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The Association Between Mood States and Physical Activity in Postmenopausal Obese, Sedentary Women

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The Association Between Mood States and Physical Activity in Postmenopausal, Obese, Sedentary Women

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Mood states influence evaluative judgments that can affect the decision to exercise or to continue to exercise. This study examined how mood associated with graded exercise testing (GXT) in sedentary, obese, postmenopausal women (N = 25) was associated with physical activity and predicted VO_{2max} during and after a behavioral weight-loss program (BWLP). Measures of physical activity included planned exercise, calories from physical activity, leisure-time physical activity, and predicted VO_{2max}. Mood before and after pre-BWLP GXT was assessed using the Profile of Mood States. Mood before and after the GXT was more strongly associated with planned exercise than other forms of physical activity, and this effect became stronger over time. Mood enhancement in response to exercise was not related to physical activity. Mood before and after exercise might yield important clinical information that can be used to promote physical activity in sedentary adults.

Key Words: exercise, behavioral weight loss program, VO_{2max}, menopause, obesity

Obesity and physical inactivity are major health hazards and account for more than $170 billion annually in estimated health care costs in the United States (Finkelstein, Fiebelkorn, & Wang, 2003; Pratt, Macera, & Wang, 2000). Older women, the focus of this study, are among the most sedentary and obese segments of the U.S. population (National Heart, Lung, and Blood Institute [NHLBI], 1998). In fact, being postmenopausal, obese, and sedentary are independent risk factors for cardiovascular disease (Manson, Colditz, & Stampfer, 1990; Manson et al., 1999; NHLBI).

Through regular participation in physical activity,[1] particularly vigorous or regular exercise, aging women can improve their cardiovascular risk profiles (Sawatzky & Naimark, 2002). In addition, with exercise, postmenopausal women can improve their lipid profiles, particularly those receiving supplemental estrogen (Green, Grandjean, Weise, Crouse, & Rohack, 2001). They can also use exercise to

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maintain lean body mass and strength during the accelerated muscle-loss period after menopause (Rosario, Villani, Harris, & Klein, 2003). Finally, as women transition from pre- to postmenopause, increasing their physical activity can lessen the impact of menopause-induced changes in HDL cholesterol (Owens, Matthews, Wing, & Kuller, 1992). In addition to mitigating some of the cardiovascular-disease risk factors after menopause such as high cholesterol and insulin resistance, exercise is an important factor in successful weight loss and maintenance (Perri & Corsica, 2002; Tremblay & Imbeault, 1999). Despite the potential health benefits of intervention programs that promote weight loss and physical activity, many participants have difficulty maintaining regular physical activity (Jeffery et al., 2000; Marcus et al., 2000). Therefore, considerable attention has focused on understanding the factors that contribute to increased physical activity and fitness (e.g., Berger, 2004; Cohen-Mansfield, Marx, & Guralnik, 2003; King, Haskell, Taylor, Kraemer, & DeBusk, 1991; Litwin, 2003).

The mood-enhancing effects of exercise have been studied extensively (e.g., Berger & Motl, 2000; Centers for Disease Control and Prevention [CDC], 1996), and the findings have been well documented in older adults (Arent, Landers, & Etnier, 2000; Stathi, Fox, & McKenna, 2002). In addition, there is evidence that self-reported enjoyment of a sport might be positively associated with mood enhancement after participation in that sport (Motl, Berger, & Leuschen, 2000).

Mood refers to a transient affective state at a particular moment in time (McNair, Lorr, & Droppleman, 1992). The subjective experiences associated with an emotion generally concern the evaluation of situations with respect to their goodness or badness (Schwarz & Clore, 1996), with the intensity of the emotion reflecting the importance of the situation that is being reacted to (Frijda, Ortony, Sonnemans, & Clore, 1992).[2] Therefore, positive or negative affective reactions to exercise likely reflect global evaluations of exercise as a "good" thing or a "bad" thing. In this investigation, mood is defined as a transient affective state at a particular moment in time (i.e., immediately before and after a graded exercise test [GXT]) concerning the evaluation of a situation or event (i.e., exercise).

Some researchers view the effects of emotions as motivational, influencing a wide variety of evaluative judgments that have the potential to influence every step in a course of action (Schwarz & Bohner, 1996; Schwarz & Clore, 1996). For example, emotions are likely to influence goal attractiveness (Schwarz & Bohner). When individuals experience a specific action necessary for goal achievement as unpleasant, they might be less likely to engage in the action and might find the goal less attractive (Schwarz & Bohner). Therefore, people who plan to be physically active to lose weight might be less likely to be physically active and find the goal of losing weight less attractive if they have a negative affective response to exercise (i.e., find it unpleasant, scary, painful, etc.).

