Effects of Resistance Training and Walking on CVD Risk in African-American Women

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ABSTRACT

Purpose: To evaluate the effects of walking (W) and walking plus resistance training (WRT) on cardiovascular disease (CVD) risk factors in inactive, middle-aged (49.0±5.5 years) African-American (AA) women (BMI: 34.7±6.4 kg m⁻²). Methods: Body composition, blood pressure, high-density lipoprotein cholesterol (HDL), triglycerides (TG), glycosylated hemoglobin (HbA₁c), C-reactive protein (CRP), and fibrinogen were measured before and after a 12-week exercise intervention. Subjects were randomly assigned to one of two training groups. W (n=25) was instructed to increase daily pedometer-measured walking to ≥10,000 steps day⁻¹, while WRT (n=19) was given the same walking prescription plus supervised resistance training two days week⁻¹. A two-way repeated measures ANOVA with an intention-to-treat analysis was performed to examine changes between groups. Significance was accepted at p≤0.05. Results: Both groups significantly (p<0.001) increased walking (W: 5,453±2,119 to 6,845±2,279; WRT: 4,823±1,758 to 6,859±2,012 steps day⁻¹). WRT significantly (p<0.001) increased both upper (100±15 to 113±18 kg) and lower (102±20 to 116±25 kg) body strength compared to W. WRT significantly decreased waist circumference (94.8±12.3 to 92.9±12.0 cm; p=0.021) and total fat mass (42.6±11.1 to 41.8±10.8 kg; p=0.036) compared to W. WRT also significantly decreased pre- to post-intervention body fat (45.8±6.2 to 45.3±6.2%; p=0.018), HbA₁c (5.9±1.2 to 5.6±1.0%; p=0.028), and mean glucose calculated from HbA₁c (122±39 to 114±32 mg/dL; p=0.028), while W showed no changes. Blood pressure, HDL, TG, and CRP were not affected by either intervention. Conclusions: Although both interventions increased steps day⁻¹, WRT was more effective in improving several body composition measures and glucose control in 12 weeks. WRT may be an important addition to a lifestyle intervention aiming to facilitate reductions in CVD risk factors in overweight and obese AA women.
Key Words: pedometer, metabolic syndrome, weight training, obesity, body composition, 10,000 steps
INTRODUCTION

Paragraph Number 1 In recent decades, the prevalence of obesity has reached epidemic proportions in the U.S. and is especially pronounced in certain subgroups. The 2007-2008 National Health and Nutrition Examination Survey (NHANES) showed that African-American (AA) women have considerably higher body mass index (BMI) values compared to women of other races and ethnicities, as a staggering 78% of non-Hispanic black females in the U.S. are overweight or obese (BMI ≥ 25 kg m⁻²) and 50% are obese (BMI ≥ 30 kg m⁻²; 16). These statistics are worrisome as they place AA women at a higher risk for obesity-related co-morbidities, particularly those related to cardiovascular disease (CVD).

Paragraph Number 2 It has been established that obesity is associated with an increased risk of CVD and metabolic syndrome (MetS). MetS includes a collection of abnormalities, associated with insulin resistance, that increase the risk of CVD. The Third Report of the National Cholesterol Education Program Adult Treatment Panel (NCEP-ATP III) specifies MetS as the presence of at least three of five abnormalities including waist circumference > 88 cm in women or > 102 cm in men, blood pressure ≥ 130/≥ 85 mmHg, triglycerides (TG) ≥ 150 mg/dL, high-density lipoprotein cholesterol (HDL) < 50 mg/dL in women or < 40 mg/dL in men, and fasting glucose ≥ 100 mg/dL (17). Pro-inflammatory and pro-thrombotic states are also associated with MetS and can be identified, respectively, by C-reactive protein (CRP) > 3.0 mg/L (27) and fibrinogen ≥ 350 mg/dL (21). With such high prevalences of overweight and obesity (16), and 39% of adult AA women in the U.S. having MetS (14), it is important to uncover new and diverse ways to treat and prevent multiple CVD risk factors in this population.

Paragraph Number 3 Weight reduction and increasing physical activity are well-established strategies for CVD risk factor improvement. AA women are currently understudied in regards to
the effects of physical activity on these risk factors. This is problematic since AA women are a population in which overweight and obesity are highly prevalent, leaving them more vulnerable to the development of CVD. It has even been shown that AA women, when compared to Caucasian, Asian, and Hispanic women, are more likely to have elevated levels of most of the CVD risk factors related to MetS including waist circumference (28), hypertension (28), fasting glucose (31), CRP (3, 24), and fibrinogen (4, 20). In addition, several studies assessing physical activity using surveys (2, 13) and pedometers (12, 18) have shown that AA women are sedentary or acquire minimal amounts of daily physical activity, and that they are consistently less active than their Caucasian (13, 18) and Native American (2) counterparts.

