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Tired, moody and pregnant? Exercise may be the answer
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Tired, moody and pregnant? Exercise may be the answer
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Negative psychological states such as depression, fatigue and anxiety are experienced by many women during pregnancy. This study examined whether engaging in an exercise programme during pregnancy is associated with improvements in psychological well-being among previously inactive women ($n=56$, $M$ age $=30.34$, SD $=4.57$; $M$ weeks pregnant $=22.58$, SD $=5.32$). Participants completed the Profile of Mood States–Short Form and State Trait Anxiety Scale-Trait version at baseline and after four weeks of exercise. Exercise was assessed using accelerometers and these data were used to determine bouts of 30-min of moderate-to-vigorous exercise. Factorial repeated measures ANOVAs demonstrated that participants who met Canadian guidelines for exercise during pregnancy at week four ($n=17$) experienced significant decreases in depression ($p=.004$, $\eta^2=.13$), anger ($p=.03$, $\eta^2=.08$), tension ($p=.03$, $\eta^2=.08$), fatigue ($p=.01$, $\eta^2=.10$), trait anxiety ($p=.01$, $\eta^2=.12$) and increases in vigour ($p=.001$, $\eta^2=.19$) compared to those who were not meeting guidelines ($n=39$). From a psychological health perspective, these findings highlight the importance of continuing to promote exercise during pregnancy.

Keywords: pregnancy; exercise; affect; fatigue; depression; anxiety

Introduction

Research has consistently demonstrated that exercise during pregnancy is associated with numerous physical health benefits for both the mother and her unborn child (Pivarnik et al., 2006). For example, exercise can help manage pregnancy-related musculoskeletal issues, improve sleep, prevent excessive weight gain, shorten labour and reduce the need for obstetric interventions (Pivarnik et al., 2006). In addition, prenatal exercise has been associated with a significantly reduced risk of two serious and potentially fatal conditions: gestational diabetes and pre-eclampsia (Lewis et al., 2008). Given these benefits, Canadian guidelines recommend that in the absence of complications, pregnant women should exercise for 30 min at a moderate intensity on four days of the week (Davies, Wolfe, Mottola, & MacKinnon, 2003; Mottola, in press). Despite these recommendations, between 60 and 75% of pregnant women are inactive (Gaston & Vamos, 2012; Poudevigne & O’Connor, 2006).

With respect to psychological health, postpartum mood disorders have been recognised for more than a century (Poudevigne & O’Connor, 2006). More recently,

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however, research has demonstrated that there is actually a higher rate of depression, anxiety and fatigue during pregnancy than following pregnancy (Poudevigne & O’Connor, 2006). Furthermore, we now know that negative affective states represent a significant health challenge for a substantial proportion of pregnant women. Field et al. (2003), for example, found that at 30 weeks gestation, the prevalence of anxiety and depression was 16.8 and 18.7%, respectively and another study found that approximately 25% of pregnant women reported elevated levels of depressive symptomatology, while 10% met diagnostic criteria for clinical depression during pregnancy (Gotlib, Whiffen, Mount, Milne, & Cordy, 1989).

Mood disturbances such as depression and anxiety during pregnancy are cause for concern for several reasons. First, approximately half of all cases of postpartum depression originate during pregnancy (Gotlib et al., 1989), indicating that untreated mood disturbances during pregnancy can become precursors to postpartum mood disorders. Second, several complications have been associated with depressed mood and anxiety during pregnancy. These include insufficient weight gain, underutilisation of prenatal care, increased substance use, premature birth, small for gestational age babies, lower Apgar scores and reduced intention to breastfeed (Insaf et al., 2011; Marcus, 2009). In addition, evidence exists that the children of mothers who are depressed or anxious during pregnancy have higher cortisol levels at birth and adolescence, impaired cognitive skills and a greater risk of developmental and mental disorders (Brennan et al., 2008; LeWinn et al., 2009).

While fatigue has not received as much research attention as depression and anxiety, evidence exists that between 90 and 97% of women report experiencing at least occasional fatigue during their pregnancy, and approximately half of women experience frequent fatigue (Chou, Lin, Cooney, Walker, & Riggs, 2004; Reeves, Potempa, & Gallo, 1991). Despite the fact that it is a common and often accepted experience of pregnancy, fatigue has been shown to significantly hinder a woman’s ability to maintain both personal and social activities (Reeves et al., 1991), disturb sleep, negatively impact physical and mental health and increase the risk of caesarean delivery (Fairbrother, Hutton, Stoll, Hall, & Kluka, 2008).

