

## A Pilot Study to Examine the Effects of a Mindfulness-Based Stress-Reduction and Relaxation Program on Levels of Stress Hormones, Physical Functioning, and Submaximal Exercise Responses

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### ABSTRACT

**Objective:** Stress has been cited as a causal factor in heart disease. The objective of this study was to examine the effects of an 8-week mindfulness-based stress-reduction program on the resting levels of stress hormones, physical functioning, and submaximal exercise responses in women with heart disease.

**Subjects:** Random selection with the numbers 1 and 2 were used to assign 18 women ( $60 \pm 6.3$  years old) with documented histories of heart disease to a treatment group ( $n = 9$ ) or a control group ( $n = 9$ ). Spielberger's state anxiety scores for the treatment ( $M = 37.88$ ; standard deviation (SD) = 10.91) and control group ( $M = 43.22$ ; SD = 12.26) were not significantly different prior to the start of the study. However, their scores fell in the upper percentile rank for normal adults in their age category.

**Intervention:** The intervention was provided one night each week for 2 hours over a period of 8 weeks. The intervention included didactic, inductive, and experiential modes of learning regarding stress responses and mindfulness skill-development training.

**Design:** Pre–post test hormonal measurements and physical function were analyzed using a 2 (group) by 2 (time) analysis of variance (ANOVA) with repeated measures following the 8-week program. Submaximal exercise responses were also compared between the treatment group and the control group following the 8-week program. A 2 (group) by 3 (time) ANOVA with repeated measures was used to analyze the data.

**Settings/Location:** Weekly meetings were held on a university medical school campus. Submaximal exercise responses were recorded while participants cycled on a stationary bike in an applied physiology laboratory following the 8-week program.

**Results:** There were no significant main effects or interaction for the resting levels of stress hormones or physical functioning. There were no significant interactions for the submaximal exercise responses, however, there were significant main effects between groups for ventilation [ $F(2,32) = 7.65$ ,  $p < .01$ ,  $f = 0.8$ ], and between group [ $F(1,16) = 8.84$ ,  $p < .01$ ,  $f = 0.8$ ] and time [ $F(2,32) = 10.42$ ,  $p < .01$ ,  $f = 0.9$ ], for breathing frequency.

**Conclusion:** While the 8-week stress reduction program for women with heart disease did not show significant interactions between groups for resting levels of stress hormones, physical functioning, or submaximal exercise responses, there was a significant difference in breathing patterns between the 2 groups during exercise following the mindfulness-based stress-reduction program. There was also a trend for change in the intervention group in the resting levels of cortisol and physical function scores that was not seen in the control group. Future studies could use the effect size generated from this pilot study to calculate the number of subjects needed for adequate power to detect significant differences between groups.

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## INTRODUCTION

Heart disease is the leading health problem in our nation. However, misperceptions still exist that cardiovascular disease does not affect women seriously, even though women account for almost 50% of deaths annually (American Heart Association, 1999). Within 1 year following a heart attack, 43% of women compared to 24% of men will die from this event (American Heart Association, 1999). There is an increased interest in the role that psychologic or emotional stress may play in provoking adverse cardiac events (Frasure-Smith, 1991; Gelernt and Hochman, 1992; Tavazzi et al., 1991; Tofler et al., 1990). Many studies have produced evidence to indicate that women report more psychologic distress than men (Hamilton and Fagot, 1988; McDaniel and Richards, 1990). The cardiovascular system is thought by many researchers to be the primary target end-organ for the stress response (Matthews et al., 1998). A chronically activated stress response results in the release of multiple stress hormones, norepinephrine, epinephrine, cortisol, aldosterone, growth hormone, thyroxin, etc. (Robert-McComb, 2000). High circulating stress hormones have been associated with cardiovascular disease (Robert-McComb, 2000; Seaward, 2002; Tataranni et al., 1996).