Paragraph Number 4 The few studies that have examined the effects of aerobic exercise and ambulation-based interventions on CVD risk factors in AA women have shown improvements in waist circumference (23, 45), abdominal visceral fat (5), fasting glucose (23), blood pressure (23, 39, 45), HDL (5, 23), and TG (5, 23). Although not specific to AA women, recent studies have also shown that resistance training (RT) improves the CVD risk factors associated with MetS (7, 30, 42) and that improvements in several CVD risk factors were similar when comparing the effects of RT to aerobic training (9, 15). In addition, studies have shown an inverse relationship between muscular strength and the prevalence of MetS that is independent of cardiorespiratory fitness (22, 44).

Paragraph Number 5 There are currently few studies that have examined the benefits of RT specifically in AA women (1, 34, 35, 38) and to our knowledge, no study has evaluated the effects of a progressive RT program on CVD risk factors in this population. The purpose of this study was to evaluate the effects of a lifestyle walking intervention and lifestyle walking combined with RT on the CVD risk factors associated with MetS in inactive, middle-aged, AA
women. We hypothesized that an intervention that combined lifestyle walking with RT would facilitate greater reductions in the CVD risk factors associated with MetS compared to the lifestyle walking intervention alone.

**METHODS**

**Subjects**

*Paragraph Number 6* Subjects included 44 self-identified AA women, ages 39-61 years, who were not currently participating in any RT and not categorized as “active” (averaging <10,000 steps day\(^{-1}\); 43). Subjects were excluded for uncontrolled hypertension, uncontrolled diabetes, active heart disease, endocrine disease, anticoagulant therapy, bleeding disorders, history of stroke, thyroid disease, pregnant or planning to become pregnant, smoking during the past six months, or any physical illness/orthopedic disability that would limit ambulation or the ability to complete RT exercises. Subjects were also excluded if they were currently participating in any type of physical activity program, special diet, or weight loss program and were asked not to begin any programs of this nature for the duration of the 12-week intervention. Interested women were pre-screened via telephone for age, current physical activity level, physical limitations, and smoking status. Those who successfully completed pre-screening were scheduled for their first laboratory visit where they would undergo additional screening for study inclusion.

**Pre-Intervention Testing**

*Paragraph Number 7* Baseline data collection occurred over a two-week period. All testing procedures were reviewed and approved by the Institutional Review Board at The Florida State University. On their initial visit, subjects reported to the laboratory in the morning after a 12-hour fast. Subjects reviewed and signed an informed consent form and a medical history questionnaire.
indirect digital blood pressure measurement (Omron Healthcare Inc.; Bannockburn, IL) was taken in
duplicate according to the standard guidelines outlined by the American Heart Association(32) after
5-10 minutes of seated rest. Height without shoes was measured by a wall-mounted stadiometer and
weight using a digital scale (Seca Corporation; Hanover, MD). Waist and hip circumferences were
measured using a Gulick fiberglass measuring tape with a tension handle (Creative Health Products,
Inc.; Ann Arbor, MI) using the American College of Sports Medicine guidelines (41).

Paragraph Number 8 Subjects then had fingerstick blood samples collected into a heparin-
treated microcapillary tube to screen for blood glucose, TG, and HDL using a Cholestech LDX®
analyzer (Cholestech Corporation; Hayward, CA). Individuals were only eligible to participate in
the study if they had at least two of the following CVD risk factors associated with MetS: waist
circumference >88 cm, blood glucose ≥100 mg/dL, blood pressure ≥130/≥85 mmHg, TG ≥150
mg/dL, and HDL<50 mg/dL. Venous blood samples were then collected to be used as dependent
variables in data analyses. Blood samples were collected into Vacutainer® tubes treated with
sodium citrate for fibrinogen, sodium heparin for HDL, and EDTA for HbA₁c, total cholesterol,
TG, and high-sensitivity CRP. Whole blood was centrifuged for 15 minutes at 3200 rpm and
aliquots of plasma were separated then stored at -80°C until further analyses. Total cholesterol,
HDL, TG, and high sensitivity CRP were quantified using colorimetric reagents and standards in
a Sirrus Clinical Chemistry Analyzer (Stanbio Laboratory; Boerne, TX). HbA₁c was analyzed
using an A1CNow+® kit (Bayer HealthCare; Sunnyvale, CA). Fibrinogen was determined using
a BBL®Fibrometer coagulation analyzer (BD Diagnostic Systems; Franklin Lakes, NJ). Blood
variables were measured in duplicate after both pre- and post-intervention samples were
collected from all subjects.
**Paragraph Number 9** Body composition was measured by a dual-energy x-ray absorptiometry scanner (iDXA®, GE Healthcare Inc.; Madison, WI) and analyzed using enCORE 2006 software, version 12.10. Testing was completed by a certified X-ray technician according to the manufacturer’s instructions and specifications. The areas of interest for fat distribution (android and gynoid regions) were obtained via total body scan. The lower boundary for the android obesity measurement was the top of the iliac crest, while the upper boundary was located at 20% of the distance between the iliac crest and the clavicle. For the gynoid obesity measurement, the upper boundary was located at the femoral neck and the lower boundary was marked at the point allowing the height of the gynoid region to equal two times the height of the android region. All subjects reported to the laboratory no later than 10:00 am in an effort to control for physical activity prior to body composition measurements. Upper and lower body strength was assessed using chest press and leg extension machine exercises (MedX™; Ocala, FL), respectively. After a warm-up, subjects were progressed towards the maximum weight that they could lift one time through a full range of motion, or a one-repetition maximum (1-RM; 41). All measurements were recorded within approximately five attempts.