No doubt, psychological well-being lies on a continuum, and few individuals can completely escape the occasional mood fluctuation. Taken together, however, the existing body of evidence has shown that even without exhibiting clinical mood disorders, pregnant women tend to report more negative affect than similar non-pregnant individuals. In a review of exercise during pregnancy and its relationship to psychological health, Poudevigne and O’Connor (2006) reported that the majority of studies revealed a moderate to large effect size for the magnitude associated with mood disturbances during pregnancy. This finding highlights the importance of continuing to explore safe ways of improving psychological well-being during pregnancy, and exercise represents one possible approach.

Exercise and psychological well-being during pregnancy
To explore what is already known regarding the relationship between exercise and mood during pregnancy, a thorough literature search was performed using the following search terms: exercise or physical activity, and pregnancy or prenatal, and mood or
psychological health or psychological well-being or mental health or depression or anxiety. Search terms had to be in the title and/or abstract and the databases searched were PubMed, PsycInfo and ScienceDirect, as well as the Internet search engine www.scholar.google.com. No date restrictions were set and this search strategy yielded a total of 268 articles including duplicates. Articles that did not focus on the quantitative relationship between exercise and psychological well-being during pregnancy were excluded, leaving only 10 original studies and two narrative review articles. Eight of the 10 studies were captured in either one or both of the two review articles and the remaining two were published more recently.

In the older of the two reviews, Poudevigne and O’Connor (2006) identified a total of six articles which quantified the relationship between physical activity and mood, with four of the studies demonstrating a positive relationship between the two variables. Wallace Boyer, Dan, and Holm (1986) found that compared to women who do not exercise, those who participate in aerobic exercise report significantly lower fatigue. Goodwin, Astbury, and McMeeken (2000) found that pregnant women who exercised four or more times per week for a minimum of 30 min at a time reported fewer anxiety symptoms than their more sedentary counterparts. DaCosta, Rippen, Dritsa, and Ring (2003) examined the relationship between leisure-time exercise and depressed mood and anxiety during each trimester of pregnancy among exercising and non-exercising pregnant women. Irrespective of trimester, exercisers reported significantly lower anxiety depressed mood compared to non-exercisers. Koniak-Griffin (1994) found that pregnant adolescents (age ranged 14–20) living in a residential maternity home who participated in a six-week aerobic exercise programme reported a significant pre-post decrease in depressive symptomatology. Poudevigne and O’Connor (2005) assessed exercise levels and mood once monthly from 12 to 36 weeks. Participants’ exercise and mood both remained relatively stable across the study and the small mood changes which did occur were not correlated with exercise in either group. Finally, Williams, Reilly, Campbell, and Sutherst (1988) compared mood among pregnant and non-pregnant exercising women. Although pregnant women reported increased fatigue and confusion across time, there were no statistically significant effects or interactions, and correlations between mood and exercise were not reported.

In the more recent review, Lewis and Kennedy (2011) examined the relationship between depression and exercise among pregnant women. The authors identified only four studies, two of which were included in the Poudevigne and O’Connor (2006) review and have been summarised above (DaCosta et al., 2003; Poudevigne & O’Connor, 2005). The remaining two studies used a two-group design to demonstrate that compared to the control group, pregnant women who participated in a single exercise session reported significant pre-post improvements in mood (Polman, Kaiseler, & Borkoles, 2006) and anxiety (Koltyn, 1994).

In addition, our literature search uncovered two additional studies which were both published in 2012. Loprinzi, Fitzgerald, and Cardinal (2012) examined the association between objectively measured exercise and depression symptoms using cross-sectional data from the National Health and Nutrition Examination Survey in the USA. More than 19% of participants experienced some symptoms of depression and compared to their counterparts without depressive symptoms, they were less physically active. Robledo-Colonia, Sandoval-Restrepo, Mosquera-Vaderrama, Escobar-Hurtado, and Ramirez-Vélez (2012) randomised pregnant women to either a control or experimental
condition. Participants in the experimental condition attended three weekly sessions of supervised aerobic exercise for 12 weeks. Results demonstrated that compared to the control group, participants in the intervention group reported significant reductions in depressive symptoms from baseline to follow-up.

