg · m^{-2}				
Men	25.5 (2.5)	25.0 (2.5)	26.1 (2.9)	26.2 (3.2)
Women	24.3 (3.0)	23.9 (2.9)	25.0 (3.0)	25.1 (3.3)
BIA, %				
Men	19.4 (3.9)	18.0 (4.9)	19.5 (4.1)	20.8 (4.2)
Women	27.1 (5.9)	26.5 (6.4)	29.4 (4.8)	30.3 (4.5)

n=25 for walking men, n=26 for control men, n=28 for walking women, n=29 for control women.

during one training session was 7.2 km (SD 0.6) (range 5.9–8.4).

The weight changes were minor during training: the mean weight of the walking group decreased by less than 1.5 kg, while that of the control group increased by about 0.5 kg (Table 2). The net difference (difference between the changes in the walking and the control group) was −1.7 (95 % CI −2.5, −1.0) kg (ANCOVA for the net difference $P<0.001$). The net difference for BMI was −0.6 (CI −0.8, −0.3) $kg \cdot m^{-2}$. Fourteen subjects in the walking group had a BMI above 27 $kg \cdot m^{-2}$ before training, and 10 after training. The proportion of overweight persons (27%) in the control group did not change during intervention. Body fat as estimated by BIA decreased by about 1 percentage point in the walking group and increased by 1 percentage point in the control group, for a net difference of −2.1 (CI −3.0, −1.2) percentage points ($P<0.001$). No changes were noted in the subjects' waist or hip measurements.

Before training, the mean estimated daily energy intake based on food diaries was 8.6 (SD 2.1) MJ in the walking group and 9.5 (SD 2.3) MJ in the controls. The breakdown for the entire group was 9.7 (SD 2.5) MJ for the men and 8.4 (SD 1.7) MJ for the women. During training, food intake increased slightly in the walking men and decreased in the control women, although no significant changes occurred in mean energy intake ($P=0.27$). The net difference was 0.4 (CI −0.3, 1.0) MJ in the whole group, and 0.1 MJ in men and 0.5 MJ in women. Some 40% of energy was derived from fat, and 16% from protein. No changes were noted in these figures during training.

Before training, mean resting systolic blood pressure was 118 (SD 12) and diastolic 75 (SD 11) mmHg. No changes in systolic pressure were noted during training but diastolic pressure increased in the control group; the net difference was −2.7 (CI −5.3, 0.0) mmHg ($P=0.05$).

In maximal exercise testing, HRmax decreased in the walking group but remained unchanged in the control group, for a net difference of −3 (CI −5, −1) beats $\cdot$ min^{-1} ($P<0.01$) (Table 3). Maximal ventilation increased by about 10 $l \cdot min^{-1}$ in the walking group and by 8 $l \cdot min^{-1}$ in the control group, and the net difference was not statistically significant. Post exercise capillary lactate concentration decreased by 0.7 $mmol \cdot l^{-1}$ in the walking group and by 0.5 $mmol \cdot l^{-1}$ in the control group (the net difference being −0.1 (CI −0.6, 0.5) $mmol \cdot l^{-1}$). The maximal respiratory exchange ratio and maximal rating of perceived exertion did not change during training.

$\dot{V}O_2max$ increased by 14% (SD 9, range −6 to 31) ($ml \cdot min^{-1} \cdot kg^{-1}$) in the walking group and by 7% (SD 8, from −13 to 26) in the control group. The increase was 0.14 $l \cdot min^{-1}$ (4.4%) ($P=0.004$) or 2.9

Table 3. Maximal heart rate (HRmax), maximal respiratory exchange ratio (RERmax), maximal ventilation ($\dot{V}_E max$), and postexercise capillary lactate concentration (LA) in maximal exercise testing before and after training in the walking and control groups. Means (SD)

	Walking ($n=53$)		Control ($n=55$)	
	Before	After	Before	After
HRmax, beats $\cdot$ min^{-1}	185 (12)	182 (11)	186 (10)	186 (9)
RERmax	1.08 (0.04)*	1.06 (0.04)*	1.08 (0.05)	1.07 (0.04)
$\dot{V}_E max$, $l \cdot min^{-1}$ (BTPS)	100 (24)*	111 (25)*	101 (25)	109 (27)
LA, $mmol \cdot l^{-1}$	10.2 (2.1)	9.5 (2.3)	9.9 (1.9)	9.3 (2.0)

* $n=52$.