Researchers have shown that the practice of relaxation techniques such as yoga, Transcendental Meditation,<sup>TM</sup> and Benson's relaxation response (Benson et al., 1978) alters resting physiologic responses associated with the stress response such as oxygen consumption ( $\dot{V}O_2$ ), carbon-dioxide production, heart rate (HR), systolic blood pressure, breathing frequency ( $f_b$ ), tidal volume ( $V_t$ ), blood lactate, and vital capacity (Birkel et al., 2000; Telles et al., 2000). Several of these same alterations in physiologic responses also can be achieved during a submaximal fixed working intensity (Benson et al., 1978; Gervino and Veazey, 1984). It was thought that the decrease in these variables during submaximal exercise while practicing relaxation may have therapeutic implications for individuals with limited exercise tolerance resulting from cardiovascular disease (Benson et al., 1978; Cortes et al., 1986; Gervino and Veazey, 1984). Benson found that  $\dot{V}O_2$  decreased 4% in subjects exercising between 95–100 beats per minute while eliciting the relaxation response (Benson et al., 1978). Similarly, Gervino and Veazey (1984) reported that there were significant decreases in  $\dot{V}O_2$ , respiratory-exchange ratio, double product (heart rate  $\times$  systolic blood pressure), systolic blood pressure, and  $f_b$  while exercising at a submaximal steady state heart rate. However, in a study published in the *Journal of Cardiopulmonary Rehabilitation* (Hayward, et al., 1987), using 11 males with coronary disease, researchers found that, while Benson's relaxation response could be easily learned and reductions in HR and  $f_b$  were observed during rest while practicing the relaxation response, these same reductions in HR, systolic blood pressure, and double product were not noted during submaximal exercise as in previous studies (Gervino and Veazey, 1984).

Therefore, the purpose of this study was to evaluate submaximal exercise responses in women with heart disease ( $\dot{V}O_2$ , HR,  $f_b$ , ventilation (VE) and  $V_t$ ) while eliciting the relaxation response following an established complementary and alternative medicine (CAM) practice. Pre- and post-test resting levels of stress hormones and perceived physical well-being were also analyzed. The CAM practice used to increase sense of physical well-being and elicit the relaxation response was Kabat-Zinn's Mindfulness-Based Stress-Reduction Program (Kabat-Zinn, 1990). Kabat-Zinn's program emerged in 1979 at the University of Massachusetts' Medical School, Worcester, MA. This program incorporates the principles of mindfulness meditation, breathing exercises, and yoga. It was hypothesized that resting levels of stress hormones would decrease and perceived physical well-being would increase following the mindfulness based stress reduction program. It was also hypothesized that  $\dot{V}O_2$ , HR,  $f_b$ , and VE would decrease and, conversely,  $V_t$  would increase while eliciting the relaxation response during submaximal exercise following this intervention program (Benson et al., 1978; Bernardi et al., 2001; Cortes et al., 1986; Gervino and Veazey, 1984).

## MATERIALS AND METHODS

### *Sample and testing procedures*

Following human subject's approval at Texas Tech University, Lubbock, TX, volunteers were recruited within medical settings to participate in a study to explore the effects of a mindfulness-based stress-reduction and relaxation program for women with cardiovascular disease. Criteria for participation in the study included documented cardiovascular disease and approval by each participant's attending cardiologist. Eligible volunteers included 20 women in a Southwestern community of approximately 200,000 (see Tables 1 and 2 for demographic information).

Prior to the initial meeting outlining study procedures, the participants were asked to refrain from caffeine and smoking for at least 3 hours. Resting blood pressure and HR were taken during the initial meeting after the participants had rested in a recumbent position for 20 minutes. During the initial meeting, the women were randomly assigned using the numbers 1 and 2 to either an 8-week treatment or an 8-week wait-control group. All participants were instructed to schedule pre-post 12-hour fasting blood serum samples at Covenant Care Laboratory, Lubbock, TX. The subjects were asked to refrain from caffeine, tobacco, and food 12 hours prior to taking their morning blood sample.

During an initial meeting, the participants completed questionnaire packets that covered demographic information, including Spielberger's State Anxiety Questionnaire (1983) and the Medical Outcomes Study 36-item Short-Form Health Survey (Ware et al., 1997).

