AEROBIC EXERCISE IMPROVES CARDIORESPIRATORY FITNESS BUT DOES NOT REDUCE BLOOD PRESSURE IN PREHYPERTENSIVE AFRICAN AMERICAN WOMEN

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Objective: To determine the effectiveness of a 10-week aerobic exercise training intervention on blood pressure, cardiorespiratory fitness, and workload in African American women with prehypertension.

Design: After we obtained informed consent and medical clearance, each participant underwent baseline measurements, an aerobic exercise-training regimen, and postintervention assessments.

Setting: This investigation took place in Columbus, Ohio, on the campus of The Ohio State University.

Participants: Twelve sedentary African American women with prehypertension volunteered to participate.

Interventions: Study participants trained three days per week for 30 minutes per session at an intensity of 70% maximal oxygen consumption ($VO_{2\ peak}$) for 10 weeks.

Main Outcome Measures: Blood pressure, cardiorespiratory fitness, and workload achieved.

Results: Exercise training resulted in a significant improvement in cardiorespiratory fitness and workload capacity. However, no significant reductions in blood pressure were seen after the 10-week aerobic exercise period.

Conclusions: Ten weeks of 30 minutes of aerobic exercise, three times a week at 70% $VO_{2\ peak}$, is a sufficient stimulus to improve cardiorespiratory fitness and workload achieved. However, this exercise regimen was not adequate in eliciting a simultaneous reduction in systolic, diastolic, or mean arterial blood pressure in this cohort of prehypertensive African American women. Additional studies are needed to determine specific exercise protocols that would be effective in lowering blood pressure in various populations. These exercise protocols may vary across ethnicity, sex, and disease status. (*Ethn Dis*. 2007;17:55–58)

Key Words: Blacks, Cardiovascular Health, Hypertension, Minorities, Physical Activity

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INTRODUCTION

Recently, the Joint National Committee (JNC) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure identified a new blood pressure category termed prehypertension. Prehypertension, formerly considered a ''normal'' blood pressure, is associated with an increased risk of developing full-scale hypertension (HTN) and associated co-morbidities. Prehypertension is defined as systolic (SBP) of 120–139 mm Hg or diastolic (DBP) of 80–89 mm Hg and indicates an increased need for frequent followup and lifestyle modifications.[1] Hypertension and prehypertension currently affect nearly 60 million Americans and close to one billion people worldwide. The prevalence of hypertension and perhypertension among African American women (45%) is higher than among Caucasian and Mexican American women (25% and 29%, respectively).[2] The JNC has recommended several behavioral interventions that include consistent physical activity as a treatment for HTN.[1] Structured physical activity is an effective nonpharmacologic intervention to improve cardiovascular health and slow the progression of chronic illnesses, such as hypertension.[3] In 1998, Duey et al[4] concluded that a consistent aerobic exercise-training regimen was effective in improving cardiorespiratory fitness (maximal oxygen consumption, or $VO_{2\ peak}$) in African American women. Additionally, in a cohort of 215 obese African Americans, Randall et al found that aerobic exercise resulted in significant reductions in SBP (7 mm Hg) and pulse pressure (5 mm Hg).[5] Although these studies support the hypothesis that aerobic exercise is an effective treatment in African Americans, no studies have identified the effects of an exercise program in persons classified as prehypertensive. Therefore, the purpose of this investigation was to determine the effectiveness of a 10-week aerobic exercise-training regimen on resting blood pressure, cardiorespiratory fitness, and workload in prehypertensive African American women. We hypothesized that this intervention would significantly reduce blood pressure levels while increasing aerobic capacity and workload achieved.

Hypertension and prehypertension currently affect nearly 60 million Americans and close to one billion people worldwide.

METHODS

Subjects

Twelve sedentary, African American women volunteered to participate. A power analysis revealed that an N of 10 would be sufficient to detect differences in blood pressure and fitness-related variables as a result of exercise training. Subjects were required to meet the following inclusionary criteria: African American woman, 30–45 years of age, body mass index (BMI) 25–35 kg/m^2,

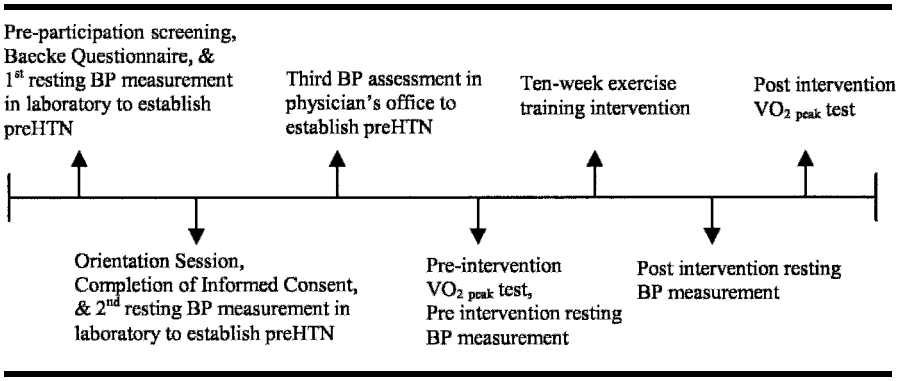

Figure 1. Progression of study participants through intervention

nonsmoking status, sedentary, free from medication use, absence of known disease, and prehypertensive blood pressure status. Each participant was screened to assure that she met all inclusionary criteria and completed the Baecke Physical Activity Questionnaire to determine her initial physical activity level.[6] Additionally, subjects were required to attend an orientation session and provide informed consent before participating in the study. (Figure 1) This investigation was approved by The Ohio State University Institutional Review Board.