Emotions also are likely to influence how optimistic people are about attaining a goal (Schwarz & Bonner, 1996). For example, in an experiment with acutely ill participants, negative moods resulted in participants reporting less confidence that they could carry out illness-alleviating behaviors (Salovey & Birnhaum, 1989). Therefore, a negative mood can diminish efficacy expectations. An individual who experiences a negative mood in response to exercise is likely to have diminished expectations for being able to engage in regular physical activity.

Anecdotally, we have observed that in previous weight loss and physical activity interventions, participants often share feelings of embarrassment, fear, and apprehension regarding exercising. Some individuals clearly have strong negative or positive feelings toward exercise. These observations are corroborated by research in sport and exercise enjoyment that indicates that people tend to develop generalized feelings such as pleasure or dislike for exercise and sport (Scanlan & Simons, 1992). As a result, an individual's mood immediately before (and after) a GXT is likely to reflect his or her generalized feelings toward exercise, such as anxiety or sadness. Furthermore, these generalized feelings toward exercise might be associated with one's level of participation in many forms of physical activity, especially in a sedentary population that does not habitually participate in physical activity.

To our knowledge, no research has examined whether mood measured either before or after a GXT is associated with physical activity and fitness during and at the end of a behavioral weight-loss program (BWLP). In addition, no research of which we are aware has examined whether acute changes in mood after exercise are associated with physical activity and fitness during and at the end of a BWLP. Participants' affective response to exercising as reflected during a GXT, however, plausibly could influence the likelihood that they participate in regular physical activity. Therefore, we examined whether an individual's mood just before or after a single bout of exercise (i.e., GXT) at baseline was associated with levels of physical activity and predicted VO_{2max} during and after a 6-month BWLP. It was hypothesized that positive mood associated with exercise at baseline would be associated with higher levels of physical activity and predicted VO_{2max} during and after the BWLP. In addition, it was hypothesized that individuals who had greater mood enhancement after a GXT (i.e., a greater increase in mood scores post-GXT) would be more likely to engage in regular physical activity. Simply stated, the more reinforcing participants found exercise, the more likely they would engage in regular physical activity.

Data from the current study were collected as part of a larger investigation that examined weight loss, physical activity, and diet in obese, sedentary, postmenopausal women participating in a BWLP (see Carels, Darby, Cacciapaglia, & Douglass, 2004). In that investigation, women lost on average 6.2 kg by the end of the BWLP. The present study used several indices of physical activity (i.e., accelerometers, physical activity diary, and the Paffenbarger Physical Activity Questionnaire [PPAQ; Paffenbarger, Wing, & Hyde, 1978]) and cardiorespiratory fitness that were collected before, during, and after the BWLP. Each index of physical activity contributes valuable, yet different, information about physical activity that might be associated with weight loss, as well as facilitating comparison between the current study and past research. For example, planned exercise is quite different from total calories used from physical activity (i.e., Caltrac accelerometers). Total calories used from physical activity include both planned exercise and calories expended through a variety of lifestyle and occupational factors. Similarly, the PPAQ has been used in numerous studies, including research with postmenopausal women (LaPorte et al., 1983). Questionnaires such as the PPAQ enhance comparisons among similar studies.

Method

Participants

Twenty-five obese, sedentary, postmenopausal women completed a GXT before and after their involvement in a BWLP. Women's mean age (years) was 53.9 (*SD* = 7.8) and mean baseline body-mass index (kg/m^2) was 35.9 (*SD* = 5.3) at the beginning of the BWLP. Overweight was defined as having a body-mass index of 25–29.9 kg/m^2, and obesity was defined as having a body-mass index greater than 30 kg/m^2 (NHLBI, 1998). Approximately one half (52.9%) of the women had an annual income exceeding $30,000 a year, over one half (58.9%) had at least a baccalaureate college degree, and 61.8% worked full-time. Ninety-two percent of the women were White. Women were recruited through local advertisements (newspaper) and fliers (distributed at women's health clinics and hospitals).

Women were included in the BWLP if they met specific eligibility requirements, which included (a) being postmenopausal (no menstruation for at least 12 months), (b) being obese (BMI ≥30 kg/m^2), (c) being sedentary (not currently participating in planned exercise such as walking two or more times per week for at least 20 min per session), (d) being willing to accept random assignment to the BWLP versus BWLP with self-control skills training (see program description later in the article), (e) being nonsmokers, (f) providing informed consent, and (g) receiving medical clearance from their primary-care physicians.

Women were excluded from participation if they had (a) past or current cardiovascular disease (e.g., myocardial infarction, stroke) determined from medical history, (b) surgical menopause within the preceding 6 months, (c) musculoskeletal problems that would prevent participation in moderate levels of physical activity (e.g., degenerative disk disorder), (d) a history of insulin-dependent diabetes (self-reported), (e) resting blood pressure ≥160/100 mmHg (assessed during screening), (f) potential problems complying with the assessment and intervention procedures, or (g) a life-limiting or complicated illness such as cancer, renal dysfunction, hepatic dysfunction, or dementia.