TABLE 1. DESCRIPTIVE STATISTICS FOR PARTICIPANTS BY GROUP (N = 18)

Variable	Intervention group (n = 9)		Control group (n = 9)	
	M	SD	M	SD
Age	57.4	6.9	64.1	3.6
Weight (kg)	71.7	22.4	76.6	10.1
Height (cm)	165.1	4.6	159.6	9.4
Resting heart rate	68.4	9.5	66.8	9.7
Resting systolic blood pressure	141.3	26.1	150.7	33.6
Resting diastolic blood pressure	82.3	11.8	80.5	14.2
Spielberger's State Anxiety Score	37.8	10.9	43.2	12.2

Note: There were no significant differences between groups for any of the descriptive measurements except for age,  $t(16) = 2.55$ ,  $p < 0.05$ .

M, mean; SD, standard deviation.

The women were informed that, at the completion of the 8-week study, they would be asked to ride a stationary bike for approximately 20 minutes to analyze the effect of the relaxation response on physiologic variables while exercising. Two individuals initially dropped out of the study leaving an N of 18, with 9 in each group. The wait-control group was given the opportunity to participate in the mindfulness-based stress reduction program following the collection of all experimental data.

#### *Mindfulness based stress-reduction program*

The intervention was provided 1 night each week for 2 hours over a period of 8 weeks. During the 8-week group meetings, participants received training in the three basic mindfulness practices, the body scan, sitting meditation, and Hatha Yoga (Kabat-Zinn, 1990; Luby 1977). The body scan involved a gradual thorough sweeping of attention through the entire body from feet to head, focusing noncritically on any sensations or feelings in body regions with periodic suggestions of breath awareness and relaxation. Sitting meditation involved mindful attention of the breath and other perceptions and a heightened state of observational yet non-judging awareness of cognitions and the stream of thoughts and distractions that constantly flow through the mind. The Hatha Yoga practice incorporated breathing exercises, simple stretches, and postures designed to strengthen and relax the musculoskeletal system. Participants were given audiotapes to facilitate daily homework practice of the meditative techniques learned during the weekly sessions. The all-day 8-hour retreat devoted to practicing the mindfulness techniques in silent awareness, generally a part of Kabat-Zinn's program, was not included in the present study because of practical restrictions of the participants' schedules.

#### *Submaximal exercise testing procedures*

At the completion of the 8 week program, appointments were made with the participants for assessing physiologic measurements in a laboratory setting while riding a cycle

ergometer. Subjects were asked to refrain from food, alcohol, or caffeine, or the use of tobacco products within 3 hours of testing.

All testing equipment was calibrated prior to testing. The MedGraphics CardiO<sub>2</sub> Breath-by-Breath System (Med Graphics Corporation; St. Paul, MN) was used to measure V<sub>O<sub>2</sub></sub>, F<sub>b</sub>, VE, and V<sub>t</sub>. Volume was calibrated prior to testing utilizing a 3-L syringe. The gas analyzers were calibrated with the use of certified reference gas tanks. The Quinton EKG Monitor (Quinton Instrument Company; Seattle, WA) was interfaced with MedGraphics using a 12-Lead electrocardiograph beat-by-beat system during testing to measure HR.

Participants were fitted for the cycle by adjusting the seat height and handlebar distance using standardized procedures. Participants cycled on a Monark (Monark, Varberg, Sweden) stationary bike for 24 minutes at a constant 50 WATT workload with 8-minute stages. During stage 1, the participants were asked to ride a cycle just as if they were exercising at home or in a health club. During stage 2, the treatment group was asked to practice the relaxation response using techniques that they had learned in the mindfulness-based stress-reduction program and the control group was asked to practice the relaxation response, however they defined this response.

Data was analyzed using breath-by-breath and beat-by-beat analysis. The last 5 minutes of data in each stage were averaged yielding a per minute value for V<sub>O<sub>2</sub></sub>, HR, F<sub>b</sub>, VE, and V<sub>t</sub>.

#### *Statistical analysis*

The Physical Component Summary Measure was calculated from the 36-Item Short-Form Health Survey to analyze physical function as indicated by Ware (Medical Outcomes Trust, 1991; Medical Outcomes Trust, 1994; Ware et al., 1994). The Physical Component Summary Measure was analyzed between group and time using a 2 (group) by 2 (time) ANOVA with repeated measures. Alpha was set at 0.05.