Establishing Prehypertension

To establish prehypertension, resting blood pressure was taken on three different occasions. An experienced and certified exercise specialist took two resting blood pressure measurements in the exercise physiology laboratory before beginning the 10-week exercise-training intervention. A third resting blood pressure assessment was also done in a physician's office before the exercise regimen. Participants were classified as prehypertensive if two of the three blood pressure measurements, one of which was taken in the physician's office, was SBP 120–139 mm Hg or DBP 80–89 mm Hg.

Blood Pressure Assessments

Blood pressure was measured by using a calibrated mercury sphygmomanometer and an appropriate size cuff (Gen-Med, American Diagnostic Group, New York, NY). Subjects were seated for five minutes with their arms supported at heart level and their feet flat on the ground before each blood pressure assessment. All blood pressure measurements were taken in the subject's dominant arm. A certified American College of Sports Medicine exercise specialist manually measured all resting blood pressures. Blood pressure measurements were conducted before and after the intervention with identical methods.

Cardiorespiratory Fitness Assessment

To determine each subject's initial cardiorespiratory fitness level and workload ability, a $VO_{2\ peak}$ test was conducted on an electrically braked cycle ergometer (Cybex, Divison of Lumex Ronkonkoma, NY). The cycling protocol began with a work rate of 25 watts, which increased an additional 25 watts every two minutes until the test ended. The test was terminated when subjects could not maintain the prescribed pedal rate of 60 rpm, reached volitional fatigue, or demonstrated a plateau in VO_2 with an increase in workload. The $VO_{2\ peak}$ value was measured as the highest value reached during the last minute of exercise based on 15-second readings. The maximal workload achieved was measured as the highest wattage that the subject reached before the test was terminated. During the $VO_{2\ peak}$ test, indirect calorimetry with the True One Metabolic System (OUSW version 3.5, East Sandy, Utah) was used to measure VO_2 and associated variables. Before each test, gas and flow meter calibrations were done to maintain equipment equilibration and measuring sensitivity (Parvo MMS-2400, Computer/DAC & Adapter PCL 177B, East Sandy, Utah).

Aerobic Exercise Training Intervention

The exercise training protocol required each participant to attend three supervised, 30-minute sessions per week for 10 consecutive weeks. Each training session took place in The Ohio State University exercise physiology training facility. Subjects were free to select any preidentified time slot to complete all of their sessions. The training facility was available six days per week from 6:30 am to 6:30 pm. Because schedules varied, most participants trained without other research participants present. A standardized exercise prescription was developed for each subject based on results from her pretraining cardiorespiratory fitness test. The initial training intensity was 70% of each individual's previously determined $VO_{2\ peak}$ value and was progressively increased by 5% every 2.5 weeks (Table 1) to match the physiologic cardiovascular adaptation expected to occur with exercise training. In order to maintain a relative intensity of 70%, training increases were based on each subject's initial $VO_{2\ peak}$ value.[7,8] During each training session, subjects wore a Polar heart rate monitoring unit (Polar Electro Inc., Polar 8A1, Woodbury, NY) and were frequently asked to rate their perceived exertion to ensure that the appropriate training intensity was being maintained. Additionally, subjects were verbally encouraged to exert their best effort to remain within the prescribed training intensity. All exercise sessions were monitored by an experienced and trained member of the exercise physiology laboratory staff. To further promote consistency and accuracy among the

Table 1. Example exercise training protocol

Subject ID #:	000	Wt: 180 lbs			
Pre $VO_{2\ peak}$	20.1 mL kg^{-1} min^{-1}				
70% $VO_{2\ peak}$	14.1 mL kg^{-1} min^{-1}	75% $VO_{2\ peak}$	15.1 mL kg^{-1} min^{-1}		
80% $VO_{2\ peak}$	16.1 mL kg^{-1} min^{-1}	85% $VO_{2\ peak}$	17.1 mL kg^{-1} min^{-1}		
Mode of Exercise	**Intensity**	**Week of Training**	**Speed**	**Incline**	**Wattage**
Treadmill	70%	1–2 wks	2.5 mph	3.2%	
Bike	70%	1–2 wks			53 watts
Treadmill	75%	3–5 wks	3.0 mph	2.4%	
Bike	75%	3–5 wks			61 watts
Treadmill	80%	6–8 wks	3.4 mph	2.1%	
Bike	80%	6–8 wks			68 watts
Treadmill	85%	9–10 wks	3.8 mph	1.8%	
Bike	85%	9–10 wks			76 watts

$VO_{2\ peak}$=cardiorespiratory fitness.