**Paragraph Number 10** At the end of the first visit, subjects received a New Lifestyles Digi-Walker SW-200 pedometer (New Lifestyles, Inc.; Lees Summit, MO; 37) and were instructed to record the total number of steps taken each day for seven days on a provided activity log. For this baseline assessment, subjects were instructed not to make any changes to their typical daily routine of work and leisure activity. Subjects were also given a food log and instructed by a Registered Dietitian on how to record their complete dietary consumption for three consecutive days, including two weekdays and one weekend day. Subjects were strongly encouraged to remain consistent with their typical dietary habits and record each item and its amount as
accurately and specifically as possible. Thesubjects’ diet for each day was analyzed using Nutritionist Pro™ nutrition analysis computer software (Axxya Systems; Stafford, TX). Average caloric intake for the three-days was calculated to provide an estimate of each subject’s typical daily consumption. Upon entering the intervention, all subjects were asked to make no changes to their typical dietary habits during the 12-week intervention period in order to better isolate the influence of the exercise interventions on CVD risk factors.

**Paragraph Number 11** At least one week later, subjects returned for their second laboratory visit to find out if they were eligible for the study based on the presence of risk factors from the fingerstick blood samples and their physical activity classification. Resting blood pressure measurements were repeated during this visit and the average measurement from the first and second visits were used for the dependent variable in data analyses. Strength 1-RM measurements were also repeated. The highest measurement for the upper and lower body of the two visits was considered the 1-RM. Subjects also submitted their physical activity log and three-day diet record from the previous week during this visit. If eligible to enter the intervention, subjects were randomized, by picking a number out of a bag, into either a walking group (W) or a combined walking and RT group (WRT).

**Exercise Intervention**

**Paragraph Number 12** Both groups were asked to increase their daily ambulation to ≥10,000 steps day−1 over the 12-week intervention. Additionally, the WRT group underwent a supervised, progressive RT program two days week−1. Throughout the study, all subjects were asked to wear a pedometer to monitor daily ambulatory activity. Subjects were instructed on appropriate pedometer placement on the waistband at hip level, while its precise alignment was individually determined based on a 20-step walking test for accuracy. Before putting the monitor on each
morning, subjects were instructed to make sure it was set to zero and to record the time at which it was placed on the waistband. Each night before retiring, subjects recorded the number of steps on the pedometer for that day, noted the time at which the pedometer was taken off, and briefly reported the specific activities engaged in during that day. Subjects recorded data daily on a provided activity log and were asked to submit them weekly.

**Paragraph Number 13** If randomly selected for WRT, subjects added progressive RT to their walking prescription on two non-consecutive days each week for the entire 12 weeks. All RT took place at The Florida State University Strength Laboratory. Subjects performed three sets of 8-12 repetitions of 10 resistance exercises for the lower and upper body and all training sessions were supervised by trained Exercise Science students. Machine exercises (MedX™; Ocala, FL) included the chest press, seated row, overhead press, biceps curl, triceps extension, leg press, leg extension, leg curl, and abdominal crunch. Low back extensions were performed using body weight or dumbbells on a 45° roman chair. A rest period of approximately one minute was given between each exercise set. Training load was progressed throughout the 12 weeks to keep the number of repetitions between 10 and 12. The intensity goal was to get subjects to train at approximately 60-70% of their 1-RM. Before and after the RT sessions, subjects performed 5 minutes of warm-up and stretching, respectively. The strength tests described above were repeated in this group after the completion of weeks 4, 8, and for both groups at the end of the 12-week intervention. Strength gains were monitored in order to prescribe the appropriate intensity progression and provide motivation.

**Post-Intervention Testing**

**Paragraph Number 14** No less than 72 hours after the completion of the intervention, all subjects returned to the laboratory to repeat all testing procedures. These included
anthropometric measurements, resting blood pressure, venous blood sample collection, a body composition scan, and strength testing. Subjects also submitted another three-day diet record that had been given to them at a previous visit or sent via e-mail.

**Statistical Analysis**

**Paragraph Number 15** A one-way analysis of variance (ANOVA) was used to analyze baseline measures between the two groups. A two-way repeated measures ANOVA (group by time) was used to analyze dependent variables with repeated measures on the last factor. An intention-to-treat analysis was used to evaluate dependent measures to address the effects of the intervention on the subjects regardless of whether or not they completed the study. Using the principle of last observation carried forward, missing data points were filled using the test scores that were collected closest to the time of dropout. Secondary analyses were done on just the subjects who completed the study. One-way ANOVA analyses were used to determine the location of significant findings. Pearson product moment correlations were used to determine if the 12 weeks of W or WRT influenced blood pressure, HDL, TG, HbA1c, mean glucose, CRP, and fibrinogen. Significance was accepted at \( p \leq 0.05 \). All statistical analyses were performed using the SPSS software, version 18.0 (SPSS Inc.; Chicago, IL). Data are presented as means ± standard deviations.