Procedure

Women completed a GXT before and after the BWLP. See Carels et al. (2004) and the Graded Exercise Test section following for details of the GXT. The women also completed the Profile of Mood States (POMS; McNair et al., 1992) just before and after the baseline GXT. Before and after the 6-month BWLP, women also completed the PPAQ (Paffenbarger et al., 1978). In addition, throughout the BWLP women recorded kilocalories expended from daily physical activity and the specific type and duration of daily planned physical activity in diaries (see Figure 1 for a timeline of physical activity, mood, and cardiorespiratory assessments). As indicated in Figure 1, to examine changes in physical activity throughout the BWLP, data from the accelerometers and the daily physical activity diaries were separated into three discrete time periods: first 8 weeks, middle 8 weeks, and final 8 weeks. The three time periods were constructed to provide an indication of the level of physical activity near the beginning, middle, and end of the intervention.

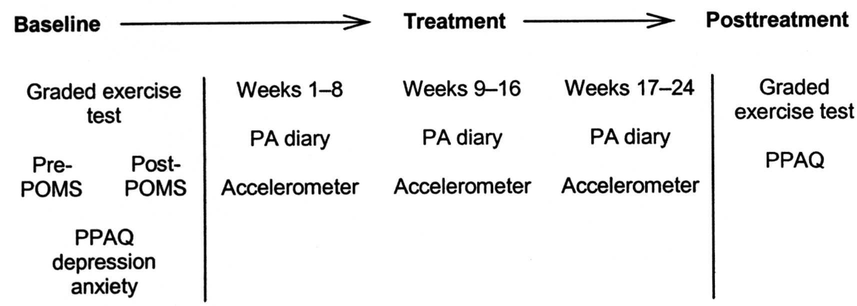

Figure 1 — Timeline of physical activity, mood, and cardiorespiratory assessments.

Behavioral Weight-Loss Program

The women in this study were part of a larger investigation examining whether cardiovascular risk factors could be reduced in sedentary, obese, postmenopausal women participating in a BWLP (Carels et al., 2004). The weekly 24-session weight-loss intervention based on the LEARN program (Brownell, 2000) was administered to women in small groups (i.e., 7–12 women). The LEARN program is an empirically supported approach to weight management devoted to achieving gradual weight loss, increased physical activity, and reduced energy and fat intake (Brownell). The investigation also was designed to determine whether the addition of self-control-skills training to an empirically supported BWLP would result in greater cardiovascular-risk reduction. Therefore, half of the women were randomly assigned to receive the BWLP alone, and the other half received the same program, which was augmented by self-control-skills training. See Carels et al. for additional information on the BWLP and the self-control-skills training.

Measures

Caltrac Accelerometer and Physical Activity Diary. Women used Caltrac accelerometers (Muscle Dynamics Fitness Network, Torrance, CA) to measure kilocalories expended in daily physical activity throughout the 6-month period. The accelerometers assess vertical acceleration and convert the measurement into caloric expenditure (Fehling, Smith, Warner, & Dalsky, 1999). Each participant was taught how to wear and operate the device and then recorded readings of total calories expended in activity in a daily physical activity diary. Although Caltrac accelerometers have been shown to overestimate the absolute energy cost (i.e., measured VO_2) of selected activities, they can be used to monitor changes in physical activity (Balogun, Martin, & Clendenin, 1989; Pambianco, Wing, & Robertson, 1999).

Women also self-reported the specific type and duration of daily exercise in their physical activity diaries. This “planned” exercise included activities such as walking, aerobics, and swimming. Daily minutes of exercise were summed to provide weekly totals of the total time spent in exercise. Women’s exercise diaries were discussed during the weekly meetings to encourage compliance and increase accuracy of the diary recordings.

Physical Activity Questionnaire. To assess leisure-time physical activity, each participant completed the PPAQ (Paffenbarger et al., 1978). Three items from the PPAQ are commonly used to provide an estimate of energy expenditure per week in kilocalories (see Pereira et al., 1997). These items include flights of stairs climbed, blocks walked, and information about recreation and sports played through open-ended questions concerning frequency and duration of activity. The three items are converted to kilocalories and then summed. The PPAQ has been used in numerous studies including a study of postmenopausal women (LaPorte et al., 1983).