Taken as a whole, there was considerable variability among the studies with regard to how exercise and mood were assessed. For example, two studies examined depression using the Center for Epidemiologic Studies Depression scale (CES-D; Koniak-Griffin; Robledo-Colonia), one used the Patient Health Questionnaire-9 (Loprinzi et al., 2012), one used the Lubin depression adjective checklist (DaCosta et al., 2003), one used the Mood adjective checklist (Williams et al., 1988), two used the Profile of Mood States (POMS; Polman et al., 2006; Poudreveigne & O’Connor, 2005) and two assessed anxiety using the State-Trait Anxiety Inventory (STAI; Goodwin et al., 2000; Koltyn, 1994). With respect to exercise, two studies relied on direct observation (Koniak-Griffin, 1994; Robledo-Colonia et al., 2012), one used accelerometry data (Loprinzi et al., 2012) and the remaining seven studies used self-reported measures.

Although eight of the 10 studies summarised above indicate that exercise is associated with improved mood during pregnancy, several limitations highlight the need for further research. These include the narrow range of psychological well-being variables assessed by any single study, an overwhelming reliance on self-report exercise data, a failure to classify exercisers vs. non-exercisers based on current guidelines, unequal contact time between experimental and control groups (Koltyn, 1994; Polman et al., 2006) and a small sample size (Poudreveigne & O’Connor, 2005). Perhaps the largest limitation, however, is that only two of the studies examined changes in mood and exercise over time amongst previously inactive women who began an exercise programme (Koniak-Griffin, 1994; Robledo-Colonia et al., 2012). The remaining studies were either observational or cross-sectional (DaCosta et al., 2003; Goodwin et al., 2000; Loprinzi, Fitzgerald, & Cardinal, 2012; Poudreveigne & O’Connor, 2005; Wallace et al., 1986; Williams et al., 1988), or examined the psychological effects of a single exercise bout (Koltyn, 1994; Polman et al., 2006).

**Objective**

The purpose of the present study was to simultaneously address some of the limitations highlighted above by examining whether engaging in a short (i.e. four week) exercise intervention programme would be associated with improvements in a wide range of psychological well-being constructs in previously inactive pregnant women. We hypothesised that women who were meeting objectively assessed Canadian guidelines for exercise during pregnancy (≥4 bouts/week) at four weeks post-intervention would report significantly decreased overall mood disturbance, depression, fatigue, anger, tension, confusion, anxiety, as well as significantly increased vigour.

**Method**

**Design**

This study represents the secondary analysis of a randomised control trial whose primary aim was to evaluate the effectiveness of three different intervention techniques.
Ethical approval (#16217E) was obtained from the Research Ethics Board of the host institution. Women were eligible to participate if they were inactive (i.e. participated in fewer than two weekly exercise sessions), had not been told by their doctor to avoid exercise, and were between 13 and 31 weeks gestation. Women in the first trimester of pregnancy were excluded based on the fact that some women may be hesitant to begin an exercise programme during the first trimester when miscarriage is more likely to occur. The upper cut-point of 31 weeks was chosen to ensure that participants could complete the study before getting too close to their anticipated delivery date. The study was promoted through an article in a weekly community newspaper, a posting on an online Ontario-based parenting newsgroup, and a midwifery clinic which agreed to pass out a written invitation letter. Women were asked to express their interest by contacting the primary investigator, and 6, 36 and 18 women were recruited through each of the aforementioned strategies, respectively ($N_{\text{total}} = 60$). Eligibility was ensured by telling women that in order to participate they must meet the above criteria. The study took place in Southwestern Ontario, Canada, between June 2010 and May 2011.

After receiving a letter of information and providing informed consent, participants were equipped with an accelerometer for their seven-day baseline assessment. At the end of this seven-day period (i.e. after the baselines accelerometer assessment was completed), participants were randomised to one of three intervention groups: (1) an information-only intervention based on protection motivation theory (PMT; Rogers, 1975), (2) a PMT-based intervention plus action planning based on the health action process approach (HAPA; Schwarzer, 2008) or (3) a PMT-based intervention plus combined HAPA-based action and coping planning. The interventions all focused on promoting leisure-time exercise to meet current recommendations. After participating in their respective exercise intervention, participants completed a baseline questionnaire assessing demographic and mood variables via an online survey website (www.surveymonkey.com). Four weeks later, all participants were contacted by email and reminded to wear the accelerometer for their final seven-day follow-up period. Participants then completed a follow-up questionnaire assessing all mood variables before being debriefed and given the opportunity to re-consent. The overall design of the study can be seen in Figure 1. Although complete details regarding the design, primary outcome measures and findings have been published elsewhere (Gaston & Pappavessis, 2012), repeated measures ANOVAs demonstrated that participants in both planning groups engaged in significantly more exercise bouts than those in the PMT-only group by four-weeks post-intervention. The conduct of the trial followed the ethical principles of research outlined in the Declaration of Helsinki (World Medical Association, 2008) and the World Health Organization’s Handbook for Good Clinical Research Practice (World Health Organization, 2005).

