Research Report

Effect of Brisk Walking in 1 or 2 Daily Bouts and Moderate Resistance Training on Lower-Extremity Muscle Strength, Balance, and Walking Performance in Women Who Recently Went Through Menopause: A Randomized, Controlled Trial

Background and Purpose. Menopause may induce a phase of rapid decreases in bone mineral density, aerobic fitness, muscle strength, and balance, especially in sedentary women. The purpose of this study was to examine the effects and feasibility of an exercise program of 1 or 2 bouts of walking and resistance training on lower-extremity muscle strength (the force-generating capacity of muscle), balance, and walking performance in women who recently went through menopause. **Subjects and Methods.** The subjects were 134 women who recently went through menopause. The study was a 15-week, randomized, controlled trial with continuous and fractionated exercise groups. The outcomes assessed were lower-extremity muscle strength, balance, and walking time over 2 km. Feasibility was assessed by questionnaires, interviews, and training logs. **Results.** One hundred twenty-eight women completed the study. Adherence to the study protocol was 92%. Both continuous and fractionated exercise groups improved equally in lower-extremity muscle strength and walking time but not in balance. Almost 70% of the subjects considered the program to be feasible. Two daily walking sessions caused fewer lower-extremity problems than did continuous walking. **Discussion and Conclusion.** Brisk walking combined with moderate resistance training is feasible and effective. Fractionating the walking into 2 daily sessions is more feasible than continuous walking. [Asikainen TM, Suni JH, Pasanen ME, et al. Effect of brisk walking in 1 or 2 daily bouts and moderate resistance training on lower-extremity muscle strength, balance, and walking performance in women who recently went through menopause: a randomized, controlled trial. *Phys Ther*. 2006;86:912–923.]

Key Words: *Balance, Muscle strength, Postmenopause, Randomized controlled trial, Walking.*

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On average, menopause occurs at 50 years of age among US and European women. *Menopause* is defined as a natural, age-related decrease and, finally, loss of ovarian estrogen production and secretion. The decreasing estrogen level, along with other related hormonal changes, affects women in many unwanted ways, especially for those who are inactive. In addition to weight gain, menopause may induce a phase of rapid decreases in bone mineral density, aerobic fitness, muscle strength (the force-generating capacity of muscle), and balance.[1] These decreases might lead to an inability to stay mobile and live independently when approaching old age. Physical activity might help women make the menopausal transition with much less dramatic changes and help them to preserve good functional ability.[2]

Some reports show the complexity of interaction among physical activity, health, fitness, and hormones.[3] However, the exact dose-response relationship of exercise and fitness in early postmenopause (ie, after menopausal changes in hormonal balance) is not clear. Decreasing levels of anabolic hormones, for example, may be associated with musculoskeletal atrophy; however, physical activity itself might have an effect on hormone action as a result of changes in protein carriers and receptors.[3] The response to exercise might differ between women with natural postmenopausal hormone levels and women taking hormone replacement therapy (HRT).

The latest exercise recommendation of the American College of Sports Medicine (ACSM) states that adults should exercise 3 to 5 days per week at 40% or 50% to 80% of their maximum oxygen uptake reserve ($\dot{V}O_2R$) for 20 to 60 minutes continuously or accumulate the same amount of exercise in several daily bouts that last a minimum of 10 minutes each. This recommendation means expending approximately 700 to 2,000 kcal per week to gain positive effects in aerobic fitness and body composition.[4] Maximum oxygen uptake reserve is calculated by computing the difference between resting and maximum oxygen consumption ($\dot{V}O_2$) and adding the percentage of this value to the resting $\dot{V}O_2$. The result is expressed as a percentage of $\dot{V}O_2R$.

Resistance training should include one set of 8 to 10 exercises that condition major muscle groups 2 to 3 days per week; each set should consist of 8 to 12 repetitions of each exercise. For people 50 to 60 years of age or older,

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10 to 15 repetitions may be more appropriate. Stretching should include appropriate static and dynamic techniques. For older adults, the ACSM recommends exercise that preserves or improves muscle mass, lower-extremity muscle strength, balance, and the ability to walk.[2]

Aerobic exercise is defined as planned, structured physical activity that involves large muscle groups in dynamic activities that, if effective, results in improvements in the function of especially the cardiovascular system and the skeletal muscles and leads to an increase in cardiovascular fitness (endurance performance). The exercise dose in aerobic exercise training is usually described by the intensity, duration, and frequency of the training session, and, in exercise trials, also by the length of the exercise program. Intensity is usually described as a relative intensity, a percentage of the subject's maximal aerobic power (%$\dot{V}O_2max$) or maximal heart rate (HRmax). *Duration* refers to the duration of a single exercise session. *Frequency* refers to the number of weekly exercise sessions. The total volume of training accomplished, expressed as exercise energy expenditure (EEE), also can be used to describe exercise dose.[4,5]

Resistance exercise is basically designed to improve muscle strength, power, and endurance. The exercise dose in resistance exercise training is usually described by the magnitude of resistance, the number of repetitions the resistance is moved in a single set of exercise, the number of sets done, and the length of resistance training program. Muscle strength is a measure of muscle's ability to generate force, muscular power is a measure of rate at which force is generated, and muscular endurance is a measure of the ability of a muscle to make repeated contractions against a constant resistance. Muscle strength is usually expressed as one-repetition maximum (1-RM) for dynamic measurements.[4,5]