**RESULTS**

**Subjects**

**Paragraph Number 16** Of the 56 women who underwent the initial assessment, four did not return to the laboratory for their second visit for unidentified reasons, seven did not meet the inclusion criteria, and one declined the opportunity to participate in the intervention. The remaining 44 women were randomized into one of two groups. Twenty-five women were randomly assigned to the W group and
eight of them discontinued the study (32% dropout rate). This included three women who acquired an illness, three who had time/scheduling conflicts, and two who discontinued for unidentified reasons. Nineteen women were randomly assigned the WRT group and four discontinued the study (21% dropout rate). Two women discontinued due to time/scheduling conflicts, one woman acquired an illness, and one woman did not enjoy strength training. Thirty-two women completed the study for a 27% dropout rate for the entire sample. At baseline, there were no significant differences between the women who did and did not complete the intervention for any variable. However, both BMI ($p=0.08$) and weight ($p=0.09$) were somewhat higher in the non-completers ($n=12$) versus the completers ($n=32$). The intention-to-treat analyses were completed on all subjects who were initially randomized into the W ($n=25$) and WRT ($n=19$) groups. There were no significant ($p>0.05$) differences between the W and WRT groups for any measured variable at baseline (presented in Tables 1 and 2). Both groups met the NCEP-ATP III criteria for MetS.

**Body Composition Variables**

*Paragraph Number 17* Table 1 presents descriptive characteristics and the effects of the two exercise interventions on body composition variables. Significant group by time interactions occurred for waist circumference ($F_{(1,42)} = 5.789$, $p \leq 0.05$, effect size (ES) = 0.12), gynoid fat mass ($F_{(1,42)} = 7.023$, $p \leq 0.05$, ES = 0.14), and total body fat mass ($F_{(1,42)} = 4.675$, $p \leq 0.05$, ES = 0.10). No variables changed in the W group. Although there was no interaction, there was a significant time effect for percent total body fat ($F_{(1,42)} = 8.017$, $p \leq 0.05$, ES = 0.16). The WRT group showed a significant decrease in percent total body fat with no change in the W group.
Physical Activity, Strength, & Diet

Paragraph Number 18 Table 2 presents changes in daily physical activity, strength measures, and diet. Both groups significantly increased their steps day$^{-1}$ (W by 1,392 steps day$^{-1}$; WRT by 2,036 steps day$^{-1}$), however, neither group reached the goal of ≥10,000 steps day$^{-1}$. There was a significant interaction effect for both upper ($F_{(1, 42)}=30.496, p≤0.05, ES=0.42$) and lower body ($F_{(1, 42)}=14.940, p≤0.05, ES=0.26$) strength between the two groups. Upper and lower body strength significantly increased in the WRT group by 13% and 14%, respectively, while strength did not change in the W group. We did not reach the 60-70% of 1-RM training intensity that we anticipated at the start of the study. On average, those in the WRT group who completed the intervention completed 12 repetitions for each exercise and trained at 56.0 ± 5.7% of their initial 1-RM for upper body and 60.7 ± 8.2% of their initial 1-RM for lower body. Over the 12 weeks, the actual RT intensity was progressed from 50.9 ± 6.1 to 60.6 ± 5.7% of initial 1-RM in the upper body, and from 51.7 ± 6.5 to 68.6 ± 10.4% of initial 1-RM in the lower body. Adherence to RT, defined as the completed percentage of the prescribed sessions per week, was 96% in women who completed the study. No individual missed more than 3 of her 24 training sessions.

Paragraph Number 19 Three-day diet records showed no changes in average energy intake or percentage of intake from fat or carbohydrate for the two groups. There was a significant time effect for protein intake ($F_{(1, 42)}=5.717, p≤0.05, ES=0.12$). The WRT group had a significant increase in the percentage of intake from protein and the W group had no change in protein consumption.
Cardiovascular Disease Risk Factors

Paragraph Number 20 Table 2 also presents the effects of both interventions on CVD risk factors. There were no interactions for any of these measures. There were significant time effects for HbA$_{1c}$ ($F_{(1,41)}=4.663$, $p\leq0.05$, ES=0.10), mean blood glucose calculated from HbA$_{1c}$ ($F_{(1,41)}=4.663$, $p\leq0.05$, ES=0.10), and fibrinogen ($F_{(1,42)}=4.266$, $p\leq0.05$, ES=0.09). When the groups were analyzed separately, the WRT group significantly decreased from pre- to post-intervention in HbA$_{1c}$ (5.9 ± 1.2 to 5.6 ± 1.0%) and mean blood glucose calculated from HbA$_{1c}$ (122 ± 39 to 114 ± 32 mg/dL). There were no changes in these two parameters for the W group. Fibrinogen significantly increased in the WRT group from 499 ± 123 to 538 ± 129 mg/dL. Neither intervention had a significant effect on systolic or diastolic blood pressure, HDL, TG, total cholesterol, or CRP. There were no significant correlations between the changes in steps day$^{-1}$ or changes in strength and blood pressure, HDL, TG, HbA$_{1c}$, mean glucose, CRP, or fibrinogen.