Pre-post test hormonal measurements were analyzed for resting levels of cortisol using a 2 (group) by 2 (time) analysis of variance (ANOVA) with repeated measures. Pre-post

TABLE 2. FREQUENCIES FOR DEMOGRAPHIC VARIABLES BY GROUP (N = 18)

Demographics	Intervention group (n = 9)		Control group (n = 9)	
	Frequency	Percent	Frequency	Percent
<b>Religion</b>				
Catholic	0	0.0%	2	22.2%
Protestant	8	88.9%	7	77.8%
Other	1	11.1%	0	0.0%
<b>Ethnicity</b>				
White	9	100.0%	7	77.8%
Hispanic	0	0.0%	1	11.1%
African American	0	0.0%	0	0.0%
Native American	0	0.0%	1	11.1%
<b>Marital Status</b>				
Married	8	88.9%	5	55.6%
Divorced	1	11.1%	2	22.2%
Widowed	0	0.0%	2	22.2%
<b>Education</b>				
High school	2	22.2%	3	33.3%
Bachelor's degree	5	55.6%	5	55.6%
Master's degree	2	22.2%	1	11.1%
<b>Heart Disease Classification</b>				
Angina	2	22.2%	4	44.4%
Cardiac valve disorders	2	22.2%	2	22.2%
Congestive heart failure	2	22.2%	1	11.1%
Hypertension	3	33.3%	2	22.2%
<b>Income</b>				
\$5,000–\$9,999	0	0.0%	2	22.2%
\$10,000–\$24,999	1	11.1%	3	33.3%
\$25,000–\$49,999	2	22.2%	1	11.1%
\$50,000 or more	6	66.7%	3	33.3%
<b>Current Work Status</b>				
Employed	7	77.8%	4	44.4%
Not employed	2	22.2%	5	55.6%

test hormonal measurements for resting total catecholamines were also analyzed using a 2 (group) by 2 (time) ANOVA with repeated measures. The Bonferroni technique was used to control for Type I error (Thomas and Nelson, 1996) for resting levels of stress hormones ( $\alpha_{EW} = \alpha/c$ ); alpha was set at 0.01.

A 2 (group) by 3 (time) ANOVA with repeated measures was used to analyze submaximal exercise responses ( $\dot{V}O_2$ , HR,  $f_b$ , VE, and  $V_I$ ). The Bonferroni technique was used to control for Type I Error (Thomas and Nelson, 1996) for the submaximal exercise responses ( $\alpha_{EW} = \alpha/c$ ); alpha was set at 0.01. Power and effect sizes were calculated for all analyzed variables as described by Cohen (1988, 1992).

### Results

There were no significant main effects or interaction for the resting levels of stress hormones or physical function-

ing. There were no significant interactions for the submaximal exercise responses, however, there were significant main effects between groups for ventilation [ $F(2,32) = 7.65$ ,  $p < .01$ ,  $f = 0.8$ ], and between-group [ $F(1,16) = 8.84$ ,  $p < .01$ ,  $f = 0.8$ ] and time [ $F(2,32) = 10.42$ ,  $p < .01$ ,  $f = 0.9$ ], for breathing frequency.

### DISCUSSION

A limitation to our study was that the participants were volunteers who were mostly white middle-upper-class females. These limitations reduce the generalizability of the findings to other ethnic and socioeconomic samples as well as male cohorts. Another limitation in our study was the small sample size; this would have an effect on the power of our test statistic and would increase the chances of making a Type 2 error (Portney and Watkins, 2000).

TABLE 3. COMPARISON OF CHANGES FROM PRETEST TO THE POST-TEST FOR THE PARTICIPANTS IN THE INTERVENTION AND CONTROL GROUPS

Variable	Intervention				Control				Interaction			
	Pretest		Post-test		Pretest		Post-test		Group (2) by time (2)			
	M	SD	M	SD	M	SD	M	SD	F	f	Power	
Resting Total												
Catecholamine levels	523.38	163.56	484.0	204.46	598.50	343.46	576.33	328.97	0.07	0.07	0.09	
Resting cortisol levels	19.74	7.92	15.76	7.35	21.00	5.60	21.22	6.37	1.99	0.35	0.57	
Transformed SF-36												
Physical component-score	40.57	13.65	42.09	14.09	38.28	11.61	35.29	9.82	1.94	0.34	0.57	

Note: The F ratio is the interaction term for the split plot analysis of variance [2 (group) by 2 (time) with repeated measures on the second factor]. Similarly, the f values are the effect sizes for the interaction term.