The basic principle of dose-response is overload. Any physical activity will cause acute responses in cardiovascular and muscular systems, but only the amount of exercise that exceeds the habitual activity of a person will cause a training effect if repeated. Initially, therefore, people who are sedentary or have a low fitness level will get fitness improvements with a smaller exercise dose than people who have a higher fitness level. The greater the exercise dose (intensity + frequency + duration), the greater the response (ie, training effect) is. This can be seen most clearly in the response of maximal aerobic power to aerobic exercise. To some extent, intensity, frequency, and duration are interchangeable parameters of exercise dose. For example, the high intensity can be changed to a lower intensity, if the frequency and duration of exercise training are enlarged in order to keep the exercise dose as effective for maximal aerobic power. All of the training effects of exercise are reversible and will disappear in time, if the exercise training is stopped.[4,5]

The ACSM classified exercise according to intensity as very light (<10% $\dot{V}O_2max$), light (30%–49% $\dot{V}O_2max$), moderate (somewhat hard) (50%–74% $\dot{V}O_2max$), heavy (75%–84% $\dot{V}O_2max$), and very heavy (>85% $\dot{V}O_2max$).[6] Light exercise is not considered effective for adults who are healthy; however, in elderly people and those who have a very low fitness level initially, it is assumed to have positive effects. The interest in moderate exercise, such as walking, has been growing because of feasibility and safety aspects.[4] Reports of sudden cardiac death during exercise show that high exercise intensity is related to this risk[7,8] and to the risk of orthopedic injury, especially in elderly people.[8] The frequency of 3 days per week is considered optimal because the added improvement in fitness is small when the frequency is increased to 5 days per week.

When exercise is performed above the minimum intensity threshold, the total volume of training accomplished, expressed as EEE, also could be used to describe exercise dose. The exercise dose of 200 to 300 kcal per session is recommended for weight loss (for a person weighing 75 kg) by the ACSM.[4] The Harvard study showed an approximately 40% reduction in age-related mortality among men at an EEE of 1,500 kcal per week.[9] Kesäniemi et al[10] found a 30% reduction in mortality for people who were sedentary at an EEE of 1,000 kcal per week. Some studies[11,12] have shown that even exercise doses as low as 500 kcal per week have some beneficial effect on all-cause mortality.

These recommendations are based both on epidemiological evidence and on exercise trials that are mostly conducted with men; therefore, they may not be completely valid for women. In addition, the effects of exercise might be different in women of different ages. Randomized, controlled trials (RCTs) on the effects of exercise on women who recently went through menopause are needed; these trials also should consider natural postmenopausal hormone status and possible HRT use.

A recent systematic review of RCTs on dose-response relationships between exercise and fitness of women who were 50 to 65 years of age indicated that women who recently went through menopause were rarely studied in exercise trials.[13] The researchers identified only 11 studies on muscle strength and 6 studies on balance or coordination; only 1 of the studies used exercise that was fractionated into several daily bouts. Most studies on muscle strength used weight machines or high-impact circuit training. There were no studies on the effect of walking and a simple resistance training program without equipment on muscle strength. The studies that focused on balance and coordination mostly used resistance training in a gym or high-impact jumping. Only one of the studies reported using walking or other low-impact aerobic training combined with resistance exercises. The only study that reported using fractionated exercise also included men, and the only result that was reported separately for both sexes was that the exercise had no effect on lipids.[14] The feasibility of fractionated exercise compared with continuous exercise was not reported. It appears that, although walking is a common mode of exercise and is recommended as effective exercise,[15] it has been studied mostly in men and other age groups.[13]

For this purpose, we conducted an RCT on women who recently went through menopause, which included moderate-intensity walking in 1 or 2 exercise bouts and moderate-intensity resistance training with simple equipment. We hypothesized that there would be improvements in lower-extremity muscle strength, balance, and the ability to walk. In addition, the feasibility of fractionated walking training was compared with continuous walking training. We also compared the effects of exercise training on women who took HRT and those who did not.

Table 1.
Baseline Characteristics of the Subjects[a]

	E1	E2	C
n	46	43	45
Age, y	57.8 (4.4)	57.6 (4.2)	56.5 (4.2)
Years from menopause	6.0 (2.2)	6.0 (1.8)	5.8 (2.0)
Weight, kg	67.6 (8.2)	67.9 (8.5)	67.0 (8.5)
BMI, kg/m^2	25.8 (2.7)	25.9 (2.8)	25.7 (2.8)
Walking time,[b] min	17.5 (1.1)	17.4 (1.2)	17.6 (1.3)
One-leg squat[c]	9.6 (2.1)	9.2 (2.1)	8.8 (2.4)
One-leg stand			
0–29 s	23%	28%	28%
30–59 s	32%	20%	14%
60 s	46%	52%	58%
Physical activity habits			
No regular weekly	0%	2%	9%
Some light every week	35%	37%	34%
Once a week brisk	65%	61%	57%

[a] Results reported as means (SD) unless otherwise indicated. E1=continuous exercise group, E2=fractionated exercise group, C=control group, BMI=body mass index.
[b] Measured by Urho Kaleva Kekkonen Institute for Health Promotion Research (UKK) Walk Test.
[c] Sum of scores of right and left feet (range=0–12 points).