Paragraph Number 21 When separate analyses were done for just the subjects who completed the study (W: $n=17$; WRT: $n=15$), there were no changes compared to the results of the intention-to-treat analyses for steps day$^{-1}$, strength, body composition variables, and CVD risk factors. All significant interactions and findings were consistent in both analyses for these measures.

DISCUSSION

Paragraph Number 22 The current study was the first to evaluate the combined effects of a lifestyle walking program and low intensity RT on CVD risk factors in AA women. Our findings suggest that pedometer-based interventions can be a successful method for significantly improving lifestyle physical activity in this population. Additionally, the WRT group was
successful in significantly increasing both upper and lower body strength, despite the low intensity nature of the protocol. The significant reductions in waist circumference, total fat mass, and gynoid fat mass in the WRT group that occurred with only moderate increases in steps day⁻¹ and strength, could have significant health implications if the prescribed exercise is maintained over time. Okosun et al. (29) showed that waist circumference was positively correlated with plasma glucose, fasting insulin, TG, systolic and diastolic blood pressure, total cholesterol, and total cholesterol/HDL ratio in black and white women and men. In addition, positive health benefits have been shown when reductions in waist circumference are achieved (15, 42). The small, but significant pre-to post-intervention improvements in percent body fat in the WRT group may also have a beneficial long-term effect on CVD risk.

**Paragraph Number 23** The significant pre-to post-intervention decreases in HbA₁c and mean blood glucose calculated from HbA₁c in the WRT group aligns with previous studies where HbA₁c was improved by RT (8, 9, 42). In fact, upon a review of the literature, HbA₁c appears to be the only CVD risk factor variable of those investigated in the current study that has been consistently shown to improve with chronic RT. A larger improvement in HbA₁c may have been seen in our study if baseline values were higher. Our subjects were excluded if they had uncontrolled diabetes, so the majority the subjects’ glucose levels were near normal or were being controlled. The mean blood glucose value calculated from HbA₁c was used in the analyses to provide a more comprehensive indication of the subjects’ blood glucose control throughout the intervention.

**Paragraph Number 24** Previous studies in overweight and obese subjects that evaluated steps day⁻¹ and CVD risk factors found improvements in body composition and several risk factors with increases in steps day⁻¹ after pedometer-based walking interventions. Improvements were shown in body weight (26, 36), BMI (10, 36), waist circumference (10, 36), hip circumference
(36), percent body fat and fat mass (36), systolic (26, 40) and diastolic blood pressure (40), glucose tolerance (40), HDL (36), and resting heart rate (10). Subjects in these studies increased their walking by 3,451 to 5,275 steps day\(^{-1}\), resulting in average daily step counts ranging from 9,213 to 10,480 steps day\(^{-1}\). Many of these improvements were observed in as little as 8 to 12 weeks.

**Paragraph Number 25** Wilson et al. (45) found improvements in systolic blood pressure, body weight, BMI, waist and hip circumferences, and percent body fat in middle-aged, obese AA female breast cancer survivors after an eight-week intervention that significantly increased walking from 4,791 to 8,297 steps day\(^{-1}\). This is similar to the number of steps day\(^{-1}\) achieved in our subjects who completed the study (W: 5480 ± 2162 to 7528 ± 2046; WRT: 4833 ± 1820 to 7412 ± 1728 steps day\(^{-1}\)), however, the Wilson et al. (45) subjects increased their steps by a larger margin. Like the current study, Schneider et al. (36) were challenged in their effort to get obese subjects to adhere to the 10,000 steps day\(^{-1}\) goal, but found that those who did had a more positive improvement in outcome measures, particularly in body composition variables. Their non-adherers (50% of those who completed the study) significantly increased steps from 5,133 ± 1,268 to 7,605 ± 1,290 steps day\(^{-1}\), also similar to the completers of the current study. The above results and those of the current study suggest that sedentary, obese adults, 10,000 steps day\(^{-1}\) could be the threshold for significant CVD and body composition benefits; however, it may not be immediately feasible. Future interventions in overweight and obese AA women may be more successful in getting subjects to achieve ≥10,000 steps day\(^{-1}\) by introducing the step increases more gradually over a longer period of time, and by incorporating more accountability into the program such as weekly laboratory check-ins or supervised group walks.
**Paragraph Number 26** Previous RT studies that had larger strength increases showed greater improvements in CVD risk factors. Cauza et al. (9) reported a 28.9% and 47.8% increase in bench press and leg press 1-RM values, respectively, and showed a significant improvement in HbA1c, blood glucose, insulin resistance, HDL, and TG in a sample of diabetic, obese women and men after a 15-week RT program. However, baseline values for HbA1c, blood glucose, and TG were notably higher in these subjects compared to those of the current study. Fencki et al. (15) showed significant improvements in BMI, waist circumference, fasting glucose, systolic and diastolic blood pressure, and TG in middle-aged, obese women after 12 weeks of RT. Except for TG which were higher in the Fencki study, all CVD risk factor variables in this population at baseline were similar to those of the current study, however, specific strength increases were not reported. Subjects in both studies trained three days week⁻¹.