Graded Exercise Test. Each participant completed a submaximal GXT (endpoint ~75% of age-predicted maximal heart rate; American College of Sports Medicine [ACSM], 2000) using the modified Balke protocol of walking on a treadmill (Balke, 1960; ACSM). Heart rate measured via a 12-lead EKG was recorded at the end of each stage. The test was discontinued if any ACSM test-termination criteria were present during the test (ACSM). The endpoint for the GXT was 75% of target heart rate (HR) as determined using the Karvonen method: (age-predicted $HR_{max} - HR_{rest}$) $\times$ 75% + HR_{rest}. When women were taking beta-blockers or other medications that blunt heart-rate response to exercise, rating of perceived exertion chosen by the participant was used at the endpoint. Functional capacity was predicted from the regression equation for the relationship between estimated submaximal VO_2 and heart rate at two or more submaximal workload tests (ACSM). Although some error is introduced because of the extrapolation of submaximal data, the measure is useful for monitoring training changes over time. Women were tested before and after the 6-month BWLP.

Profile of Mood States. The POMS (McNair et al., 1992) is a 65-item self-report inventory that assesses transient, fluctuating mood states along six dimensions: tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment. Affective states are assessed along four-point scale (0 = *not at all,* 1 = *a little,* 2 = *moderately,* 3 = *quite a bit,* and 4 = *extremely*). Often employed in exercise settings to measure acute changes in mood (see Berger & Motl, 2000, for a review), the POMS has good internal consistency (α = .84 to .95) and adequate test–retest reliability (r = .65–74; McNair et al.).

Depression and Anxiety. Sad mood is a primary symptom of major depression (American Psychiatric Institute, 2000), and the POMS has been significantly associated with depressive and anxious symptoms (McNair et al., 1992). Thus, to control for the confounding influence of depressive symptoms and anxiety on mood, the Beck Depression Inventory (Beck, 1976; Beck, Steer, & Garbin, 1988) and the Spielberger Trait Anxiety Inventory (Spielberger, 1983) were used to assess pre-BWLP depression and anxiety, respectively. Depression and anxiety were controlled for in subsequent statistical analyses. The Beck Depression Inventory is a 21-item test presented in multiple-choice format that assesses presence and degree of depression in adolescents and adults. The Spielberger Trait Anxiety Inventory is a 20-item questionnaire that assesses trait anxiety along a 4-point scale (1 = *almost never,* 2 = *sometimes,* 3 = *often,* and 4 = *almost always*). The instruments were selected based on their established validity and reliability (Beck; Beck et al.).

Data Analyses

Data from the BWLP alone and the same program augmented with self-control-skills training were combined, because there were no significant effects of self-control-skills training on any intervention outcomes (i.e., weight loss, physical activity and predicted VO_{2max}, and diet; Carels et al., 2004). Pearson's correlations (age, income, and education) and a *t* test (race) were employed to examine the relationship between the baseline physical activity variables and the demographic characteristics.

To facilitate normative comparisons on the POMS subscales, POMS scores were converted to *T* scores based on the adult normative sample (McNair et al., 1992). Paired *t* tests were used to compare POMS subscales before and after baseline GXT.

To examine changes in physical activity throughout the 6-month BWLP, data from the accelerometers were computed to indicate total calories expended in daily physical activity, and data from the daily physical activity diaries were computed to indicate the weekly duration of time spent in planned exercise. Data from the accelerometers and the daily physical activity diaries were separated into three discrete time periods: first 8 weeks, middle 8 weeks, and final 8 weeks. Women completed 77% of their physical activity diary entries. Given that a woman's average physical activity over the 8-week periods was used in the data analysis, the influence of missing data (e.g., missing physical activity diary data in any given week) was minimized. Paired-sample *t* tests were used to compare differences among the three 8-week time periods in calories expended from physical activity and time spent in planned exercise. In addition, paired-sample *t* tests were used to compare the pre- and post-BWLP differences in calories expended in leisure-time physical activity (i.e., PPAQ), predicted VO_{2max}, and exercise time on the treadmill.

Partial correlation analyses were used to examine the association between mood measured before and after the GXT at baseline and the following measures of physical activity: average weekly time spent in planned exercise during the beginning, middle, and end of the BWLP (physical activity diary); calories expended from total physical activity during the beginning, middle, and end of the BWLP (accelerometers);calories expended from leisure-time physical activity (PPAQ); and fitness as measured by predicted VO_{2max}. The partial-correlations procedure in SPSS 11.0 for Windows (SPSS, Inc., Chicago, IL) computes partial correlation coefficients that describe the linear relationship between two variables while controlling for the effects of one or more additional variables. Any significant associations between physical activity and demographic influences, as well as change in BMI over the course of the intervention, were partialed out of all correlations. In addition, to control for differences in physical activity at baseline, leisure-time physical activity (PPAQ at baseline) was partialed out of the correlation analyses that examined post-BWLP: average time spent in planned exercise (diaries), calories expended from physical activity (accelerometers), and leisure-time physical activity (PPAQ). Baseline VO_{2max} was partialed out of the analyses that examined post-BWLP VO_{2max}. Partial correlations between moods measured before and after the GXT at baseline and physical activity and predicted VO_{2max} were assessed while partialing out the influence of anxiety and depressive symptoms.