M, mean; SD, standard deviation.

*Resting levels of stress hormones*

Normal reference resting levels of morning cortisol range from 8.0–24.0 ug/dL (Quest Diagnostic Laboratory). Interestingly, prior to the initiation of the study, the women reported anxiety scores that fell in the 76 (treatment) and 90 (control) percentile rank compared to normal females in their age range (Spielberger, 1983). However, the pretest values of resting cortisol were within the normal range in both groups (Table 3). Although there were no significant differences between groups in cortisol levels, there was a decrease in the resting levels of cortisol in the intervention groups while the control group had no change. The effect size for the interaction term was considered to be medium-to-large, so this may be considered to be a meaningful find-

ing even though it did not reach significance levels at 0.05. According to Cohen (1988), the sample size needed to detect significance at a power of 0.80 and this effect size was 26. Therefore, with a larger sample size, a significant difference might have been found between groups. Furthermore, it may take more than 8 weeks to adopt lifestyle habits that would be reflected in resting levels of cortisol.

The normal reference range for resting total plasma catecholamines (epinephrine, norepinephrine, and dopamine) is <643 pg/mL (Laboratory Corporation of America, 1996). The pretest resting total catecholamine levels for both groups in this study also fell within the normal range (Table 3).

Therefore, it is perhaps not surprising that we did not see a significant difference in measures of catecholamines and cortisol between time or groups in this study. Previous stud-

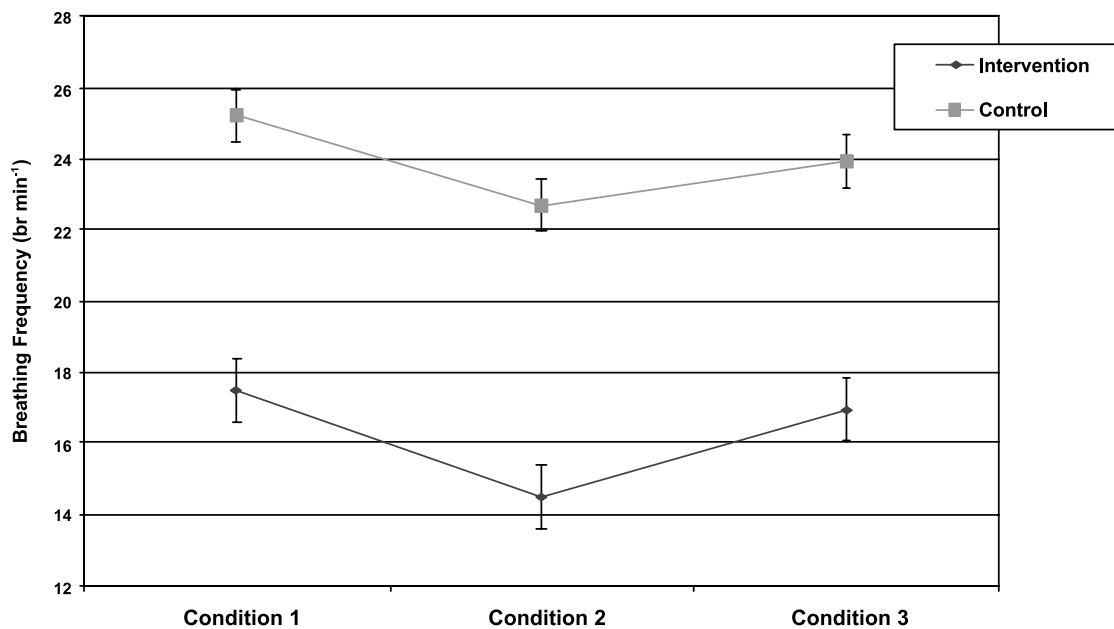
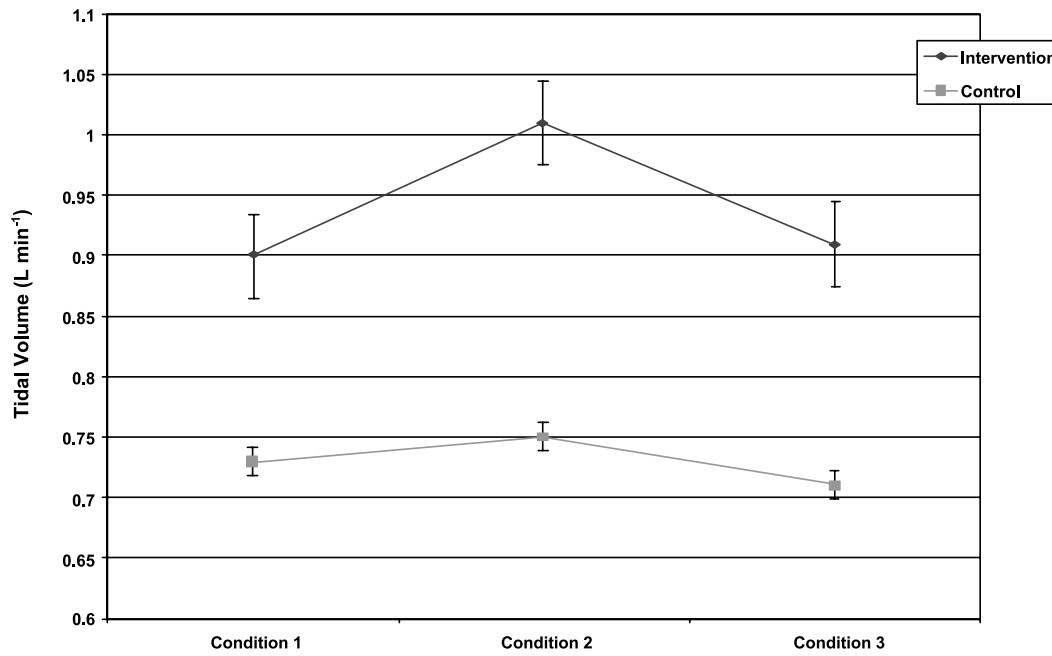