**Paragraph Number 27** Our results and those of previous studies in obese populations (36, 45) suggest that a 10,000 steps day⁻¹ physical activity prescription may be too aggressive initially for sedentary individuals. However, the 96% adherence to the RT sessions (in the women who completed the study) suggests that RT may be an effective method to improve CVD risk factors over time. In the event that body weight is hindering obese individuals from taking up ambulatory activities, this population may benefit from adopting a RT program first to stimulate positive body composition changes, then incorporating ambulatory activities later to maximize CVD risk factor improvements. RT may also be more appealing and promote a greater feeling of success (11) compared to cardiovascular-based training, as improvements in maximal strength can occur faster than those in maximal aerobic capacity (9). Sedentary, obese, or aging individuals, or those with orthopedic or other clinical limitations may also find that RT is an
attractive mode of exercise to adopt in an effort to improve CVD risk, as it requires little impact or ambulation and can promote self-efficacy and psychological well-being (11).

**Paragraph Number 28** Our study adds a novel aspect by evaluating both an anti-inflammatory and a pro-thrombotic marker for CVD by measuring CRP and fibrinogen, respectively. Despite the fact that baseline CRP for both groups was above normal (>3.0 mg/L; 27), there were no changes detected for either group at the completion of the intervention. A study by Pieroni et al. (33) stratified a sample of blood donors by BMI to examine CRP values and found significant increases in CRP as BMI increased. When comparing our sample to patients of similar age and BMI from the Pieroni et al. (33) study, mean CRP values in our sample were slightly higher (4.34 ± 2.91 vs. 3.46 ± 2.76 mg/L). Both of our intervention groups had increases in fibrinogen, however, the increase observed in the WRT group was significant. Banz et al. (6) found similar results showing a significant increase in fibrinogen after 10 weeks of RT in middle-aged, android-obese men. Those authors speculated that one reason for this increase may have been due to taking the measurement too soon after the last exercise session (~72 hours), eliciting an acute elevation. This was not likely a factor in the current study as all subjects underwent post-testing ≥72 hours after their final RT session, with most post-tests occurring within five to seven days. The significant fibrinogen increase in the current study is more bothersome than that found by Banz et al. (6) because the AA women in the current study had initial values that were already above the recommended values (≥350 mg/dL; 21), placing them at a higher risk for CVD at baseline. The only speculation that we can offer for the fibrinogen increase in WRT subjects is the significant increase in protein consumption, as there is evidence that following a vegan diet (i.e. low protein) for as little as three weeks significantly decreases fibrinogen levels (19).

Research on the effects of diet and exercise, particularly RT, on fibrinogen is lacking overall and
non-existent in AA women. More studies are needed to evaluate whether or not a fibrinogen increase occurs consistently after chronic RT exercise and should include simultaneous monitoring of diet. The lack of research on the effects of RT on inflammatory and thrombotic markers in general makes it difficult to draw a definitive conclusion as to whether or not the current findings are typical for AA women, or whether or not RT of a greater intensity and/or duration of longer than 12 weeks may eventually lead to improvements in either measurement. Further research is needed in order to identify any patterns that may exist in RT-induced changes in inflammatory and thrombotic markers.

**Paragraph Number 29** Some limitations of this study need to be addressed. A power analysis to determine effect size was calculated for fasting blood glucose (15). This variable was chosen as previous studies have shown that RT consistently improves fasting glucose. With an effect size of 0.55 and alpha set at 0.05, this calculation predicted that 21 subjects per group were needed for a power of 70% and 26 subjects per group were needed for a power of 80% (25). Due to the smaller number of subjects in each group, the effect size was not reached and may have affected the results. The results of this study were also limited because only 4 of the 32 subjects who completed either intervention actually reached the goal of 10,000 steps day⁻¹ (three subjects in the W group and one subject in the WRT group). This made it difficult to clearly define the potential benefits of the intervention and likely decreased the expected CVD risk improvements. Although step goal prescriptions were progressed individually based on each subject’s baseline activity, all subjects were prescribed 10,000 steps day⁻¹ no later than the beginning of week five. Therefore, subjects with lower baseline step measures may have been asked to increase their activity by as much as 8,000 steps day⁻¹ within 4 weeks, an aggressive prescription. Regardless, the intervention was successful in initiating a significant physical activity behavior change in AA women.
Paragraph Number 30  The current study met for RT only twodays week\(^{-1}\) in an effort to minimize the time commitment and dropout rate, as subjects were simultaneously asked to adopt a walking program into their lifestyle. Twodays week\(^{-1}\) is also the minimum recommended frequency for RT prescribed by the American College of Sports Medicine (41). Post-intervention analyses revealed that subjects who completed the study lifted a lower intensity (56.0 ± 5.7% and 60.7 ± 8.2% of their 1-RM for chest press and leg extension exercises, respectively) than the study goal of 60-70% of 1-RM. The RT intensities achieved were also lower than those achieved in previous studies which found significant improvements in several of the same CVD risk factors that were measured in the current study (9, 15). Investigators and trainers found that subjects, most of which had never trained with weights previously, felt more comfortable completing a higher number of repetitions with a lighter weight load, compared to less repetitions with a great amount of weight. The current study’s strength increases were not as pronounced as those achieved in other investigations, suggesting that the RT stimulus of the current study did not appear to be large enough to promote changes in many of the CVD risk factors that were measured. It seems that a threshold of strength gains or improvement of muscle quality is needed before changes in CVD risk factors are achieved. Future research on the effects of RT combined with pedometer-based ambulation on CVD risk factors in AA women should focus on the attainment of the 10,000 steps day\(^{-1}\) threshold and include higher-intensity RT protocols for maximum benefits. Alternatively, future interventions of lower intensities, such as ours, may achieve more CVD risk factor benefits if they are longer in duration.