Participants
The final sample consisted of 56 pregnant women who provided complete data. The women had a mean age of 30.34 years (SD = 4.57), were on average 22.58 weeks pregnant (SD = 5.32), and weighed an average of 76.37 kilograms (SD = 14.03). None of the participants met Canadian guidelines for exercise during pregnancy at study entry ($M = 0.34$ bouts of moderate-intensity exercise lasting 30 or more minutes per week, $SD = 0.58$). Sixty percent were pregnant with their second or subsequent child, all were...
married or living with a common-law spouse, and 91.1% were Caucasian. With respect to socio-demographic characteristics, 83.9% had a college degree or higher, the median household income was $60,000–$79,999 and 53.6% were employed either full or part time. Compared to the mean demographic characteristics of pregnant women living in the same geographical area, the present sample was similar in age, ethnicity and income level. However, women who participated in the study were more likely to be married, better educated or a stay at home mother (Brant County Health Unit, 2006, 2011).

Main outcome measures

Mood

Mood was assessed using the Profile of Mood States – Short Form (POMS-SF; Shacham, 1983). The short form of the POMS was selected in order to reduce participant burden, and several studies have demonstrated that this 37-item questionnaire has excellent reliability, validity and factor structure (Baker, Denniston, Zabora, Plland, & Dudley, 2002; Curran, Andrykowski, & Studts, 1995, Shacham, 1983). The POMS-SF uses individual adjectives to measure six distinct mood states: depression, anger, tension, confusion, fatigue and vigour. Items were written in reference to how participants feel in general, and were rated on a five-point scale ranging from 1 = ‘never or rarely true’ to 5 = ‘very often or always true’. Sample items include ‘sad’, ‘hopeless’ (depression),
‘bitter’, ‘peeved’ (anger), ‘nervous’, ‘anxious’ (tension), ‘confused’, ‘forgetful’ (confusion), ‘worn out’, ‘fatigued’ (fatigue) and ‘energetic’ ‘active’ (vigor). A mean score was created for each subscale by summing individual items and dividing by the number of items. A total mood disturbance (TMD) score was calculated by adding the six affective states (with vigor negatively weighted). Reliability for all subscales was adequate ($\alpha = .67 – .85$ at baseline and $\alpha = .82 – .90$ at follow-up).

**Trait anxiety**

Trait anxiety was measured using the 20-item Trait version of the State-Trait Anxiety Inventory (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The STAI-T is a self-report scale which has been used extensively as a clinical and research instrument, and has been demonstrated to be a valid tool for assessing anxiety during pregnancy (Grant, McMahon, & Austin, 2008). Items are rated on a four-point scale ranging from 1 = ‘almost never’ to 4 = ‘almost always’, and some questions refer to the absence of anxiety and are reverse scored. The scale measures the general tendency to be anxious and sample items include: ‘I worry too much over something that really doesn’t matter’ and ‘I am content; I am a steady person’. Mean scores were calculated by summing the items and dividing by the total number of items and a higher score is indicative of higher anxiety. The scale has been shown to have good construct and concurrent validity (Spielberger, 1989). Reliability coefficients for the present study were adequate ($\alpha = .87$ at baseline and $\alpha = .88$ at follow-up).

**Behavioral outcome measures**

**Exercise**

Objective exercise was measured using the Actical® accelerometer (Mini MitterRespironics, Inc., Bend, OR), a small, lightweight and water-resistant monitor which has been validated to measure exercise in adults (Heil, 2006). All data are blind to participants while the device is being worn. Accelerometer data were collected with one-min epochs, and monitors were calibrated by the manufacturer prior to the beginning of the study. Accelerometer data used for this analysis were obtained from each participant for two distinct seven-day periods: baseline and follow-up (the seven-day period beginning four weeks after the intervention).

