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Short communication

Effects of home-based exercise on fatigue in postpartum depressed women: Who is more likely to benefit and why?

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Abstract

Objectives: (1) To explore moderators of the effects of home-based exercise on reductions in physical and mental fatigue scores in postpartum depressed women and (2) to explore mediators of the intervention on changes in physical fatigue. **Method:** Eighty-eight women in the postpartum period (4–38 weeks) obtaining a score ≥10 on the Edinburgh Postnatal Depression Scale were randomly assigned to a 12-week individualized home-based exercise intervention (n=46) or a no-treatment control group (n=42). The present analyses include the 35 women who adhered to the intervention and the no-treatment control group. Participants completed a cardiovascular fitness test, and a battery of questionnaires assessing the outcomes (Physical and Mental Fatigue) as well as potential moderators and mediators at baseline and posttreatment. **Results:** Hierarchical linear regressions evaluating moderators of changes in mental fatigue with exercise showed that the intervention was effective for women entering the study later in the postpartum period (P=.001) and women with higher depression scores (P=.014). Reductions in physical fatigue with exercise were partially mediated by reductions in perceived stress and increased exercise-related energy expenditure. **Conclusion:** Identification of moderators allows for the tailoring of exercise interventions to particular subgroups of women that are most likely to benefit. The identified mediators may be enhanced and directly tested in future trials.

Keywords: Exercise; Fatigue; Mediators; Moderators; Postpartum depression

Introduction

We recently demonstrated that exercise is effective in alleviating physical fatigue in postpartum depressed women [1]. The intervention was also effective in alleviating mental fatigue for women with lower physical fatigue and greater mental fatigue at study entry.

Given the paucity of randomized trials evaluating exercise interventions in this patient population, much more can be learned from this trial that can help guide application of findings and generate future hypotheses.

The focus of the present analyses was to identify potential moderators and mechanisms of the effects of the home-based exercise on changes in fatigue levels.

Specifically, the objectives were to explore the following questions:

1. Do clinical factors (delivery mode, parity, time elapsed since delivery), depression levels at study entry, cardiovascular fitness levels, and social support moderate the effects of home-based exercise on mental and physical fatigue in postpartum depressed women?
2. Are changes in depressed mood, sleep quality, perceived stress, physical fitness, and exercise-related energy expenditure mechanisms through which exercise alleviates physical fatigue in postpartum depressed women?

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Method

Participants

Women in the postpartum period (4–38 weeks) experiencing symptoms of postpartum depression were recruited. Interested participants were screened over the telephone and those obtaining a score ≥10 on the Edinburgh Postnatal Depression Scale (EPDS) [2] were invited to participate.

Outcome measure

The Multidimensional Fatigue Inventory (MFI-20) [3] is a self-report instrument developed to assess the following dimensions of fatigue: general fatigue, physical fatigue, reduced activity, reduced motivation, and mental fatigue. Scores on each subscale range from 4 to 20, with higher scores indicating a higher degree of fatigue [3,4]. Changes on the Physical and Mental Fatigue subscales were used as outcome measures.

Potential mediators and moderators

Major complications experienced during pregnancy and labor/delivery, demographic information, and medical history were assessed via a semistructured interview.

The EPDS measures depressive symptomology in new mothers over the past 7 days [2]. A cutoff point of 10 has been shown to have a sensitivity of 84% to 100% and a specificity of 76% to 88% when compared to a diagnosis of depression using structured psychiatric interviews [5–7]. Baseline scores were evaluated as potential moderators, while change scores from baseline to posttreatment were evaluated as potential mediators.

Sleep quality was assessed with the Pittsburgh Sleep Quality Index (PSQI), a self-report measure assessing sleep quality and disturbances over a 1-month time interval. A global score of greater than 5 yields a diagnostic sensitivity of 89.6% and specificity of 86.5% in differentiating good and poor sleepers [8]. Change in global PSQI scores from baseline to posttreatment were evaluated as potential mediators.

Stress was evaluated with the Perceived Stress Scale (PSS) which measures the extent to which situations in one's life are appraised as stressful in the past month [9]. Score range from 0 to 40 with higher scores indicating greater perceived stress. The mediating effects of changes in PSS from baseline to posttreatment were evaluated.

MOS social support survey [10] measures perceived availability of social support. Higher scores indicate greater perceived support. The moderating effect of social support at study entry was evaluated.

The Aerobic Centre Longitudinal Study Physical Activity Questionnaire (ACLS-PAQ) was used to track exercise participation [11]. Participants provide information about activities performed regularly in the last 3 months. Scores are estimates of weekly energy expenditure expressed as metabolic equivalent (MET)-hours per week. ACLS-PAQ scores excluding household activities [weekly exercise-related energy expenditure (ACLEX)] at posttreatment were evaluated as potential mediators.

Cardiovascular fitness was measured using a maximal graded exercise stress test on a treadmill using a Bruce protocol [12,13]. Fitness was then evaluated by time on test and maximal METs capacity. Baseline fitness was examined as a potential moderator of the effects of exercise on mental and physical fatigue, while change in fitness levels with exercise was evaluated as a potential mediator.

Procedures

Following the initial telephone interview, consenting participants were mailed the questionnaire battery along with a preaddressed stamped envelope.