Table 4. Mean (SD) maximal aerobic power ($\dot{V}O_2max$) before and after training, and the net differences observed during training (differences between the changes in the walking and control groups), 95% confidence intervals (CI) and *P* values for statistical significance (ANCOVA) in men and women in the walking and control groups

	Walking ($n=53$)		Control ($n=55$)		Mean	Net difference	*P* value
	Before	After	Before	After		95% CI	
$\dot{V}O_2max$, $l \cdot min^{-1}$	2.95 (0.61)	3.30 (0.71)	3.03 (0.68)	3.26 (0.78)	0.14	(0.04, 0.23)	0.004
Men	3.50 (0.35)	3.95 (0.34)	3.62 (0.41)	3.95 (0.51)	0.11	(−0.02, 0.24)	
Women	2.45 (0.27)	2.72 (0.34)	2.51 (0.36)	2.63 (0.33)	0.13	(0.01, 0.25)	
$\dot{V}O_2max$, $ml \cdot min^{-1} \cdot kg^{-1}$	40.2 (5.7)	45.8 (7.2)	39.9 (5.6)	42.6 (6.7)	2.9	(1.6, 4.2)	<0.001
Men	43.5 (3.5)	50.2 (4.9)	43.3 (3.6)	47.0 (4.8)	3.1	(1.2, 4.9)	
Women	37.2 (5.6)	41.9 (6.7)	36.8 (5.2)	38.7 (5.7)	2.8	(1.0, 4.5)	

$n=25$ for walking men, $n=28$ for walking women, $n=26$ for control men, $n=29$ for control women.

Table 5. Mean (SD) serum total cholesterol (chol), lipoprotein fractions of cholesterol, serum triglycerides (TG), plasma fibrinogen before and after training, the net differences during training (differences between the changes in the walking and control groups), 95% confidence intervals (CI) and *P* values for statistical significance (ANCOVA) in the walking and control groups

	Walking (n=53)		Control (n=55)		Net difference	
	Before	After	Before	After	Mean	95% CI
Chol, mmol · l^{-1}	5.24	5.06	5.36	5.37	−0.20	(−0.34, −0.06)
HDL chol, mmol · l^{-1}	1.299	1.355	1.304*	1.338*	0.022	(−0.019, 0.064)
HDL_2 chol, mmol · l^{-1}	0.337	0.379	0.336*	0.354*	0.024	(−0.003, 0.052)
HDL_3 chol, mmol · l^{-1}	0.962	0.976	0.968*	0.983*	−0.003	(−0.029, 0.024)
LDL chol, mmol · l^{-1}	3.35†	3.20†	3.52*	3.51*	−0.17	(−0.29, −0.05)
HDL chol/total chol (ratio)	0.257	0.277	0.250*	0.256*	0.014	(0.005, 0.023)
TG, mmol · l^{-1}	1.14†	0.94†	1.19*	1.12*	−0.15§	(−0.26, −0.04)
Fibrinogen, g · l^{-1}	3.16	3.16	3.28	3.17	0.07	(−0.05, 0.17)

* n=54, † n=51, § Training · sex interaction, P<0.001.

ml · min^{-1} · kg^{-1} (6.8%) (P<0.001) more in the walking group than in the control group (Table 4). The net increase was similar in both sexes.

Total and LDL cholesterol decreased by about 0.2 mmol · l^{-1} in the walking group but remained unchanged in the controls (net difference P=0.005, P=0.007) (Table 5). HDL cholesterol increased slightly in both groups but the net difference was not statistically significant. HDL_2 cholesterol increased more in the walking group than in the controls, while HDL_3 cholesterol increased more in the controls (net difference P=0.09, P=0.85). The ratio of HDL cholesterol to total cholesterol and of HDL cholesterol to LDL cholesterol increased in the walking group but remained unchanged in the controls (net difference P=0.003, P=0.004). Three subjects had triglyceride values above 4 mmol · l^{-1} before training, and one subject after training. These values were excluded from the data analysis. There was a statistically significant interaction (P<0.001) between training and sex in serum triglycerides, which decreased only in the men. The net difference was −0.35 mmol · l^{-1} in men and 0.02 mmol · l^{-1} in women. Plasma fibrinogen was unchanged in the training group but decreased slightly in the controls; the net difference was not statistically significant.

Discussion

In the current study, walking training for 15 weeks resulted in a modest increase in $\dot{V}O_2$max in the study subjects, healthy middle-aged men and women. The changes observed in body weight and serum lipoproteins after training were minor but consistent, including decreased serum total cholesterol, LDL cholesterol, and triglycerides while the ratio of HDL cholesterol to total cholesterol or to LDL cholesterol increased. Biological variation in lipoproteins was decreased by repeated sampling.

Few studies have compared walking with other exercise modes in a controlled setting (8). Santiago et al. (20) compared walking and jogging in young women, while Suter et al. (21) made the same comparison in middle-aged men. Neither study showed substantial differences in the gains in $\dot{V}O_2$max between the training modes (with different exercise intensities but equal energy consumption). In addition, no changes in serum lipoproteins were found.