Partial correlations between mood enhancement and physical activity and fitness were also examined. Mood enhancement after cardiorespiratory testing was computed by subtracting POMS subscale scores after cardiorespiratory testing from POMS subscale scores before cardiorespiratory testing. In this investigation, an alpha of .01 was used for the comparisons between mood and physical activity and fitness to reduce the probability of making a Type I error that can occur as a function of multiple comparisons. All data analyses were performed using SPSS 11.0 for Windows.

Results

Demographic Characteristics and Indices of Physical Activity

Pearson's correlations (age, income, education) and a *t* test (race) were employed to examine the relationship between the baseline physical activity variables and the demographic characteristics. Results indicated that women with higher annual income had significantly greater predicted VO_{2max} at baseline ($r = .42$, $p \leq .05$). Women with more years of education expended significantly more calories in leisure-time physical activity at baseline ($r = .40$, $p \leq .05$). Age and race were not associated with baseline physical activity or predicted VO_{2max}. Baseline education and income were partialed out of all correlations.

Pearson's correlations were used to examine the associations among the indices of physical activity and fitness assessed at baseline. Calories expended from leisure-time physical activity (PPAQ) at baseline were not significantly correlated with predicted VO_{2max} at baseline. Similarly, calories expended from leisure-time physical activity at the end of the BWLP were not significantly correlated with predicted VO_{2max} at the end of the BWLP. In addition, Pearson's correlations were used to examine the association between calories expended in physical activity and average time spent in planned exercise over the beginning, middle, and end of the program. Calories expended in physical activity were not significantly associated with the average time spent in planned exercise during the beginning, middle, and end of the program.

Affective Response Before and After the Baseline GXT

The women reported desirable mood states on all six of the POMS subscales as noted by their *T* scores of 50 or less on the negative-mood subscales and a *T* score higher than 50 on the vigor subscale (McNair et al., 1992). Paired *t* tests were used to compare POMS subscales before and after the baseline GXT. As indicated in Table 1, women reported significant decreases in tension, $t(25) = 3.37$, $p < .05$; depression, $t(25) = 2.55$, $p < .05$; anger, $t(25) = 2.62$, $p < .05$; and confusion, $t(25) = 3.29$, $p < .05$, after the GXT.

Physical Activity, Predicted VO_{2max}, and Enhancement of Mood After Cardiorespiratory Testing

As reported, women reported significant decreases in tension, depression, anger, and confusion after the GXT. Desirable changes in mood after the GXT (i.e.,

Table 1 POMS T scores Before and After the Graded Exercise Test (*N* = 25)

	Pretest		Posttest	
POMS dimension	*M*	*SD*	*M*	*SD*
Tension-anxiety	42.1	5.3	38.4*	4.0
Depression-dejection	43.7	6.4	41.2*	2.6
Anger-hostility	42.0	4.5	40.3*	2.4
Vigor-activity	52.1	8.1	54.9	8.9
Fatigue-inertia	47.6	8.2	47.8	7.4
Confusion-bewilderment	45.1	5.5	41.4*	4.4

*$p < .05$; significant changes in mood pre- to posttest.

mood enhancement), however, were not significantly associated with any indices of physical activity (accelerometers, physical activity diaries, PPAQ) or predicted VO_{2max} at the end of the BWLP.

Changes in Physical Activity Throughout the BWLP

Results of the paired-sample *t* tests indicated that calories expended from physical activity (accelerometers) decreased significantly between the first 8 weeks and the middle 8 weeks, $t(25) = 2.61$, $p < .05$, and between the first 8 weeks and last 8 weeks, $t(25) = 3.14$, $p < .05$, of the BWLP. Women then showed a nonsignificant change between the middle 8 weeks and final 8 weeks of the BWLP (see Table 2). Women exhibited a similar pattern for the time spent in planned exercise. Again, the time spent in planned exercise (physical activity diary) decreased significantly between the first and the middle 8 weeks, $t(25) = 2.65$, $p < .05$, and between the first and final 8 weeks, $t(25) = 2.78$, $p < .05$, of the BWLP, but the women showed a nonsignificant change between the middle 8 weeks and final 8 weeks of the BWLP (see Table 2; Carels et al., 2004). Within-treatment changes in physical activity (Caltrac and physical activity diaries) indicated that women exercised significantly less near the end of the BWLP than they did near the beginning.