Method

Subjects

An announcement in a local newspaper produced 700 responses; 300 respondents participated in a questionnaire screening, 236 respondents participated in a medical examination, 151 respondents participated in submaximal exercise test, and 145 respondents participated in maximal exercise test, and finally 134 subjects were included in the intervention. All of these subjects fulfilled the eligibility criteria. The eligibility criteria were: (1) female, (2) 2 to 10 years after the onset of menopause, (3) 48 to 63 years of age, (4) no chronic diseases, (5) no regular medication except possible HRT, (6) nonsmoker, (7) body mass index $<$32 kg/m^2, (8) resting blood pressure $<$160/100 mm Hg, (9) not engaged in strenuous work or regular brisk leisure-time exercise more than once a week, (10) willing to continue previous diet and physical activity habits in addition to the exercise requirements of the study group, and (11) willing to accept the result of randomization. An equal number of women who were taking HRT and women who were not taking HRT were accepted. The process was described in detail previously.[16]

Procedure

The study was an RCT with 2 exercise groups. The subjects in group E1 used continuous exercise (ie, the training was performed in one daily exercise bout). The exercise training in group E2 was fractionated into 2 daily bouts, and control group subjects (group C) kept their daily physical activity habits unchanged. We have previously reported that both of these training regimens improved $\dot{V}O_2$max, measures of submaximal fitness, resting blood pressure, body mass, the proportion of body fat[16] as well as blood lipids and glucose and insulin levels.[17] The main outcome measures were lower-extremity muscle strength, balance, and walking performance. All the subjects gave their written informed consent.

Randomization. The women who used HRT and those who did not were randomized separately into the 3 groups in blocks of 15 subjects, each including an approximately equal number of women who used HRT and those who did not. The procedure yielded 46, 43, and 45 subjects in groups E1, E2, and C, respectively. The baseline characteristics of the subjects are presented in Table 1.

Exercise intervention. The exercise program was planned according to the principles of the ACSM recommendation.[4] The minimum recommended length for an exercise training intervention, 15 weeks, was chosen. Walking was chosen as the mode of aerobic exercise. It was considered to be the most common, most feasible, and safest form of sustainable dynamic aerobic exercise for our subjects.[15] An intensity of 65% of the $\dot{V}O_2$max was chosen because the ACSM considers this intensity to be moderate.[4] We chose a total EEE of walking training of 300 kcal per day, which yields a weekly exercise volume

Table 2.
Rationale for the Resistance Training Program and the Order and Dosage of Each Exercise

Exercises and Their Rationale	Dosage
Warm-up and to improve standing balance and body coordination	
1. Knees-up in standing position with alternating legs	20 repetitions (10 reps for each leg)
2. Back touch in standing position with alternating legs	20 repetitions (10 reps for each leg)
Warm-up and enhancement of endurance of the trunk, legs and upper-limb muscles	
3. Dumbbell military press with alternating arms	20 repetitions (10 reps for each arm) with 2- to 5-kg weight
4. Squat exercise on two legs	10 repetitions
5. Back extensor exercise in prone position, lifting opposite upper and lower limbs	10 repetitions, with 5-s hold
6. Upper-body extensor exercise on prone	10 repetitions with 5-s hold
7. Curl-ups in supine position with alternating legs	10 repetitions
8. Curl-ups and side-bending in supine position	20 repetitions (10 reps for each side)
Recovery after aerobic exercise to increase flexibility and to prevent musculoskeletal complaints	
9. Stretching exercise for hamstring muscles	30 s for each leg
10. Stretching exercise for pectoralis major muscle	30 s for each side
11. Stretching exercise (lateral bending) for neck muscles	30 s for each side
12. Stretching exercise for calf muscles	30 s for each leg
13. Stretching exercise for thoracic region	30 s

The resistance training program consisted of 1 set of 10 repetitions for each of 8 moderate, dynamic exercises for the main muscle groups twice a week according to the minimum requirements of the ACSM.[4] Body weight or 2- to 5-kg dumbbells were used as resistance. The program consisted of 2 exercises in standing position to improve the strength of leg muscles, balance, and coordination; 1 exercise for the strength of hip and knee extensor muscles; 1 exercise for the upper arms using dumbbells; 2 exercises for the back extensor muscles in prone position; 2 exercises for the muscle strength of abdominal region; followed by 5 stretching exercises. The main emphasis of the resistance training program, however, was on mobility-related aspects, and improving lower-limb strength and balance. It also served as a warm-up for the main muscle groups. This warm-up was considered important in order to prevent injuries. The duration of this resistance training bout was approximately 15 to 20 minutes. The rationale for the resistance training program and the order and dosage of each exercise are described in Table 2. The resistance training program is illustrated in Figure 1.

of 1,500 kcal. We chose a weekly EEE that was recommended by the ACSM.[4] A frequency of walking training, 5 days per week, that was more than the minimum requirement of the ACSM also was chosen. The frequency also had to be high because the intensity was moderate and the weekly EEE was considerably high, in order to keep the duration feasible.

Daily walking was continuous in group E1 and was fractionated in group E2 into 2 equal sessions with at least a 5-hour interval between sessions. The individual target heart rate in walking, corresponding to 65% of the $\dot{V}O_2max$, was determined for each subject in a maximal graded exercise test. The mean target heart rate was 132 bpm (SD=10.7) in group E1 and 130 bpm (SD=11.2) in group E2. The duration of daily walking training corresponding to 300 kcal was calculated individually using the Weir formula, which estimates energy expenditure from measured oxygen consumption and carbon dioxide production.[18] The mean target exercise duration was calculated to be 46.6 minutes (SD=5.4) for group E1 and 2 times 24.0 minutes (SD=3.2) for group E2.