FIG. 1. Breathing frequency for the 3 conditions (control, relaxation response, control) during the steady-state exercise bout (50 WATTS) for the intervention and the control group.

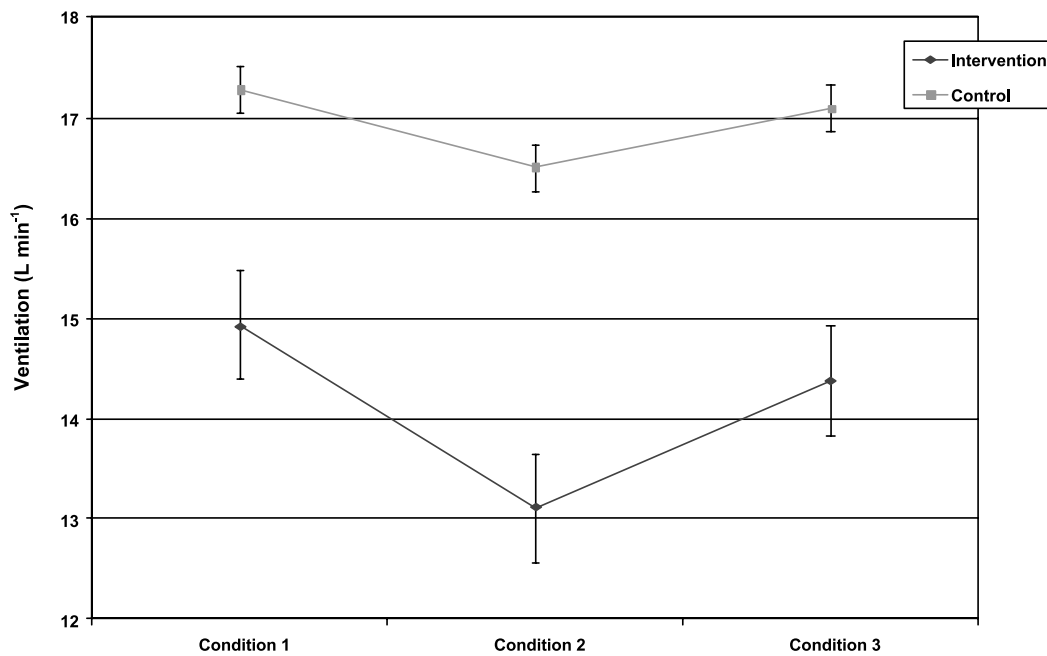


**FIG. 2.** Tidal volume for the 3 conditions (control, *relaxation response*, control) during the steady-state exercise bout (50 WATTS) for the intervention and the control group.

ies have not demonstrated a significant difference in the resting levels of catecholamines after a physical training program (Cleroux et al., 1984). Nor have these studies found a difference in plasma adrenocorticotrophic hormone or cortisol levels in response to physical stimuli after training (Blaney et al., 1990).