Physical Activity and Predicted VO_{2max} Before and After the BWLP

Paired-sample *t* tests indicated that there was a significant pre- to post-BWLP increase in predicted VO_{2max} (pre $M = 21.4$, $SD = 4.7$ vs. post $M = 23.5$, $SD = 5.1$), $t(25) = 3.62$, $p < .05$, and exercise time on the treadmill (pre M = 6:58, SD = 2:38 vs. post M = 8:21, SD = 4:14), $F(1, 21) = 20.92$, $p < .05$. The pre- to post-BWLP increase in calories from leisure-time physical activity (PPAQ; pre $M = 890$, $SD = 818$ vs. post $M = 1326$, $SD = 898$) was not significant, $t(25) = 2.01$, $p = .06$.

Table 2 Indices of Physical Activity During Treatment

Physical activity	Weeks 1–8		Weeks 9–16		Weeks 17–24	
	M	*SD*	*M*	*SD*	*M*	*SD*
Duration of planned exercise (weekly minutes)	215	138	158*	134	124**	108
Total activity calories (kcal)	518	148	450*	125	445**	115

Note. Changes in physical activity between Weeks 9–16 and 17–24 were not significant.
*$p \leq .05$; Significant changes between Weeks 1–8 and Weeks 9–16.
**$p \leq .05$; Significant changes between Weeks 1–8 and Weeks 17–24.

Mood and Physical Activity Throughout the BWLP

The association between mood measured before and after the GXT at baseline and average weekly time spent in planned exercise during the beginning, middle, and end of the BWLP (physical activity diary) and calories expended from total physical activity during the beginning, middle, and end of the BWLP (accelerometers) was examined. Affective responses reported on the POMS subscales before and after the GXT at baseline were significantly correlated with duration of planned exercise (see Table 3). Women who reported greater pre- and postexercise vigor and less postexercise confusion scores reported greater time spent in planned exercise during the middle and final 8 weeks of the BWLP ($p \leq .01$). In contrast, women who reported high post-GXT fatigue scores reported less time spent in planned exercise during the final 8 weeks of the BWLP ($p \leq .01$). The association between mood before and after the GXT and planned exercise became stronger over the course of the BWLP. No mood states were significantly correlated with total activity calories expended during treatment (see Table 3).

Relationships Between Initial Mood States and Physical Activity and Predicted VO_{2max} After the BWLP

Mood states were significantly correlated with predicted VO_{2max} at the end of the intervention (see Table 4). Contrary to prediction, higher postexercise depression and anger scores were associated with greater VO_{2max} by the end of the BWLP ($p \leq .01$). Mood states were not significantly correlated with calories expended from leisure-time physical activity (PPAQ).

Relationships Between Initial Mood States and Physical Activity and Predicted VO_{2max} Partialing out Depression and Anxiety

Partial correlation analyses were conducted between the mood subscales and indices of physical activity and predicted VO_{2max} while partialing out the influences of depression (Beck, 1976; Beck et al., 1988) and anxiety (Spielberger, 1983). All

Table 3 Correlations Between Mood and Physical Activity Diary Data With Income, Education, Change in Body-Mass Index, and Baseline Physical Activity Partialed Out (*N = 25*)

	Weeks 1–8		Weeks 9–16		Weeks 17–24	
Mood subscale	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Duration of planned exercise						
tension-anxiety	–.33	–.40	–.37	–.30	–.42	–.47
depression-dejection	–.08	.00	–.06	–.12	.01	–.10
anger-hostility	–.20	–.14	–.22	–.18	–.28	–.20
vigor-activity	.43	.48	.54**	.57**	.51**	.68**
fatigue-inertia	–.21	–.20	–.35	–.36	–.42	–.60**
confusion-bewilderment	–.18	–.51	–.38	–.58**	–.33	–.67**
Total activity calories (accelerometers)						
tension-anxiety	.18	.16	–.06	–.01	–.09	.06
depression-dejection	.01	–.18	.17	–.01	.09	–.05
anger-hostility	–.05	–.12	–.03	.08	.01	–.06
vigor-activity	–.07	–.10	.31	–.26	.40	.22
fatigue-inertia	–.11	–.19	–.24	–.25	–.42	–.27
confusion-bewilderment	.38	–.06	.23	–.14	.17	–.21

$^{**}p < .01$.