Table 2. Baseline physical characteristics of participants (*N*=12)

Characteristic	Value
Age (years)	38.2 ± 1.5
Weight (kg)	86.9 ± 10.7
Height (inches)	65.6 ± .82
Body mass index (kg/m^2)	30.8 ± 1.1
Physical activity status	5.8 ± .27

All values presented as the mean ± standard error.

training sessions, an exercise log was completed and signed by all laboratory staff after each exercise session. The modes of exercise used during the training sessions were the treadmill, cycle ergometer, and air-dyne cycle.

STATISTICS

To assess the effectiveness of our exercise program on cardiorespiratory fitness and resting blood pressure, before and after the intervention period, a Wilcoxon signed rank test was used. A *P* value ≤.05 was set to establish statistical significance. All statistical analyses were conducted with the SPSS statistical package (Windows version 13.0).

RESULTS

Physical characteristics of the subjects are presented in Table 2. No significant differences were seen in SBP, DBP, mean arterial pressure (MAP), or body weight before and after exercise training (Table 3). Our results did show a significant increase in cardiorespiratory fitness (Fig. 2) and workload (Fig. 3) after the intervention.

DISCUSSION

The major findings of this study indicate that a 10-week aerobic exercise training protocol of 30-minute sessions at 70% of the $VO_{2\ peak}$ three days per week is a sufficient stimulus to improve cardiorespiratory fitness and workload. However, this exercise regimen was not sufficient to reduce blood pressure in this cohort of prehypertensive, African American women. These results suggest that the amount and level of exercise required to improve cardiorespiratory fitness/workload and reduce blood pressure are not necessarily the same. According to Fattirolli et al[9] improvements in cardiorespiratory fitness are easy to achieve in low-fit individuals with only mild-to-moderate levels of exercise. However, improvements in health-related variables, like blood pressure, seem to require specific exercise guidelines in order to be effective. Although a relationship between exercise and health benefits has been identified in the literature, little is known about the optimal level of exercise required to improve specific health conditions, which may partially account for the lack of blood pressure reductions seen in the present study.[10,11] Systolic blood pressure (SBP) tended to decrease; however, the de-

Table 3. Hemodynamic measurements before and after the intervention

Hemodynamic Measurement	Before	After
Systolic blood pressure (mm Hg)	127 ± 3	122 ± 3
Diastolic blood pressure (mm Hg)	83 ± 1	82 ± 2
Mean arterial pressure (mm Hg)	97 ± 2	93 ± 3
Body weight (lbs)	191 ± 11	193 ± 10

All values presented as the mean ± standard error (*P*<.05).

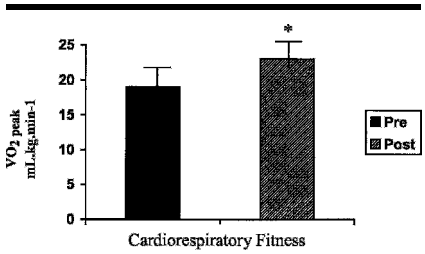

Figure 2. Cardiorespiratory fitness before and after exercise training intervention

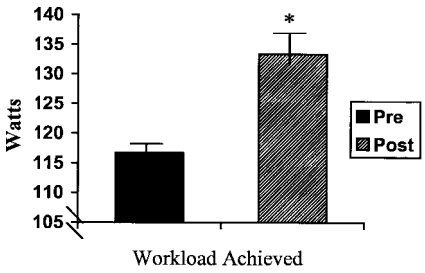

Figure 3. Workload achieved before and after the exercise training intervention

The lack of change in body weight and blood pressure in our study could suggest that exercise training that does not result in decreases in body weight is not an effective treatment to lower blood pressure in obese, prehypertensive, African American women.

crease did not reach statistical significance. This trend may have clinical relevance and suggests that an increased level of exercise may be needed to significantly reduce prehypertensive blood pressure.

Several studies have shown that blood pressure is positively affected by the combined action of diet and exercise.[12] We assessed each subject's dietary patterns with a four-day food recall and found no significant difference before and after the intervention. However, we did not advise, monitor, or restrict our subject's eating habits during the course of the study, and the effects of exercise to decrease blood pressure may be diminished by diets high in salt.[13]

Our subjects did not lose weight as a result of the exercise protocol. Obesity contributes to hypertension and often confounds the effects of exercise training and other preventive interventions.[14] The lack of change in body weight and blood pressure in our study could suggest that exercise training that does not result in decreases in body weight is not an effective treatment to lower blood pressure in obese, prehypertensive, African American women.

Our findings may have been limited by small sample size, extremely low fit and overweight subject population, and absence of dietary monitoring/control. We conclude that "one size does not fit all" when using exercise to enhance fitness and concurrently reduce elevated blood pressure levels. Instead, exercise interventions must specifically address ethnicity, fitness level, and disease status in order to be effective.

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Manuscript draft: Stephens, Kirby, Devor
Statistical expertise: Kirby
Acquisition of funding: Stephens, Kirby, Buckworth
Administrative, technical, or material assistance: Kirby, Hamlin
Supervision: Stephens, Kirby, Buckworth, Devor, Hamlin