Two weekly walking sessions, including the resistance training program, were supervised by an exercise leader on an indoor track. The other weekly walking sessions, 3 for group E1 and 8 for group E2, were unsupervised and took place outdoors. A few minutes of light flexibility exercises of the subject's choice were recommended before and after every session as a warm-up and cooldown and for injury prevention.

Heart rate monitors (Polar Edge*) were used to control the target heart rate in the 2 weekly supervised sessions and every third week in all weekly sessions. The subjects also were advised to periodically estimate the length of their walking route in order to keep the same relative pace in all weekly sessions. Every exerciser used an exercise diary to record the following information after every exercise session: date, time of the beginning and the end of exercise, exercise duration with target heart rate from heart rate monitor reading, and time spent in habitual physical activity (including walking other than exercise training, cycling, calisthenics, and so forth).

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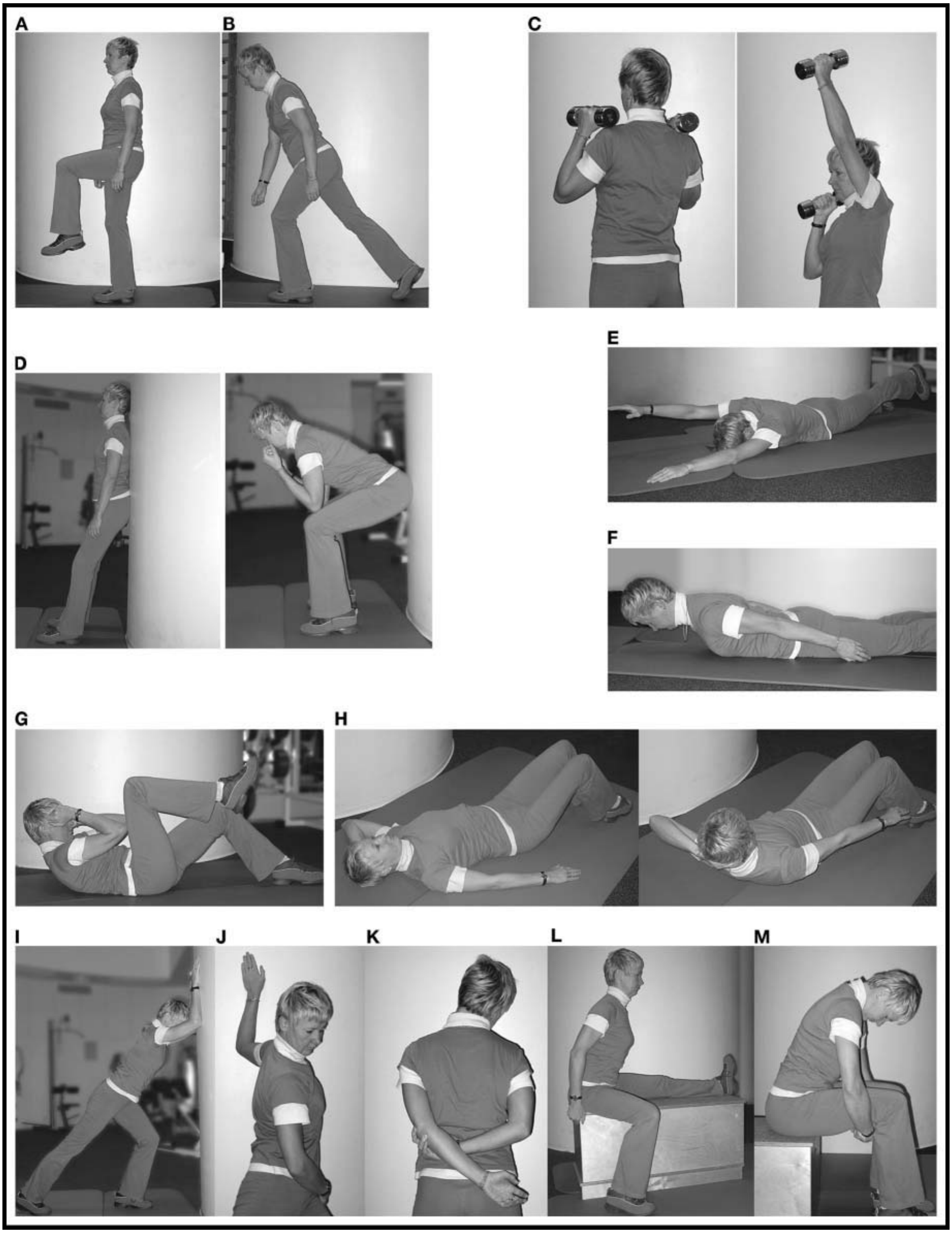

Figure 1.
Resistance training program. (A) Warm-up with knees-up (20 repetitions), (B) warm-up with back touch (20 repetitions), (C, left and right) upper-limb extension with 2- to 5-kg dumbbells: military press (10 repetitions for each arm), (D, left and right) thigh muscles: squat (10 repetitions), (E) back extension: lifting and holding opposite upper and lower limbs for 5 seconds (10 repetitions for each side), (F) back extension: lifting shoulders and upper body (10 repetitions with 5-second hold), (G) abdominal crunch, straight (10 repetitions), (H, left and right) abdominal crunch with rotation (10 repetitions for each side), (I) stretching exercise for hamstring muscles (30 s each leg), (J) stretching exercise for pectoralis major muscle (30 s each leg), (K) stretching exercise (lateral bending) for neck muscles (30 s each side), (L) stretching exercise for calf muscles (30 s each leg), (M) stretching exercise for thoracic region (30 s).