Table 4 Correlations Between Mood and Physical Activity and Predicted VO_{2max} With Income, Education, Change in Body-Mass Index, and Baseline Physical Activity Partialed Out (*N* = 25)

Mood subscale	**Pretest**	**Posttest**
Leisure-time physical activity		
tension-anxiety	–.37	–.46
depression-dejection	.06	.04
anger-hostility	–.18	–.12
vigor-activity	.35	.31
fatigue-inertia	.04	–.09
confusion-bewilderment	–.45	–.33
VO_{2max}		
tension-anxiety	.34	.44
depression-dejection	.12	.53**
anger-hostility	.40	.64**
vigor-activity	.03	–.25
fatigue-inertia	.09	–.03
confusion-bewilderment	.00	.19

$^{**}p < .01$.

comparisons indicating significant associations between the POMS subscales and physical activity remained significant after controlling for self-reported depression and anxiety. Because the results were basically unchanged from previous analyses, only changes in significance levels are discussed in the next section. In addition, the previously reported nonsignificant relationship between lower preexercise confusion scores and greater leisure-time physical activity became significant ($p \leq .01$). Thus, ongoing states of depression and anxiety appeared to have little influence on the relationship between mood and the various physical activity indices and predicted VO_{2max}.

Discussion

This investigation examined the relationships between acute affective responses to the GXT, levels of physical activity, and predicted VO_{2max} during and after a BWLP in sedentary, obese, postmenopausal women. It was hypothesized that an individual's mood immediately before and after the GXT would reflect her generalized feelings toward exercise and that an individual's generalized feelings toward exercise might influence physical activity and fitness during and at the end of the BWLP. It was further hypothesized that greater positive mood enhancement after exercise, an indication of the reinforcing qualities of the exercise, would also be positively associated with future physical activity participation in previously sedentary women.

Mood measured before and after the baseline GXT was associated with level of planned physical activity and predicted VO_{2max} at the end of the BWLP. Subsequent analyses indicated that the association between mood and physical activity during and after the BWLP and predicted VO_{2max} after the BWLP remained significant after controlling for the influence of depression and anxiety. Contrary to prediction, there was no evidence that mood enhancement after exercise was associated with level of physical activity or predicted VO_{2max} during or after the BWLP. It is plausible that factors not assessed in this investigation, such as motivation to lose weight or barriers to exercise, might have a stronger association with level of physical activity or predicted VO_{2max} during or after a BWLP than mood enhancement.

As mentioned earlier, some individuals experience powerful affective responses when they exercise. Some BWLP participants express a general dislike for exercise, which includes feelings of anxiety, embarrassment, and apprehension. It is surprising that, to our knowledge, no research has examined whether an affective response before or after exercise is associated with physical activity and fitness during and at the end of an intervention. We hypothesized that generalized feelings toward exercise in a sedentary population would be associated with physical activity and fitness during and at the end of a BWLP.

Several striking patterns between mood and physical activity during and after the BWLP emerged. First, mood before and after a single bout of exercise was more strongly associated with time spent in planned exercise than other forms of physical activity, such as the calories expended in physical activity. These results are not altogether surprising. The accelerometers provide an estimate of total activity calories expended each day. These daily estimates include numerous forms of physical activity including activity associated with domestic and occupational activities, spontaneous physical activity performed during the day (e.g., taking the stairs, parking farther away), and planned exercise. Calories expended in response to occupational and domestic responsibilities might be under minimal volitional control and, therefore, might vary considerably between individuals. In contrast, individuals decide when, where, and how long they are going to participate in planned exercise. Thus, planned exercise is under much greater volitional control. In this investigation, planned exercise activities, which are subject to greater volitional control, were strongly associated with mood. Physical activity subject to less volitional control (but measured by accelerometer) was not associated with mood.

A second pattern that emerged from the findings was that the association between mood and planned exercise became stronger over the course of the BWLP. For example, during the first 8 weeks of the BWLP, no POMS subscales were associated with level of planned exercise. By the end of the BWLP, however, four POMS subscales (i.e., pre- and postexercise vigor, postexercise fatigue and confusion) were associated with level of planned exercise. In nearly all instances, the correlation coefficients between mood before and after exercise testing and planned exercise increased over the course of the BWLP. One possible explanation for these findings is that during the beginning of the BWLP, all women were excited about the program and pushed themselves to exercise regularly. As the novelty of the new program began to wane, however, exercising regularly might have become more difficult. In fact, although level of physical activity and VO_{2max} improved from pre- to post-BWLP in this investigation, examination of the within-treatment changes in physical activity (Caltrac and physical activity diaries) indicated that women exercised significantly less near the end of the BWLP than they did near the beginning. Therefore, it is plausible that after the initial excitement of the exercise regimen dissipated, the women's global feelings toward exercise became more salient motivators of planned exercise. Given that emotions can influence motivation, self-efficacy, and evaluations of an activity (Frijda et al., 1992; Hirt, McDonald, & Melton, 1996), it is not surprising that negative emotions associated with exercise resulted in lower levels of future physical activity.

Because acute affective responses to exercise and post-BWLP physical activity remained significant after we controlled for the influence of self-reported depression and anxiety, the association between acute mood state and subsequent physical activity levels did not appear to be a function of depression and anxiety (as assessed with the Beck Depression Inventory and the Spielberger Trait Anxiety Inventory). These findings indicated that affective responses specific to exercise might have a meaningful association with sustained physical activity levels at the end of the BWLP.

