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Aerobic exercise training without weight loss reduces dyspnea on exertion in obese women

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ABSTRACT

Dyspnea on exertion (DOE) is a common symptom in obesity. We investigated whether aerobic exercise training without weight loss could reduce DOE. Twenty-two otherwise healthy obese women participated in a 12-week supervised aerobic exercise training program, exercising 30 min/day at 70–80% heart rate reserve, 4 days/week. Subjects were grouped based on their Ratings of Perceived Breathlessness (RPB) during constant load 60 W cycling: +DOE (n = 12, RPB $\geq$ 4, 37 ± 7 years, 34 ± 4 kg/m^2) and –DOE (n = 10, RPB $\leq$ 2, 32 ± 6 years, 33 ± 3 kg/m^2). No significant differences between the groups in body composition, pulmonary function, or cardiorespiratory fitness were observed pre-training. Post-training,peak was improved significantly in both groups (+DOE: 12 ± 7, –DOE: 14 ± 8%). RPB was significantly decreased in the +DOE (4.7 ± 1.0–2.5 ± 1.0) and remained low in the –DOE group (1.2 ± 0.6–1.3 ± 1.0) (interaction $p < 0.001$). The reduction in RPB was not significantly correlated with the improvement in cardiorespiratory fitness. Aerobic exercise training improved cardiorespiratory fitness and DOE and thus appears to be an effective treatment for DOE in obese women.

1. Introduction

Obesity rates have been rising to epidemic levels worldwide. In the United States alone, two third of adults are currently classified as overweight or obese (Yang and Colditz, 2015). Obesity is associated with numerous health problems, including type 2 diabetes, hypertension, stroke and heart attacks, sleep disordered breathing, and respiratory disorders (Azagury and Lautz, 2011; Kenchaiah et al., 2002; Van Gaal et al., 2006). Health care providers must decide whether obesity is a contributor or confounder of patient symptoms.

A common symptom of obesity is dyspnea on exertion (DOE), or the feeling of shortness of breath associated with even low intensity exercise (Gibson, 2000; O'Donnell et al., 2010; Sin et al., 2002; Wasserman, 1982). Approximately one-third of otherwise healthy women and men experience a heightened intensity of DOE during submaximal constant load cycling exercise of ~4 METs (Babb et al., 2008; Bernhardt and Babb, 2014a; Bernhardt et al., 2013). DOE and breathing discomfort in the obese individual are major barriers to physical activity and thus in the management of obesity.

Recommendations for obesity interventions typically include weight loss combined with aerobic exercise training (Anon., 1998; Donnelly et al., 2009). We recently demonstrated that moderate weight loss without aerobic exercise training was effective in reducing DOE in otherwise healthy obese women (Bernhardt and Babb, 2014b). It was still unknown if, conversely, aerobic exercise training without concomitant weight loss could produce similar effects. Aerobic exercise training improves cardiorespiratory fitness and exercise capacity, which in turn could reduce DOE. Exercise is Medicine® is a global health initiative that was put into place by the American College of Sports Medicine (ACSM) to encourage physical activity as an integral part in the prevention and treatments of diseases (ACSM, 2015). Thus, understanding if and how exercise could alleviate DOE in obese individuals is of critical clinical importance.

The main objective of this study was to investigate whether aerobic exercise training via a 12-week exercise program could reduce DOE in otherwise healthy, obese women who experienced DOE at baseline. A secondary objective was to investigate whether changes in cardiorespiratory fitness were associated with the potential reduction in DOE. We hypothesized that aerobic exercise training without weight loss would not significantly reduce DOE in the obese women as we expected no significant changes in body com-

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position, fat distribution, and/or pulmonary function, and we have not found obese subjects to be deconditioned (Lorenzo and Babb, 2011).

2. Methods

2.1. Subjects

Twenty-two obese women participated in the pre-post intervention study. Subjects were initially identified based on BMI ($\geq 30 \leq 50$ kg/m^2), and level of obesity was confirmed by hydrostatic weighing (≥ 30 total body fat $\leq 55\%$). Exclusion criteria included history of smoking, asthma, cardiovascular disease, sleep disorders, or musculoskeletal abnormalities that would preclude maximal exercise. Subjects participating in regular exercise (i.e., exercise more than 2×/week) during the last 6 months were also excluded. Written informed consent was obtained before participation in accordance with the UT Southwestern IRB (STU122010-108). Some data have been previously published in abstract form (Bernhardt et al., 2015).

All participants underwent the same testing procedures before and after a 12-week aerobic exercise training program. Testing was performed on four separate visits each before and after the intervention as previously described (Bernhardt and Babb, 2014b). Additional detail on the methods is provided in an online data supplement.

2.2. Visit 1—body composition and pulmonary function

Visit 1 included body composition measurements via hydrostatic weighing as well as spirometry, lung volume, and diffusing capacity determinations via whole body plethysmography (model V62W, SensorMedics) according to ATS/ERS guidelines (Anon, 1995).