The exercise diary was checked by the exercise leaders every 3 weeks. In addition, the subjects wore electronic pedometers (step counters) (Fitty-3[†]) for 3 days, from Friday through Sunday, in the middle of the intervention period.

Once a month, the control group attended a meeting with lectures on health topics and performed a few minutes of light flexibility exercises. All of the subjects were asked to keep their diet, daily physical activity habits, and use of HRT constant, and these were checked with a questionnaire followed by an interview at the beginning and at the end of the intervention. The subjects were asked to rate their physical activity using a score of 1 to 5 as follows: 1=no regular physical activity during each week, 2=some light physical activity every week, 3=brisk physical activity once a week, 4=brisk physical activity twice a week, and 5=brisk physical activity 3 times a week or more. Questions concerning exercise-related pain and injuries were asked at the end of intervention.

Feasibility. Injury prevention included instructions on proper walking technique and advice in purchasing suitable walking shoes, and also giving the subjects the possibility that they could gradually progress to the full exercise program during the first 2 weeks. An additional 2 weeks was allowed for 6 subjects in group E1 and 7 subjects in group E2 to progress to the full exercise program. During the last weeks of intervention, 5 subjects in group E1 and 6 subjects in group E2 were allowed to use extra 1-kg wrist weights, stair walking, or occasional steps of jogging to reach their target heart rate.

During the intervention, the feasibility and safety of this exercise regimen were assessed in several ways. Adherence to the exercise program was measured from exercise diaries by calculating a percentage of completed exercise versus prescribed exercise for the duration of the exercise session, frequency of sessions per week, supervised sessions per week, and length of exercise program. Total amount of weekly walking was estimated from a 3-day pedometer recording. Pedometer measurement was measured only in the exercise groups, and it included all physical activity of the day, including walking training.

Feasibility and safety of the exercise also was assessed using a questionnaire completed during the postintervention interview concerning the subjects' perceptions of intensity of exercise and exercise-related pain and injuries. Safety of the exercise regimen was assessed by recording the injuries from the data from physician's consultations. If any health problems occurred, the subjects were advised to contact the consulting physician (TMA) at the onset of the problem.

Measurements

Lower-extremity muscle strength, balance, and ability to walk were measured using tests from the UKK Health-related Fitness Test Battery for Middle-Aged Adults (UKK HRF test battery)[19,20]: the one-leg squat test for lower-extremity muscle strength, the one-leg standing balance test for balance, and walking time on the UKK 2-km Walk Test (WT) for ability to walk. The reliability, safety, feasibility, and health-related validity of these field-based fitness tests have been established in a series of studies.[21–26] Based on our experience with the population study in which the UKK HRF test battery was developed, we considered the selected tests suitable for the subjects in the present study who were of the same age range and a high-functioning population.[19]

All tests followed a standard sequence. Balance was measured first, then strength; the WT was performed on another day. The 2 physical therapists who conducted the testing were educated using a standard education program with a test manual developed for the UKK HRF test battery to ensure quality and safety of the measurements. The consulting physician (TMA) gave written safety instructions, and was consulted in all cases of suspected health risk. In the case of an emergency during fitness testing, a physician, nurses, and equipment for cardiopulmonary resuscitation were available. Figure 2 describes the test methods.

Sample Size and Statistical Analyses

As described in a previous publication,[16] the main outcome was directly measured $\dot{V}O_2max$. The calculations for adequate sample size were based on the assumption of an approximately 10% (3 $mL \cdot min^{-1} \cdot kg^{-1}$ [SD=4]) increase from the baseline $\dot{V}O_2max$ in the exercise group when compared with the change in the control group (type 1 error alpha=.05). The power of the test was .90. The calculations yielded a minimum of 39 subjects for each study group. The actual number of subjects in each group was 43 to 46 at the onset of the study. The intention-to-treat principle was used, and all of the subjects were asked to participate in the 15-week measurements at the end of the intervention, regardless of whether they dropped out of the exercise program. On the basis of the calculated confidence intervals (CIs) of the group differences of $\dot{V}O_2max$, the sample sizes also can be considered adequate for finding meaningful group differences of other outcomes.