**Accelerometer data analysis**

A day was defined as valid if it had 10 or more hours of monitor wear time, and 4 or more valid days for each time period were required for analyses (Colley et al., 2011). Wear time was obtained by subtracting non-wear time from 24 h, and non-wear time was defined as 60 or more consecutive minutes of zero counts. Minimum wear time was obtained for 100% of participants for both seven-day periods. The raw data were analysed using custom software KineSoft version 3.3.62 (KineSoft, Saskatchewan, Canada) according to the procedures outlined by Esliger Copeland, Barnes, and Tremblay (2005). Cut-points were applied which classified the data according to level of intensity – light, moderate or vigorous. The main variable of interest was 30-min bouts
of moderate-vigorous physical activity (MVPA). A maximum of five observations falling below the cut-point were allowed (i.e. 25 out of 30 min had to be above the cut-point; Colley et al., 2011). As no validation studies have been conducted to determine appropriate intensity cut-points for pregnant women, the cut-points used were in accordance with Actical® manufacturer recommendations (Heil, 2006). Intensity-level cut-points corresponded to the following metabolic equivalent of task (MET) values: light intensity (<3.0 METs), moderate intensity (3.0 to <6.0 METs) and vigorous intensity (≥6.0 METs) (Heil, 2006). These MET values are in line with exercise intensity recommendations for pregnant women (Chasan-Taber, Freedson, Roberts, Schmidt, & Fraga, 2007). Participants were characterised as ‘meeting guidelines’ if they accumulated a minimum of four bouts of MVPA during the seven-day follow-up assessment period.

Results

Fidelity check

All analyses were conducted using SPSS 17 for Windows and included only participants which provided complete data (n = 56, see Figure 1). As a fidelity check of the exercise classification system used in the present study, a 2 (i.e. meeting vs. not meeting exercise guidelines) by 2 (time: baseline, follow-up) repeated measures ANOVA was used to confirm that participants who were meeting exercise guidelines at follow-up were significantly more active than those who were not meeting guidelines. As expected this interaction was significant (see Table 1).

Furthermore, several steps were taken to ensure that changes in mood were independent of intervention group. First, separate repeated measures ANOVAs with mood as the dependent variable and intervention group as the between-subjects factor demonstrated that no significant group differences existed (ps = .34–.97). In addition, because meeting guidelines was not directly related to intervention group, separate one-way ANOVAs were conducted to confirm that follow-up mood scores were also unrelated to intervention group within each group (i.e. meeting vs. not meeting guidelines). Results were non-significant for all variables in participants meeting guidelines (ps = .26–.98) and in participants not meeting guidelines (ps = .47–.96).

Group equivalency

Independent t-tests and \( \chi^2 \) procedures were used to ensure that there were no systematic differences between groups (i.e. meeting vs. not meeting exercise guidelines) on demographic characteristics or baseline exercise. All results were non-significant (ps = .27–.93), except for a trend effect for parity (p = .08). In addition, independent group t-tests confirmed that no group differences existed with respect to baseline POMS-SF or trait anxiety scores (ps = .23–.86). Based on these results, the use of demographic, exercise and/or mood variables as covariates in the subsequent analyses was deemed unnecessary.

Treatment of data and statistical analysis

Two (group: meeting vs. not meeting guidelines) by 2 (time: baseline vs. follow-up) repeated measures ANOVAs were computed for POMS-SF and STAI-T variables.
Table 1. Repeated measures ANOVA results for POMS-SF, STAI-T and exercise scores.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Not meeting recommendations (&lt;4 bouts/week) (n = 39)</th>
<th>Meeting recommendations (≥4 bouts/week) (n = 17)</th>
<th>Wilks’ lambda</th>
<th>F (1, 54)</th>
<th>p</th>
<th>Effect size (η²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline mean (SD)</td>
<td>Follow-up mean (SD)</td>
<td>Baseline mean (SD)</td>
<td>Follow-up mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POMS-SF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMD</td>
<td>8.46 (2.71)</td>
<td>8.40 (2.91)</td>
<td>8.71 (2.60)</td>
<td>6.50 (2.02)</td>
<td>.81</td>
<td>12.50 .001 .19</td>
</tr>
<tr>
<td>Depression</td>
<td>1.52 (.49)</td>
<td>1.59 (.55)</td>
<td>1.71 (.58)</td>
<td>1.39 (.38)</td>
<td>.87</td>
<td>8.22 .006 .13</td>
</tr>
<tr>
<td>Vigour</td>
<td>2.69 (.60)</td>
<td>2.62 (.59)</td>
<td>2.73 (.75)</td>
<td>3.23 (.56)</td>
<td>.81</td>
<td>12.30 .001 .19</td>
</tr>
<tr>
<td>Tension</td>
<td>2.21 (.68)</td>
<td>2.19 (.75)</td>
<td>2.31 (.63)</td>
<td>1.98 (.52)</td>
<td>.92</td>
<td>4.55 .037 .08</td>
</tr>
<tr>
<td>Anger</td>
<td>1.95 (.61)</td>
<td>1.88 (.65)</td>
<td>1.92 (.62)</td>
<td>1.58 (.49)</td>
<td>.93</td>
<td>4.15 .047 .07</td>
</tr>
<tr>
<td>Confusion</td>
<td>2.16 (.57)</td>
<td>2.10 (.68)</td>
<td>2.31 (.71)</td>
<td>2.14 (.77)</td>
<td>.99</td>
<td>.32 .575 .01</td>
</tr>
<tr>
<td>Fatigue</td>
<td>3.30 (.89)</td>
<td>3.25 (.84)</td>
<td>3.18 (.75)</td>
<td>2.62 (.45)</td>
<td>.90</td>
<td>5.93 .018 .10</td>
</tr>
<tr>
<td>STAI-T</td>
<td>1.89 (.38)</td>
<td>1.87 (.41)</td>
<td>1.93 (.46)</td>
<td>1.68 (.35)</td>
<td>.88</td>
<td>7.02 .011 .12</td>
</tr>
<tr>
<td>Bouts of MVPA</td>
<td>0.28 (.51)</td>
<td>1.48 (1.27)</td>
<td>0.47 (.72)</td>
<td>4.82 (.88)</td>
<td>.43</td>
<td>71.79 .000 .57</td>
</tr>
</tbody>
</table>