2.3. Visit 2—exercise testing

On visit 2, subjects completed a submaximal constant load cycling exercise at 60 W and a graded maximal cycling test.

2.3.1. Submaximal constant load exercise at 60 W

After 3 min of resting baseline measurements, subjects pedaled at 60 W for 6 min (Lode Corival). During minute 6, Ratings of Breathlessness (RPB, Borg scale 0–10) and Ratings of Perceived Exertion (RPE, 6–20) were collected (Borg, 1982). Cardiorespiratory responses, including heart rate (HR), respiratory exchange rate (RER), ventilation ($\dot{V}_E$), and gas exchange ($\dot{V}O_2$ and $\dot{V}CO_2$) were measured at rest and throughout exercise.

2.3.2. Peak cardiovascular exercise capacity

Graded maximal cycling test was used to determine peak cardiovascular exercise capacity, $\dot{V}O_2$ peak. Briefly, the test started with a work rate of 20 W. Subsequently, work rate was increased by 20 W each minute until voluntary termination and/or inability of the subject to maintain pedal cadence above 50 rpm. Maximal effort was evidence by achieving predicted peak HR > 90%, [lactate] > 7 mmol/L, and RER > 1.1.

2.4. Visit 3—Oxygen cost of breathing and submaximal constant load exercise at ~50% of $\dot{V}O_2$ peak

2.4.1. Oxygen cost of breathing

The O_2 cost of breathing was determined from measurements of $\dot{V}O_2$ and $\dot{V}_E$ at rest and during eucapnic voluntary hyperpnea at 40 L/min and 60 L/min as previously described. O_2 cost of breathing was calculated as the slope of the linear regression between whole body $\dot{V}O_2$ (mL/min) vs. $\dot{V}_E$ (L/min) at rest and during the two levels of hyperpnea.

2.4.2. Ratings of Perceived Breathlessness during submaximal constant work rate exercise at ~50% $\dot{V}O_2$ peak

Due to the potential variability in peak aerobic capacity between participants, submaximal constant load cycling at 60 W may represent different relative work rates (i.e., exercise $\dot{V}O_2$ as a percentage of $\dot{V}O_2$ peak). Therefore, all subjects completed an identical exercise protocol to the submaximal constant load exercise at 60 W. However the work rate was individually tailored to elicit approximately 50% of their $\dot{V}O_2$ peak. In order to maintain the relative exercise intensity, work rate at post-testing was set to ~50% of post-$\dot{V}O_2$ peak, due to the altered $\dot{V}O_2$ peak post-intervention.

2.5. Visit 4—Body fat distribution

Multiple T2-weighted, water-suppressed, magnetic resonance images were taken to estimate fat distribution in the chest, abdominal, subcutaneous, visceral, and peripheral regions as previously described (Babb et al., 2008; Lorenzo and Babb, 2011). Images were analyzed using custom interactive software (Wafter 1.3)

2.6. Aerobic exercise training program

Each participant completed a 12-week supervised aerobic exercise training program, consisting of 30-min sessions on 4 days/week at 70–80% heart rate reserve. Participants met with a personal trainer 3 days/week and exercised on their own on the fourth day. Each participant received a heart rate monitor (Polar, Lake Success, NY, USA), was instructed on how to use it during the exercise sessions and was provided with their target heart rate range. Heart rate data were downloaded frequently to assess compliance. In the hopes of increasing adherence to the exercise training program, participants were given the choice of equipment to use (e.g. cycle, elliptical, treadmill, rower, etc.). However, they had to exercise at least 10 min per session on the cycle ergometer, as exercise testing in the lab was performed on the cycle.

All participants were instructed to maintain their initial weight. They weighed in before every exercise session to ensure compliance and were advised on slight diet changes if weight increased or decreased by more than 1 kg. Therefore, any changes observed after completing the aerobic exercise program could be attributed to improvements in cardiorespiratory fitness only, and not to changes in weight.

2.7. Data analysis

The subjects were assigned to one of two groups according to their RPB (0–10 Borg scale) during minute 6 of the constant load exercise at 60 W test as previously described (Bernhardt and Babb, 2014b). Women who rated an RPB ≤ 2 were designated as having no or mild DOE (−DOE, $n = 10$) and those who rated an RPB ≥ 4 were designated as having strong dyspnea on exertion (+DOE, $n = 12$). Women who rated an RPB = 3 were excluded from the study in order to better delineate differences between the +DOE and –DOE groups. This grouping has been used in previous studies (Babb et al., 2008; Bernhardt and Babb, 2014a,b; Bernhardt et al., 2013).

Differences between +DOE and –DOE groups before and after the aerobic exercise training program were analyzed using a two-way ANOVA (i.e., group and exercise training) with a repeated measure on one factor (i.e., exercise training). The correlation between changes in RPB and changes in VO_2 from pre- to post-intervention were analyzed on an individual basis. Data was analyzed using SAS 9.3. Values are presented as mean ± SD.