#### *Physical component summary measure*

The Physical Component Summary Measure is referred to as a generic measure of health that assesses health-related quality-of-life outcomes, namely, those known to be most directly affected by disease and treatment (Ware, 1987,



**FIG. 3.** Ventilation for the 3 conditions (control, *relaxation response*, control) during the steady-state exercise bout (50 WATTS) for the intervention and the control group.

TABLE 4. F RATIOS, EFFECT SIZES, AND POWER FOR THE MAIN EFFECTS BETWEEN GROUP (2) AND TIME (3) AND THE INTERACTION BETWEEN GROUP AND TIME DURING EXERCISE

Variable	Main effects						Interaction		
	Group			Time			F	f	Power
	F	f	Power	F	f	Power			
Heart Rate	0.20	0.11	0.08	0.59	0.19	0.23	0.17	0.10	0.09
Oxygen consumption	0.42	0.17	0.21	0.48	0.39	0.73	0.45	0.16	0.14
Breathing frequency	8.84**	0.74	0.98	10.42**	0.80	0.99	0.47	0.17	0.14
Tidal volume	4.94*	0.55	0.89	2.46	0.39	0.73	0.73	0.20	0.23
Ventilation	2.56	0.40	0.66	7.65**	0.69	0.99	1.20	0.27	0.34

\*Denotes significance at 0.05, \*\*at 0.01; *f* values are the effect sizes.

1990). In our study, there was no significant difference between group or time for the Physical Component Summary Measure (Table 3). However, this may have been the result of a small sample size because there was a medium-to-large effect size (Cohen, 1988, 1992).

#### Submaximal exercise responses

**Oxygen consumption and heart rate.** Previous studies have shown significant decreases in oxygen consumption during steady-state submaximal exercise while eliciting the relaxation response (Benson et al., 1978; Gervino and Veazey, 1984). A decrease in  $\dot{V}O_2$  during submaximal exercise while eliciting the relaxation response would enable patients to perform increased work at a given level of oxygen consumption or prolonged work at a diminished level of oxygen consumption (Benson et al., 1978). In both the Benson and Gervino studies, each participant served as his or her own control; results were not compared between groups (treatment and control) as in the present study. Benson reported a 4% decrease in  $\dot{V}O_2$  for the participants while eliciting the relaxation response. He also stated that the sig-

nificance level was less than 0.01, using a one-tailed *t*-test. If he had used a two-tailed *t*-test, the results would not have been significant. In the present study, even though we saw a 7% decrease in  $\dot{V}O_2$  during the practice of the relaxation response, there were no significant differences between groups, time, and interaction for  $\dot{V}O_2$  while eliciting the relaxation response (Table 4).

There were no significant differences between groups, time, and interaction for HR (Table 4). Not Benson (Benson et al., 1978) nor Gervanio (Gervino and Veazey, 1984) nor Hayward et al. (1987) reported any significant decreases in HR during submaximal exercise, which supported the results of our study.

**Breathing patterns.** Following the intervention program, several physiologic responses during exercise were measured ( $\dot{V}O_2$ , HR,  $f_b$ , VE and  $V_t$ ). A significant difference between the groups was seen in breathing patterns (Tables 4–5 and Figs. 1–3). Even though VE was not significantly different between groups, there was a decrease in  $f_b$  for the intervention group ( $p < 0.01$ ). Because  $VE = f_b \times V_t$ ,  $V_t$  had

TABLE 5. MEANS AND STANDARD DEVIATIONS FOR THE THREE CONDITIONS (CONTROL, RELAXATION RESPONSE, CONTROL) DURING THE STEADY-STATE EXERCISE BOUT (50 WATTS) FOR THE INTERVENTION AND THE CONTROL GROUP