Paragraph Number 31  The non-supervised approach in the W group compared to the twice weekly contact provided through the RT sessions in the WRT group could have affected the study outcomes, however, with the exception of an increased consumption of protein in the WRT
group, there is no statistically significant data to support this assumption. Although our
pedometers did not quantify walking intensity, our aim was for subjects to carry out their typical
daily routine and focus on increasing overall ambulation (i.e. steps day$^{-1}$) through lifestyle
changes, especially since the walking portion of the intervention was unsupervised. We also
wanted to encourage physical activity awareness by helping subjects develop the habit of
recording and interpreting their physical activity levels daily. The lower energy intake in the
WRT group may raise the question of its contribution to the significant improvements in body
composition and glucose control, however, results of the intention-to-treat analysis revealed no
significant interaction ($p=0.230$) or time effect ($p=0.230$) for energy intake. Our groups were not
matched for energy expenditure, so differences in the two protocols may not be directly
attributed to RT. In lieu of a non-active control group, we chose to match the walking
prescription in both groups in order to isolate the effects of the RT. As we had hoped, both
groups increased walking to the same extent essentially providing an “active” control group.

**Paragraph Number 32** In summary, both interventions increased steps day$^{-1}$, but WRT was more
effective in improving several body composition measures and glucose control in 12 weeks.
WRT may be an important addition to a lifestyle intervention aiming to facilitate reductions in
CVD risk factors in overweight and obese AA women. Since there was no significant difference
in steps day$^{-1}$ between the two intervention groups at baseline, and both groups increased their
steps by a similar margin, these results suggest that the incorporation of RT could play a role in
the reduction of abdominal obesity in AA women. Even though some of the blood variables for
CVD risk were not affected by the 12-week WRT program, these results did show that
improvements in body composition variables can be achieved in 12 weeks. The improvement in
body composition variables, particularly waist circumference, suggests that...
improvements in CVD risk factor blood variables may occur given a longer period of time. AA women should be a population of priority in future intervention research as they are particularly vulnerable to the development of MetS in that they appear to be more susceptible to several of the individual CVD risk factors comprising MetS. In addition, AA women continue to be shown as a physically inactive group, a critical contributor to the development of obesity and many CVD risk factors. As physical inactivity is modifiable, adopting an active lifestyle could prevent pharmacological intervention and protect or improve the quality of life in those at-risk for CVD or other CVD-related chronic diseases.

ACKNOWLEDGEMENTS

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REFERENCES


38. Schuler PB, Marzilli TS, Kozusko J. Effect of five weeks of strength and flexibility training on associations between self-reported and performance-based measures of...


Table 1: Descriptive characteristics and comparison of body composition variables (N=44).

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>W (n=25)</th>
<th>WRT (n=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>49.2 ± 6.1</td>
<td>48.7 ± 5.0</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.65 ± 0.06</td>
<td>1.63 ± 0.05</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>100.0 ± 21.4</td>
<td>100.0 ± 21.1</td>
</tr>
<tr>
<td>BMI (kg m(^{-2}))</td>
<td>36.5 ± 7.6</td>
<td>36.5 ± 7.5</td>
</tr>
<tr>
<td>Waist Circumference (cm)(^x)</td>
<td>99.3 ± 12.1</td>
<td>99.3 ± 11.8</td>
</tr>
<tr>
<td>Hip Circumference (cm)</td>
<td>124.7 ± 16.2</td>
<td>124.0 ± 15.6</td>
</tr>
<tr>
<td>Body Fat (%)</td>
<td>45.8 ± 5.8</td>
<td>45.6 ± 5.9</td>
</tr>
<tr>
<td>Android Fat (%)</td>
<td>56.0 ± 6.1</td>
<td>55.9 ± 6.1</td>
</tr>
<tr>
<td>Gynoid Fat (%)</td>
<td>53.9 ± 7.4</td>
<td>53.9 ± 7.3</td>
</tr>
<tr>
<td>Trunk Fat (%)</td>
<td>49.4 ± 6.2</td>
<td>49.3 ± 6.3</td>
</tr>
<tr>
<td>Total Fat Mass (kg)(^x)</td>
<td>46.4 ± 14.8</td>
<td>46.3 ± 14.8</td>
</tr>
<tr>
<td>Android Fat Mass (kg)</td>
<td>4.4 ± 1.7</td>
<td>4.4 ± 1.6</td>
</tr>
<tr>
<td>Gynoid Fat Mass (kg)(^x)</td>
<td>8.7 ± 3.0</td>
<td>8.7 ± 3.0</td>
</tr>
<tr>
<td>Trunk Fat Mass (kg)</td>
<td>25.6 ± 9.2</td>
<td>25.7 ± 9.4</td>
</tr>
<tr>
<td>Total Lean Mass (kg)</td>
<td>49.8 ± 6.9</td>
<td>50.2 ± 6.6</td>
</tr>
</tbody>
</table>