The results are given as means and standard deviations (SD) or proportions of study subjects. Analysis of covariance (ANCOVA) with the baseline measurements as the

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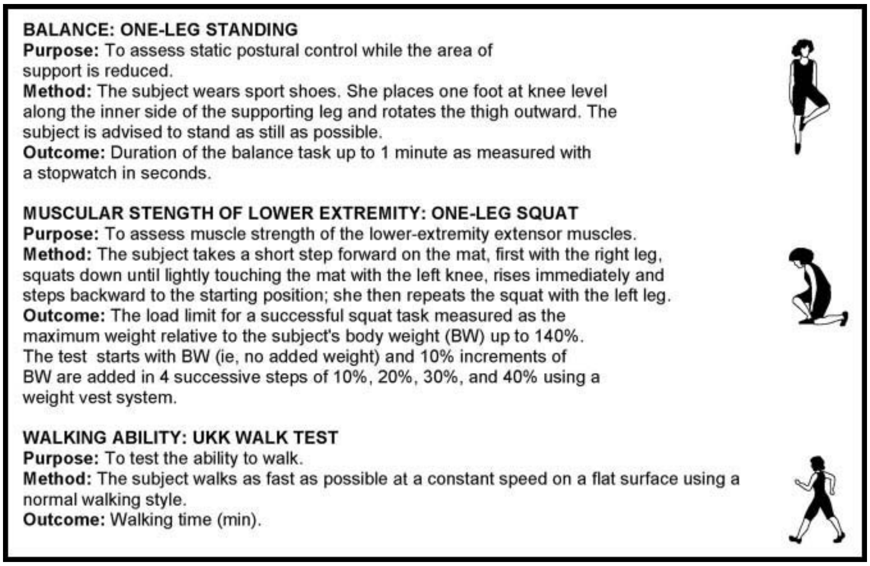

Figure 2.
Description of the selected tests from the Urho Kaleva Kekkonen Institute for Health Promotion Research (UKK) Health-related Fitness Test Battery.[20]

covariates was used to analyze training effects on walking performance. *P* values were calculated in testing for any differences between the groups. Training effects were determined as net differences (ie, differences between the changes in both exercise groups and the control group) and their 95% CIs for net change.

The outcomes for the one-leg standing balance test and one-leg squat test showed a skewed distribution because a considerable number of subjects achieved maximum results at the beginning of the study. Thus, the results were analyzed using the proportion of the subjects who achieved maximum results in tests before and after the intervention. Binary logistic regression analysis was used as the statistical method, and the odds ratios and their 95% CIs were calculated between exercise and control groups at the end of intervention adjusted for differences in baseline distributions. A subgroup analysis of the women who did and did not use HRT was carried out to determine the possible effects of HRT on the results.

Results

Adherence

Three of the 88 subjects in the exercise groups interrupted the exercise program; however, all 3 participated in the 15-week postintervention measurements and were included in the analysis according to the intention-to-treat principle. Six of 134 subjects did not participate in all of the 15-week measurements because of acute transient medical conditions. Subjects in both exercise groups followed the exercise prescription closely. Most subjects reached their target heart rate after 2 weeks of training, and all subjects reached their target after 4 weeks. Both groups exceeded the mean prescribed target duration by 1 minute per session. The attendance in exercise sessions ranged from 88% to 95%. According to the exercise diaries, questionnaire answers, and pedometer recordings, the habitual physical activity of the subjects in both exercise groups was equal. These data are reported in detail in a previous publication.[17]

Feasibility

The mean values calculated from the exercise diaries showed that group E1 attended 89% of the prescribed 75 sessions and group E2 attended 95% of the 150 prescribed sessions. Group E1 attended 88% and group E2 attended 92% of the 30 supervised exercise sessions. Absence from exercise was due to health problems, family reasons, work duties, or travel. Less than 1% of the absence was due to musculoskeletal problems and the difference between the exercise groups was not statistically significant. The information from exercise diaries showed that the mean total duration of walking at the target heart rate per session was 47.9 minutes (SD=14.2) for group E1 and 25.0 minutes (SD=3.2) for group E2. The mean total daily duration of habitual physical activity, other than prescribed exercise, was 23.9 minutes (SD=18.3) for group E1 and 27.8 minutes (SD=18.8) for group E2.

The mean total daily amount of walking, estimated from the pedometer recordings, was 9.2 km (SD=3.1) for group E1 and 10.4 km (SD=3.0) for group E2. The mean length of the intervention was 14.4 weeks (SD=2.9) for group E1 and 14.8 weeks (SD=2.5) for group E2. The walking program was stopped 1 day before the exercise test.

According to the results of the questionnaire and the interview completed at the end of the intervention, most of the subjects considered their exercise program feasible (not too light and not too strenuous). In group E1, 3 subjects (7%) considered the program very strenuous, 10 subjects (22%) considered it somewhat strenuous, 30 subjects (65%) considered it not light but not strenuous, 3 subjects (7%) considered it somewhat light, and none considered it very light. In group E2, none of the subjects considered the exercise program very strenuous, 11 subjects (26%) considered it somewhat strenuous, 29 subjects (67%) considered it not light but not

Table 3.
Percentage of Subjects Who Achieved the Maximum Result in the One-Leg Squat and One-Leg Stand Tests Before and After the Intervention and the Odds Ratios and 95% Confidence Intervals (CI) Among the Exercise and Control Groups at the End of the Intervention Adjusted for Differences in Baseline Distributions[a]

		% Subjects Achieving Maximum Result				
	N[b]	Before Intervention	After Intervention	Odds Ratio	95% CI	P[c]
One-leg squat test[d]						.008
E1	46	24%	53%	4.1	1.5 to 11.6	
E2	43	16%	51%	4.6	1.6 to 13.2	
C	43	23%	26%	1.0[e]		
One-leg stand test[f]						.175
E1	46	52%	72%	2.6	0.9 to 6.9	
E2	43	58%	63%	1.2	0.5 to 3.4	
C	44	46%	52%	1.0[e]		

[a] E1=continuous exercise group, E2=fractionated exercise group, C=control group.
[b] Dropouts excluded.
[c] Binary logistic regression analysis.
[d] Sum of scores of right and left feet (range=0–12 points)
[e] Reference category.
[f] Scoring range=0–60 seconds.

strenuous, 2 subjects (5%) considered it somewhat light, and 1 subject (2%) considered it very light.