Variable	Intervention						Control					
	Condition 1		Condition 2		Condition 3		Condition 1		Condition 2		Condition 3	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Heart rate	86.79	15.56	85.07	15.56	85.77	14.79	88.81	10.28	88.29	9.12	88.51	9.37
$\dot{V}O_2$ (mLkg <sup>-1</sup> min <sup>-1</sup> )	6.31	0.77	5.83	1.00	6.07	1.14	6.50	0.81	6.26	0.65	6.21	1.09
Breathing rate (br min <sup>-1</sup> )	17.50	3.44	14.51	3.60	16.94	2.72	25.21	7.85	22.67	7.04	23.92	6.86
Tidal volume (L min <sup>-1</sup> )	0.90	0.23	1.01	0.35	0.91	0.28	0.73	0.13	0.75	0.09	0.71	0.79
Ventilation (L min <sup>-1</sup> )	14.93	4.49	13.11	3.81	14.38	4.10	17.27	3.6	16.50	3.05	17.09	3.71

Note: Bold in heading indicates a change in the condition (relaxation response was elicited). M, mean; SD, standard deviation.

to increase for the intervention group. A significant main effect between time was also found for  $f_b$  (see Tables 4–5 and Figs. 1–3). This would suggest that even without an intervention program, breathing patterns could be changed through conscious awareness during sub-maximal exercise. Hayward et al. (1987) also found that the relaxation response could be easily learned. There also were large effect sizes between groups for  $f_b$  ( $f = 0.74$ ) and between time for  $f_b$  ( $f = 0.80$ ). Boone and De Weese (1998) also found statistically significant changes in breathing patterns associated with the elicitation of the relaxation response during exercise related specifically to a decrease in breathing frequency. Boone and De Weese (1998) associated it with increased ventilatory efficiency and a possible shift in autonomic balance to parasympathetic dominance during relaxation resulting in significant decreases in  $f_b$  and VE.

Some of the most invalidating symptoms in patients with chronic heart failure, such as dyspnea, are more related to the respiratory system rather than myocardial pump failure. Evidence reported by researchers in the *Italian Heart Journal* indicated that nonpharmacologic interventions, such as general physical training, or, particularly, specific types of training of the respiratory pattern has potential favorable effects on patients with heart disease (Porta and Bernardi, 2001).

Because the control of breathing results from complex interactions (Caruana-Montaldo et al., 2000; Johnson, 1997) involving afferent input from the higher brain centers (behavior), sensory mechanoreceptors, and chemoreceptors, which provide input to a central control mechanism (central integration), that, in turn provides output to effector muscles, it is difficult to isolate precisely the mechanisms that control the change in breathing patterns as observed in this study. It is, however, hypothesized, that the participants in this study learned to influence their breathing patterns during the mindfulness based stress reduction program through a conscious awareness of breathing patterns incorporating the higher brain centers (behavior) in the CNS.

## CONCLUSION

In conclusion, after participating in a form of Kabat-Zinn's Mindfulness-Based Stress-Reduction Program, which did not include the 8-hour training day, significant differences in breathing patterns between the intervention and control group were noted (Tables 4–5 and Figs. 1–3). It is thought that patients with many disease states, including cardiovascular disease, might benefit from increased ventilatory efficiency during exercise. The intervention group exhibited decreased  $f_b$  patterns during exercise compared to the control group after participating in the intervention program. Ventilation was also significantly lower for both groups during the practice of the relaxation response during submaximal exercise (Tables 4–5 and Figs. 1–3).

This CAM practice did not evoke significantly different changes in the resting levels of stress hormones in women with heart disease. However, it must be noted that the pretest resting levels of stress hormones for these women were within the normal range. Additionally, HR and  $VO_2$  responses during submaximal exercise while eliciting the relaxation response were not significantly lowered in either group. There was also no significant difference in the Physical Component Summary Measure between groups.

Because this is the first published study to our knowledge that used Kabat-Zinn's Mindfulness-Based Stress-Reduction Program as an intervention for females with heart disease, it is suggested that future researchers use the effect size generated from this study to calculate the number of participants that would be needed to detect significant differences.

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