Note: MVPA= moderate-vigorous physical activity; POMS-SF = Profile of Mood States – Short Form; SD = standard deviation; STAI-T = State-Trait Anxiety Inventory – Trait version; TMD = Total Mood Disturbance. POMS-SF items were rated on a five-point scale ranging from 1 = ‘never or rarely true’ to 5 = ‘very often or always true’. STAI-T items are rated on a four-point scale ranging from 1 = ‘almost never’ to 4 = ‘almost always’. Lower mean scores therefore represent less depression, anger, confusion, tension, fatigue, vigor, anxiety as well as less overall mood disturbance.
Group differences

Mood

Significant interaction effects were found for five out of the six mood subscales and TMD (Table 1). Specifically, participants who were meeting guidelines at follow-up (≥4 bouts of MVPA/week) reported significantly reduced depression, tension, anger, and fatigue and significantly increased vigour (all ps < .05) compared to those who were not meeting guidelines (<4 bouts of MVPA/week).

Trait anxiety

Significant interaction effects were found for trait anxiety (Table 1). Specifically, participants who were meeting guidelines at follow-up reported significantly lower overall anxiety compared to baseline whereas their less active counterparts did not experience any significant changes in anxiety across the same time period.1

Discussion

The relationship between exercise and psychological well-being during pregnancy represents an important but understudied area of research. The evidence to date, however, suggests that exercise may be useful for improving mood, and the results of the present study support this view by demonstrating that previously inactive women who succeeded in meeting objectively assessed exercise guidelines following a four-week exercise intervention also reported significant improvements in psychological well-being across this same time period. Beyond this generalised conclusion, several issues warrant more detailed commentary.

The improvements in depressive symptoms reported by participants who met guidelines at follow-up are in line with the results of previous intervention studies (Koniak-Griffin, 1994; Robledo-Colonia et al., 2012). Although, different scales were used to assess depression, it is worth noting that the magnitude of the pre-post improvements were on the order of .41, .50 and .55 standard deviations in Koniak-Griffin’s, Robledo-Colonia’s and the present work, respectively. Interestingly, these differences mirror the frequency of exercise specified in each study (2, 3 or 4 days per week, respectively). While these results alone are insufficient to support a dose–response association between exercise and mood, it is possible that until a ceiling effect is reached, increased exercise volume will be associated with greater mood improvements.

Both physiological and psychological mechanisms have been advanced in an attempt to explain the beneficial effects of exercise on depressed mood. For example, although the neurobiological basis of depression is poorly understood, the monoamine hypothesis proposes that exercise’s antidepressive properties stem from neurotransmitter (i.e. dopamine, serotonin and norepinephrine) enhancement as well as hippocampal neurogenesis (Shivakumar et al., 2011). Several psychological hypotheses have also been advanced. For example, the distraction hypothesis suggests that physical activity can distract individuals from depressive thoughts or worries, and the self-efficacy hypothesis proposes that physical activity has the ability to increase self-efficacy through meaningful mastery experiences (Craft & Perna, 2004). While evidence exists to support each hypothesis, attempts to understand the relationship between exercise and mood should
Ideally take into account a combination of mechanisms utilising a biopsychosocial approach (Craft & Perna, 2004).