The women's scores on the POMS (i.e., depression, anger) after the GXT were significantly and positively associated with greater VO_{2max} by the end of the intervention. These findings were surprising and are difficult to interpret with the data available from this investigation. All women in this investigation were obese and sedentary. The women's POMS subscales generally showed favorable mood states before and after the GXT when compared with normative data (McNair et al., 1992). It is nonetheless conceivable that some of the women experienced undesirable moods after the GXT. These negative postexercise moods might have encouraged the women to make positive changes in exercise that were reflected in post-BWLP VO_{2max}. As this investigation showed, however, it was difficult for all women to sustain high levels of physical activity, particularly those with a negative affective response to exercise. Future research in this area is clearly warranted.

A particular strength of this investigation was its use of three different indices of physical activity, as well as predicted VO_{2max}. Physical activity was assessed using a self-report questionnaire, a physical activity diary, and an accelerometer, and predicted VO_{2max} was assessed with GXT. Given the robust findings between planned physical activity and mood, however, those doing future research examining the relationship between mood and physical activity might want to assess physical activity that is under greater volitional control, such as planned physical activity.

Although the findings in this investigation suggest an association between acute mood states before and after the GXT and subsequent level of physical activity and predicted VO_{2max} by the end of the BWLP, these relationships should be viewed tentatively for several reasons. The number of women in this intervention was modest, multiple statistical tests might have increased the likelihood of Type I error, and most of the women were White, of European-American descent, and from the Midwest. Replication of these preliminary findings with a large, more diverse sample is clearly warranted. Caution should be taken in applying the findings from this investigation to urban populations or ethnic minority patients. Although it is common to examine mood enhancement after walking (Berger & Owen, 1998; Jin, 1992), walking on a treadmill during a GXT is arguably quite different than a brisk walk with friends or on a treadmill at the gym. In addition, a GXT might be an intimidating task for sedentary, obese individuals. Nevertheless, the women appeared to evidence minimal psychological distress on the POMS subscales before the GXT and demonstrated the commonly observed mood enhancement after exercise. Therefore, although it is not a perfect proxy for exercise, there was no evidence that the women dreaded the treadmill task or responded differently to the GXT than they would have responded to different forms of physical activity or sport. In addition, mood before and after the GXT was significantly associated with engagement in regular exercise. Finally, this investigation only examined mood states associated with exercise before the beginning of a BWLP. Therefore, future investigations might focus on how mastery of exercise is associated with changes in mood states over time.

In conclusion, exercise is recognized to be one of the most important factors in successful weight maintenance after weight loss (Perri & Corsica, 2002; Tremblay et al., 1999). Nonetheless, many women entering formal weight-loss or physical activity programs every year might evidence a number of risk factors for poor treatment outcome. Women who have more negative mood states before and after exercise might exercise less than women who have more positive mood states. Affective responses associated with exercise might yield important evaluational, motivational, and cognitive information that can be used to effectively identify and promote physical activity in reluctant adults (Berger, 2004).

A baseline assessment of mood states (such as with the POMS) before and after exercise might help identify individuals at risk for poor treatment outcome. Individuals exhibiting negative moods before or after exercise might benefit from a brief intervention to overcome negative feelings or ambivalence toward exercise. Motivational interviewing (a therapeutic technique developed to enhance intrinsic motivation to change by exploring and resolving ambivalence; Miller & Rollnick, 2002) has been used in numerous interventions to enhance motivation across a variety of conditions including substance abuse, eating habits, and exercise (Dunn, Deroo, & Rivara, 2001). The effectiveness of behavioral weight-loss programs appears to have reached a plateau during the 1990s (at approximately 10% of total body-weight loss; Perri & Fuller, 1995). Perhaps, through early identification and remediation of risk factors for poor treatment outcome, such as mood states toward exercise, physical activity and weight-loss programs can continue to improve into the 21st century.

Notes

[1]Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure beyond resting expenditure (Thompson et al., 2003). Exercise is a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improving or maintaining physical fitness is the objective (Thompson et al.). Sport is also a subset of physical activity that commonly refers to a physical activity that requires practice or preparation to improve or perfect, often occurs in a structured environment with standard rules, and often involves competition. In this investigation, we assessed the influence of mood before and after a GXT on both physical activity and exercise behavior. We attempted to employ terminology consistent with our definitions in this article.

[2]Although various terminological distinctions between affect, emotion, and mood have been offered (Morris, 1989), there are no universally agreed-on distinctions (Schwarz & Clore, 1996). Therefore, the terms *mood, emotion,* and *affect* are used interchangeably throughout this article.

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