The training effects of three walking speeds (4.8, 6.4, 8.0 km · h^{-1}) were compared in 20–40-year-old women (5). Because the subjects walked the same distance (4.8 km) during training sessions, the duration of the session varied between the groups. After 24 weeks of training, a dose-response increase for $\dot{V}O_2$ max was found. Santiago et al. (22) conducted a training program for sedentary women for 40 weeks using moderate to high intensity walking. Their findings showed a 20% increase in $\dot{V}O_2$max, most of which occurred during the first 20 weeks of the program.

Ready et al. (10) compared training effects of walking three or five days weekly for 24 weeks in postmenopausal women. The increase in aerobic power was similar after both regimens.

In the current study, exercise training was monitored by HR meters, pedometers, training logs and weekly supervised training sessions. Training adherence was good, and the drop-out rate was small. Of the prescribed weekly training, about 80% was performed within the target HR zone. Walking training resulted in two severe injuries. Suter et al. (21) found no difference in the occurrence of training injuries between joggers and walkers, while Duncan et al. (5) reported no training injuries even in the fastest walkers (8 km · h^{-1}).

In the current study, training intensity was moderate. Because no jogging was allowed, however, the perceived strain of walking was high, especially in subjects whose fitness level was better before training. Walking at a self-selected speed, the female subjects

typically recorded a mean HR of 70% (range 51–89) of HRmax (23). Such walking is within the recommended exercise intensity for improving health-related fitness.

Although they did not exercise regularly, the volunteers recruited for the current study were not in poor physical condition. This is one apparent explanation for the modest increase in $\dot{V}O_2$max compared with previous studies of sedentary middle-aged persons (6, 9, 22). The improvement in $\dot{V}O_2$max was similar for men and women in the present study. However, the net difference was partly diminished by the unexpected increase in $\dot{V}O_2$max in the control group (more than 10% (measured in milliliters per minute per kilogram) in 13 men and 8 women vs. 20 men and 17 women in the training group), which was evidently due to increased physical activity (contrary to the study instructions and not reflected in exercise logs).

In the current study, walking training of moderate to high intensity for 15 weeks resulted in minor changes in serum lipoproteins in healthy, non-smoking, middle-aged persons. As their HDL cholesterol concentration was within the normal range at the beginning of the training, no marked improvements were to be expected, especially as no major weight loss occurred. The short duration of the training program was another reason for the modest changes in serum lipoproteins. Fifteen weeks is sufficient time, however, for healthy sedentary persons to achieve improvements in $\dot{V}O_2$max (22, 24, 25). In agreement with the current study, no major alterations in serum lipoproteins were found after walking training for at least four months in men (21, 26) or in women (10, 20, 22, 27). On the other hand, serum HDL cholesterol increased in women after 12 months of training (28). In Duncan et al.'s study (5), HDL cholesterol increased by about the same amount in all three walking groups exercising at different speeds after 24 weeks' training but the increase was not statistically different from the control group.

The changes observed in serum lipoproteins (decreased serum total and LDL cholesterol) in the current study could most probably be attributed to dietary changes (decreased fat intake, especially in saturated fats) but no clinically significant changes in diet were observed in the dietary records. If the energy expenditure of brisk walking varies from 17 to 25 $kJ \cdot min^{-1}$ (4–6 $kcal \cdot min^{-1}$), the mean weekly energy expenditure of prescribed walking in the present study was estimated to be 3.9–5.8 kJ (900–1400 kcal). On this basis, the slight decrease in body weight in the walking group was as expected. This agrees with other studies of moderately intense walking training without dietary restrictions in non-obese persons (10, 29, 30) or mildly obese women (31): no marked changes in body composition were found.

Increased plasma concentration of fibrinogen is a coronary risk factor. There is also an inverse association between physical fitness and plasma fibrinogen (12). Data on the effects of exercise training on plasma fibrinogen in healthy persons are scarce and inconsistent (12, 32); in most cases, no marked changes have been found in controlled trials. The current study is the first one to report the effects of walking training on plasma fibrinogen, and the first to include women. In agreement with most previous training studies, no substantive changes were found in plasma fibrinogen.

In conclusion, the results of this randomized, controlled exercise training trial with good compliance indicate that HR-monitored walking training of moderate intensity for 15 weeks resulted in a modest increase in $\dot{V}O_2$max in healthy, middle-aged, non-smoking adults whose initial fitness was not poor. Minor but consistently favorable changes regarding the risk of coronary heart disease occurred in serum lipoprotein fractions, while no changes occurred in food intake and the weight loss was clinically insignificant. Plasma fibrinogen remained unchanged during training. Our results support the premise that regular brisk walking is an effective mode of exercise for improving the health-related fitness of sedentary adults.

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