It should not be overlooked, however, that the POMS was designed to assess mood fluctuations among psychologically normal populations and is not intended to be used as a clinical diagnosis of depression. Although no cut-off scores have been proposed for the use of the POMS as a screening test for depression during pregnancy (Kermode, Fisher, & Jolley, 2000), the low mean scores ($M = 1.58, SD = 0.52$ on a five-point scale) reported by the participants in the present study are unlikely to be indicative of clinical levels of depression. As such, it is unknown whether the present findings are of any clinical significance.

The present study complements the work of Koniak-Griffin (1994) and Robledo-Colonia et al. (2012) on the relationship between exercise and depressed mood during pregnancy in several important ways. First, while Koniak-Griffin (1994) and Robledo-Colonia et al. (2012) assessed depressive symptoms after six or 12 weeks of exercise, respectively; the present study was able to demonstrate that significant improvements in this construct can occur in as little as four weeks. Given the fact that pregnancy is a transitory state, it is encouraging to find that significant improvements in mental health can take place in this short a time frame. Second, Koniak-Griffin and Robledo-Colonia et al.’s samples were composed primarily of young, and, in the former study, single, socially disadvantaged and highly depressed participants. In contrast, the participants in the present study are more representative of the general population, increasing the generalisability of these findings.

Not surprisingly, the most commonly reported negative affect at baseline was fatigue. Additional examination of baseline fatigue scores revealed that over 60% of participants reported occasional fatigue (an overall score of three or greater on a five-point scale) and approximately 25% had an overall score of four or greater, where five reflects ‘very often or always’. In contrast, participants classified as meeting guidelines at follow-up reported mean scores that were almost one standard deviation lower than baseline. These improvements in energy were also confirmed by the significant increase on the POMS-vigor subscale from baseline to follow-up. Taken together, these results are encouraging as well as in line with Wallace et al.’s (1986) observation that pregnant women who participate in aerobic exercise report lower fatigue compared to their more sedentary counterparts. In light of the fact that fatigue is one of the most commonly reported barriers for exercise during pregnancy (Evenson, Moos, Carrier, & Siega-Riz, 2009), the present findings indicate that all healthy pregnant women should be encouraged to engage in regular exercise as a first step towards managing pregnancy-related fatigue.

Although significant improvements emerged for five out of the six POMS-SF subscales, there was no significant effect for confusion. The absence of a significant relationship between exercise and confusion is unfortunate as an examination of baseline scores reveals that confusion was a common experience among this sample. Furthermore, this finding is also inconsistent with the bulk of previous work examining the psychological benefits of exercise using the POMS-SF. According to meta-analytic work by Biddle, Fox, and Boutcher (2000), aerobic exercise has a small-to-moderate positive effect on confusion in non-pregnant samples. Given the fact that this variable did exhibit a small effect size in the present study, it is possible that had our sample size been larger a significant group difference would have indeed emerged. A second
possibility is that confusion may be compared to non-pregnant samples, confusion may be more resistant to change during pregnancy. A meta-analysis of 14 studies examining pregnancy-related cognitive deficits indicated that compared to non-pregnant controls, pregnant women demonstrated significant impairment on several measures of memory, particularly those requiring higher executive cognitive control (Henry & Rendell, 2007). POMS-Confusion is assessed through a number of descriptive terms, including ‘forgetful’, ‘unable to concentrate’ and ‘bewildered’, all of which may be measuring different aspects of pregnancy-related cognitive impairment.

Participants who met objectively assessed guidelines at four weeks post-intervention also demonstrated significant pre-post reductions in tension and trait anxiety, confirming previous correlational investigations into the relationship between exercise and anxiety during pregnancy (DaCosta et al., 2003, Goodwin et al., 2000). Not only is this finding encouraging, but it may also be clinically significant when we consider the fact that 48.2% of participants exceeded previously defined cut-off points for high baseline trait anxiety during pregnancy (Grant et al., 2008). In addition to physiological explanations, chronic worry over the unborn child’s health, the birth itself and impending maternal responsibilities have been identified as psychological causes of prenatal anxiety (Poudevigne & O’Connor, 2006). Furthermore, research supports the idea that self-empowerment and being proactive are important processes in the maintenance of mental health (Young & Ensing, 1999). It is possible that participants who were successful in achieving their exercise goals at follow-up felt a sense of satisfaction and that they were doing everything within their control to ensure a healthy pregnancy. These feelings may have helped to decrease worry which in turn may have played a role in helping to decrease anxiety and to a lesser extent tension.