Only changes in exercise, corresponding to the intervention program, were reported in the questionnaire in groups E1 and E2. No changes in exercise were reported by the subjects in the control group. Six subjects changed their HRT status. In group E1, 2 subjects started and 1 subject stopped taking HRT. In group E2, 1 subject started and 2 subjects stopped taking HRT. All 6 subjects were included in their original group in the analyses to meet the intention-to-treat principle. There were no changes in diet reported in the questionnaire.

According to the questionnaire and interview, most of the subjects in the exercise groups did not have any exercise-related, lower-limb problems: stiffness, pain, or injuries. Two daily walking sessions (fractionated exercise) caused fewer lower-limb problems compared with one continuous exercise session: 28 subjects in group E2 (65%) reported no exercise-related, lower-limb problems versus 19 subjects in group E1 (41%) (P=.021 for the difference in proportions); 8 subjects in group E2 (19%) reported problems at the beginning of the program versus 14 subjects in group E1 (30%); 5 subjects in group E2 (12%) reported problems during the middle or at the end of exercise program versus 11 subjects in group E1 (24%); and 2 subjects in group E2 (5%) reported exercise-related, lower-limb problems all the time during the exercise program versus 2 subjects in group E1 (4%), respectively.

The descriptive data of physician consultations shows that, out of the total 73 consultations, 49 concerned exercise-related problems. Most of the problems were minor. Of the 134 subjects, only 4 (3%) incurred major exercise-related health problems. Three of the 88 subjects in the exercise groups interrupted the exercise program: 2 because of lower-limb problems (persistent plantar fasciitis or newly detected knee arthrosis) and 1 because of psychosocial reasons. One case of mild, recurrent arrhythmia (paroxysmal ventricular extrasystoles) was detected in a subject in group E1 after the intervention. A specialist in cardiology suspected that the problems might have been caused by overtraining because no other reason for the arrhythmia was found, but no specific overtraining laboratory tests were conducted because the problem was mild. One subject in the control group fell on an icy walking trail and fractured a radius bone.

Lower-Extremity Strength

At baseline, 21% of the subjects achieved the maximum score of 12 points (able to squat down with an additional load of 40% of their body weight) in the one-leg squat test (Fig. 2). The proportion of subjects reaching maximum points increased statistically significantly in both exercise groups when compared with the control group (odds ratios=4.1 and 4.6 in groups E1 and E2, respectively) (Tab. 3). In group E1, the mean sum score of both legs on the one-leg squat test was 9.6 (SD=2.1) at the onset and 10.4 (SD=2.2) at the end of intervention. In group E2, the corresponding values were 9.2 (SD=2.1) and 10.3 (SD=2.2), and, in the control group, the corresponding values were 8.8 (SD=2.4) and 8.8 (SD=2.6).

Balance

At baseline, more than 50% of the subjects achieved the maximum score of 60 seconds on the one-leg standing balance test. The proportion of subjects reaching this maximum after the intervention increased in all study groups (Tab. 3), but the differences of the between-group changes were not statistically significant. Twenty-four out of 46 subjects in group E1 and 23 out of 43 subjects in group E2 achieved maximum results at the beginning of the intervention, and 33 and 28 subjects in groups E1 and E2, respectively, achieved maximum results at the end of the intervention. In the control group, the number of subjects with the maximum result

Table 4.
Walking Time in UKK Walk Test[a]

	N[b]	Mean Walking Time, min (SD)		Net Change (95% CI)	P[c]
		Before Intervention	After Intervention		
E1	45	17.5 (1.1)	15.6 (1.0)	−1.2 (−1.6 to −0.9)	
E2	43	17.4 (1.2)	15.5 (1.0)	−1.3 (−1.6 to −0.9)	
C	44	17.6 (1.3)	16.9 (1.2)		<.001

[a] E1=continuous exercise group, E2=fractionated exercise group, C=control group. Mean values (SD) before and after the intervention, and the net change, (95% confidence interval [CI]) between exercise and control groups.
[b] Dropouts excluded.
[c] Analysis of covariance.

changed from 20 to 23 out of 44 participants at the beginning and end of the intervention, respectively. The group mean value of balance time of those subjects who did not reach the maximum value at baseline, however, increased in both exercise groups after the intervention: in this subgroup of group E1 (n=22), the mean value increased by 13.9 seconds (SD=23.9) and, in group of E2 (n=18), the mean value increased by 12.4 seconds (SD=18.4). In the subgroup of control group (n=24), the mean value decreased by 0.3 seconds (SD=26.5).

Walking Performance

The improvement in walking time on the WT was equal and statistically significant in both exercise groups when compared with the control group (Tab. 4). The net improvement in walking time was 3.3% (95% CI=2.3%–4.2%) in group E1 and 3.4% (95% CI=2.4%–4.3%) in group E2.

Interactions of Exercise and Hormone Replacement Therapy

The subgroup analysis of the women who used and did not use HRT showed equal results in all of the measurements: the one-leg squat test for the lower extremities, the one-leg standing balance test, and walking time in the WT. This indicates that exercise was equally beneficial for women who used and did not use HRT.