Values are mean ± SD.
\(^x\)Significant interaction between groups (p≤0.05).
*Significant change from pre- to post-intervention (p≤0.05).
W=walking group; WRT=walking plus resistance training group; BMI=body mass index.
Table 2: Comparison of steps day\(^1\), strength, dietary factors, and cardiovascular disease (CVD) risk factors (N=44).

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>PRE</th>
<th>POST</th>
<th>PRE</th>
<th>POST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Activity, Strength, &amp; Diet</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steps day(^1)</td>
<td>5453 ± 2119</td>
<td>6845 ± 2279*</td>
<td>4823 ± 1758</td>
<td>6859 ± 2012*</td>
</tr>
<tr>
<td>Upper Body Strength (kg)(^¥)</td>
<td>102 ± 17</td>
<td>103 ± 16</td>
<td>100 ± 15</td>
<td>113 ± 18*</td>
</tr>
<tr>
<td>Lower Body Strength (kg)(^¥)</td>
<td>105 ± 24</td>
<td>105 ± 25</td>
<td>102 ± 20</td>
<td>116 ± 25*</td>
</tr>
<tr>
<td>Energy Intake (kcals day(^-1))</td>
<td>1896 ± 583</td>
<td>1896 ± 569</td>
<td>1794 ± 485</td>
<td>1612 ± 488</td>
</tr>
<tr>
<td>Daily Intake from Fat (%)</td>
<td>34.1 ± 5.4</td>
<td>33.9 ± 4.4</td>
<td>35.0 ± 4.4</td>
<td>35.1 ± 3.6</td>
</tr>
<tr>
<td>Daily Intake from Carbohydrate (%)</td>
<td>48.2 ± 10.0</td>
<td>44.2 ± 9.7</td>
<td>48.5 ± 6.7</td>
<td>47.4 ± 8.6</td>
</tr>
<tr>
<td>Daily Intake from Protein (%)</td>
<td>17.5 ± 4.3</td>
<td>18.7 ± 5.3</td>
<td>16.1 ± 2.6</td>
<td>18.2 ± 3.7*</td>
</tr>
<tr>
<td><strong>CVD Risk Factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg)</td>
<td>126 ± 12</td>
<td>127 ± 15</td>
<td>130 ± 16</td>
<td>131 ± 22</td>
</tr>
<tr>
<td>Diastolic Blood Pressure (mmHg)</td>
<td>84 ± 9</td>
<td>85 ± 10</td>
<td>87 ± 10</td>
<td>85 ± 10</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>36 ± 10</td>
<td>36 ± 10</td>
<td>38 ± 9</td>
<td>38 ± 9</td>
</tr>
<tr>
<td>TG (mg/dL)</td>
<td>97 ± 52</td>
<td>98 ± 40</td>
<td>80 ± 31</td>
<td>88 ± 41</td>
</tr>
<tr>
<td>Total Cholesterol (mg/dL)</td>
<td>209 ± 32</td>
<td>210 ± 34</td>
<td>208 ± 33</td>
<td>212 ± 47</td>
</tr>
<tr>
<td>HbA(_1c) (%)</td>
<td>6.0 ± 1.1</td>
<td>5.9 ± 1.2</td>
<td>5.9 ± 1.2</td>
<td>5.6 ± 1.0*</td>
</tr>
<tr>
<td>Mean Blood Glucose (mg/dL)^</td>
<td>126 ± 36</td>
<td>122 ± 38</td>
<td>122 ± 39</td>
<td>114 ± 32*</td>
</tr>
<tr>
<td>CRP (mg/L)</td>
<td>4.4 ± 2.9</td>
<td>4.5 ± 2.8</td>
<td>4.2 ± 3.0</td>
<td>4.4 ± 3.1</td>
</tr>
<tr>
<td>Fibrinogen (mg/dL)</td>
<td>421 ± 138</td>
<td>445 ± 153</td>
<td>499 ± 123</td>
<td>538 ± 129*</td>
</tr>
</tbody>
</table>

Values are mean ± SD.
\(^¥\)Significant interaction between groups (\(p\leq0.05\)).
*Significant change from pre- to post-intervention (\(p\leq0.05\)).
^Calculated from HbA\(_1c\).
W=walking group; WRT=walking plus resistance training group; HDL=high density lipoprotein cholesterol; TG=triglycerides; HbA\(_1c\)=glycosylated hemoglobin; CRP=C-reactive protein.