Evidence also exists that mood may worsen as pregnancy progresses (Poudevigne & O’Connor, 2006). While that hypothesis may have been confirmed had a decrease been observed in the mood scores of participants not meeting guidelines, all participants took part in some type of exercise intervention. To further explore changes in these participants’ exercise behaviour, a paired t-test was used to compare baseline and follow-up exercise scores. The results of this analysis revealed a significant increase ($p = .000$, see Table 1 for mean group exercise scores), suggesting that although these participants did not engage in enough activity to be classified as meeting guidelines, the additional exercise that they did participate in may have been sufficient to prevent decreases in mood that may have otherwise taken place. This premise is in line with the work of Poudevigne and O’Connor (2005) who found that low levels of exercise seem to play a role in stabilising mood and preventing pregnancy-related mood deterioration.

Despite these positive findings, several limitations need to be acknowledged. The main limitation of this work stems from the design of the study and the fact that all participants took part in an exercise intervention. Therefore, the lack of a true control group precludes any cause and effect conclusions from being drawn. For example, it is possible that women whose well-being improved for other, unknown reasons, were also more likely to become more physically active or that a third variable may have accounted for both the increase in physical activity and the improvement in mood. Another limitation is self-selection bias due to the recruitment method. Furthermore, the absence of a longer term follow-up prevents us from drawing conclusions regarding the longevity of the effect. In addition, these results can only be generalised to white, married, well-education and middle-class healthy women with non-clinical mood
disturbances. This is problematic because evidence exists that pregnant women who are single, less educated, part of a visible minority group and have lower incomes are not only less likely to be meeting exercise guidelines (Gaston & Vamos, 2012), but also more likely to experience depressed or anxious moods (Lancaster et al., 2010).

Several practical and research implications stem from these findings. From a practical standpoint, all pregnant women without complications should be encouraged to adopt exercise as a means of improving both psychological and physical well-being. However, the causes of inactivity during pregnancy appear to be numerous and complex and need to be addressed if intervention strategies are to be effective (Gaston & Cramp, 2011). For example, in addition to commonly cited barriers such as fatigue, lack of time, and physical limitations, many women fail to engage in adequate levels of exercise due to concerns regarding the safety of exercise during pregnancy or in response to well-intentioned (but misinformed) family members who discourage them from being active (Clarke & Gross, 2004; Duncombe, Wertheim, Skouteris, Paxton, & Kelly, 2009; Evenson et al., 2009). Thus, continued efforts to educate women, their families and prenatal health professional about current guidelines and the benefits and barriers associated with exercise during pregnancy are needed.

From a research standpoint, future investigators should continue to make efforts to use objective exercise measures (i.e. accelerometry) in order to improve measurement reliability as well as explore the relationship between mood and (a) incidental physical activity (i.e. physical activity associated with the tasks of daily living) and (b) sedentary behaviour (i.e. sitting and reclining). Future studies should also assess mood at more frequent intervals across the study (i.e. once a week) in order to better understand the timeframe involved in mood improvement and if and when a floor or ceiling effect occurs. In addition, more research needs to be conducted examining the role of exercise in treating clinical mood disturbances, such as major depressive disorder (MDD). According to Shivakumar et al. (2011), exercise may be an excellent form of treatment for women with MDD as concerns have been raised about the safety of using psychotropic medications during pregnancy. Thus, much could be learned from a large, longitudinal randomised control trial which would include women with clinical levels of depression and/or anxiety.

Conclusion

Within the limitations of the present study, these findings suggest that as little as four weeks of exercise participation is associated with decreases in negative mood states and anxiety among previously inactive healthy adult pregnant women. From a psychological health perspective, these findings highlight the importance of continuing to promote exercise during pregnancy.

Note

1. In addition to the objective exercise measure described in this study, the main investigation also assessed self-reported exercise using the leisure-time exercise questionnaire (LTEQ; Godin & Shephard, 1985). For exploratory purposes, we repeated the main analyses using self-reported exercise scores as a basis for classifying participants as meeting or not meeting guidelines. The following differences in the data were found. First, the use of self-reported
data resulted in significantly more participants being classified as meeting guidelines \( (n = 36) \) and significantly less participants not meeting guidelines \( (n = 20) \) when compared to participants being classified using accelerometer data \( (\chi^2 = 13.56, p = .000) \). Second, significant interaction effects emerged for four of the six POMS subscales, TMD and anxiety (i.e. no significant differences were found for tension and confusion). Third, all effect sizes were attenuated slightly. Despite these minor differences, this comparison confirms previous research demonstrating that self-report measures remain a valid method of assessing moderate-to-vigorous intensity exercise during pregnancy (Haakstad, Gundersen, & Bø, 2010).

References