Discussion and Conclusion

The main purpose of this study was to report the effects of 2 exercise programs—which included moderate-intensity walking in 1 or 2 exercise bouts and moderate-intensity resistance training—on lower-extremity muscle strength, balance, and walking performance of women who recently went through menopause and were sedentary. In addition, the feasibility of the training program was evaluated. The results show that lower-extremity muscle strength and walking speed improved equally in the 2 exercise groups when compared with the control group; however, the effect of training on balance was not statistically significant. The exercise was equally beneficial for women who used or did not use HRT.

The prescribed exercise combination proved to be a feasible training method with only a relatively small risk of injury or other health problems among the subjects, who were sedentary. The amount and severity of the injuries in our program (3%) were similar to those in other walking studies of women who recently went through menopause.[13] According to a systematic review of RCTs of this age group of women[13] in the training studies that combined walking with resistance exercise, the injury rate varied from 0% to 13%.

Our results further indicate that walking training can be divided into 2 daily bouts without compromising the training effects in women who recently went through menopause, an age group that has so far been in only one other RCT using fractionated exercise.[14] In our study, fractionated exercise not only improved walking performance as continuous exercise did, it also caused fewer lower-limb problems and was not considered to be more strenuous than the continuous exercise. To our knowledge, this is the first report to suggest that fractionated exercise causes fewer exercise-related lower-limb complaints in subjects who are sedentary. The finding could be explained by the fact that fractioned exercise allows the lower-limb muscles to rest between the exercise sessions compared with continuous exercise. Fractionated physical activity also may be easier to integrate into everyday life compared with one longer continuous session and, therefore, may improve the possibilities to start regular exercise compared with physical activity prescription requiring special arrangements.[27–29]

Lower-limb strength improved equally in both exercise groups in our study. In practice, the subjects in the training groups were able to perform the squat test with an extra load of 30% of body weight, which was one level higher on average than at baseline (20%). The subjects in our study accomplished this result by engaging simple closed–kinetic-chain muscular exercises and walking without specific resistance-training equipment. Heavy resistance training with special equipment can result in much larger (2- to 3-fold) increases in strength.[30–32] However, it also requires close supervision and that participants travel to exercise facilities, which may become barriers to training. High-impact aerobic circuit training combined with aerobic dance[33] as well low-impact aerobic dance combined with other low-impact aerobic exercise[34,35] also have been reported to improve muscle strength. This is the first study to show that walking combined with a simple resistance exercise program, which could easily be performed at home, will improve lower-extremity muscle strength in women who have recently went through menopause and who are sedentary.

At a population level, maintaining a good ability to walk is perhaps one of the key issues in the prevention of mobility-related disability. Previous population studies among middle-aged[21] and older[22] populations have shown a strong association between different performance tests using walking and mobility-related function. Slow walking speed also has been associated with increased risk of falls.[36,37] In the present study, walk performance, as measured by walking time of 2 km, improved significantly and equally in both exercise groups. Walking time measured by the WT reflects both submaximal aerobic capacity and musculoskeletal functioning.[20]

Balance was not improved by our exercise program; however, there was a positive trend toward improvement in group E1. The fact that more than 50% of the subjects reached the maximum score in the baseline balance testing might have decreased the possibility to detect a real training effect. A more challenging test of balance would have been more appropriate for the subjects in our study. Three upright exercises in our muscular training program (knees-up, back touch, and squat) were aimed at improving balance and coordination of hip, knee, and ankle muscles.[38] Heitkamp et al[39] reported significant improvements in both balance and lower-limb strength after similar type of closed kinetic chain balance exercises in younger subjects. They measured balance with a more difficult one-leg standing test on a narrow edge. Improvement in postural stability in women who recently went through menopause have been reported with programs of low-impact aerobic dancing and walking combined with resistance training,[40] with strength training alone,[32] with aerobic dance,[34] and with high-impact jumping.[41,42]

When approaching old age, muscle strength, balance, and the ability to walk preserve adequate functional capacity for the requirements of everyday living and for preventing falls.[43–46] Mobility limitations appear earlier in women who are aging than in men[47]; therefore, muscle strength, balance, and ability to walk already are very important aspects of fitness for women who have recently went through menopause.

Our study had several strengths that add to its reliability. The number of subjects was sufficient for adequate statistical comparisons and the randomized groups were comparable. The exercise dose was controlled with supervision, heart rate monitors, exercise diaries, and pedometers. Adherence was high, and the dropout rate was small. The muscle exercise program was of short duration, required very little equipment, and was easy to perform. Our study included both women who used HRT and those who did not, and exercise was equally beneficial for both groups. A weakness of our study was that the selected balance test was not demanding enough for our study population.

We conclude that our 15-week exercise program, consisting of brisk walking in 1 or 2 daily sessions, 5 days a week combined with a moderate muscle training program twice a week, improved lower-limb muscle strength and walking performance in women who recently went through menopause and were previously sedentary. The training program was equally beneficial for those who used HRT and those who did not. The training programs were feasible and safe. Fractionating walking in 2 daily exercise bouts caused less leg complaints than walking in 1 continuous exercise bout. The training program may serve as one means that women can use to become physically active, and it can promote healthy aging by preserving mobility function and independent life. Our results also encourage the use of everyday possibilities for multiple walking bouts as part of daily chores. At the population level, the impact of exercise on health is largest when those who are most inactive become at least moderately active.[48]

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