Participants then underwent a physician supervised cardiovascular fitness test and were randomly assigned to either the exercise or the no-treatment control group. Information from the baseline fitness test was used to individualize exercise programs for women assigned to the exercise group. Following the 12-week intervention, all participants completed a second cardiovascular fitness test. All follow-up questionnaires were mailed to participants.

Exercise intervention

Participants assigned to the exercise group met four times with the same exercise physiologist during a 12-week training phase. The first visit included a review of the cardiovascular fitness test results, an overview on the benefits of exercise, an individualized exercise prescription, and a supervised exercise session. Follow-ups were scheduled at 1, 3, and 9 weeks following the initial visit.

The exercise prescription was individualized and followed ACSM guidelines for developing and maintaining cardiorespiratory fitness [14]. These guidelines suggest individuals perform 60–120 min/week of aerobic exercise within their target heart rate zone (60–85% of maximal heart rate).

Heart rate monitors were provided to assure proper intensity of training. All subjects maintained an exercise log for the duration of the 12-week training phase.

Results and discussion

Flow of participants has been previously described [1]. Eighty-eight women were successfully randomized, 46 were assigned to the exercise group and 42 to the control group. During the 12-week training phase, adherence to the aerobic exercise component of the program was 76.1% (based on 60 min/week of cardiovascular exercise), with an average of 124.09 min/week (S.D.=96.33). Thirty-five out of the 46

Table 1
Patient characteristics at study entry

	Exercise (n=35)	Control (n=42)
	Mean (S.D.)	Mean (S.D.)
Age (years)	34.57 (3.36)	32.67 (4.80)
Education (years)	16.03 (1.56)	15.10 (2.22)
Years with current partner	7.40 (4.23)	6.15 (3.62)
	Mean (S.D.)	Mean (S.D.)
Weeks since delivery	10.83 (7.07)	12.09 (8.08)
Body mass index	27.05 (5.75)	26.43 (4.92)
METS at stress test	10.67 (1.79)	11.01 (1.66)
	%	%
Primiparous	42.8	33.3
Cesarean delivery	37.1	21.4
	Mean (S.D.)	Mean (S.D.)
Physical fatigue	14.70 (3.23)	13.55 (4.25)
Mental fatigue	14.52 (4.00)	12.60 (4.54)
EPDS	13.86 (3.88)	13.57 (3.90)
PSQI	9.14 (3.52)	8.60 (3.49)
PSS	22.89 (6.34)	20.83 (7.23)
ACLEX [a]	2.33 (1.54)	2.21 (1.80)
Social support	16.34 (5.88)	17.79 (5.69)

[a] Square root transformation.

women in the exercise group adhered to the exercise intervention. Women in the control group reported an average of 54.6 min/week (S.D.=55.8) of aerobic exercise during the 12-week period. The focus of the present analyses was to identify moderators and mechanisms of change in fatigue with exercise; hence, only women who adhered to the intervention (i.e., completed 60 min/week of aerobic exercise within their target heart rate zone) were included and compared to the control group.

Participant's characteristics at study entry are summarized in Table 1. The groups were similar on all baseline characteristics, except for a significant difference in baseline mental fatigue scores [$t(75)=2.32$, $P<.05$]. To avoid the risk of confounding the between-group comparisons by this imbalance, all multivariate analyses were adjusted for baseline mental fatigue scores.

Potential moderators

To identify potential moderators, we investigated whether the effects of the intervention on the mean change in mental and physical fatigue depended on clinical variables at study entry (e.g., parity) or on the baseline value of psychosocial variables (e.g., EPDS). Hypotheses were tested by computing a series of linear regressions following recommendations proposed by Aiken and West [15].

As summarized in the left portion of Table 2, women in the exercise group entering the study after 9.4 weeks postpartum showed a somewhat larger decrease in physical fatigue. Simple slope analyses showed that parity was a significant moderator in the control group but not in the exercise group. Women in better cardiovascular fitness at

Table 2
Moderators of physical and mental fatigue: adjusted change scores and regression results

	Physical fatigue			Mental fatigue		
	Exercise	Control	Test of interactions	Exercise	Control	Test of Interactions
	Mean change (S.D.)	Mean change (S.D.)	β	Mean change (S.D.)	Mean change (S.D.)	β
Weeks [a]						
≤9.4 (n=39)	−4.32 (3.48)	−1.78 (3.57)	.282[t]	−0.97 (4.13)	−3.07 (4.23)	.518 **
>9.4 (n=38)	−4.73 (3.43)	−1.50 (3.44)		−4.95 (4.07)	−1.85 (4.06)	
Parity						
Primiparous (n=29)	−4.28 (3.38)	−3.24 (3.36)	.243[t]	−1.89 (4.32)	−3.46 (4.29)	.251[t]
Multiparous (n=48)	−4.70 (3.36)	−0.84 (3.35)		−3.75 (4.28)	−1.90 (4.28)	
Delivery mode						
Vaginal (n=55)	−4.83 (3.56)	−1.71 (3.46)	.030	−4.21 (4.35)	−2.15 (4.24)	−.279[t]
C-section (n=22)	−4.05 (3.41)	−1.30 (3.42)		−1.03 (4.17)	−3.10 (4.24)	
METs [a]						
≤10.5 (n=38)	−3.95 (3.38)	−2.11 (3.49)	.243[t]	−3.22 (4.29)	−2.96 (4.43)	.152
>10.5 (n=39)	−5.08 (3.52)	−1.11 (3.37)		−2.66 (4.45)	−1.87 (4.28)	
EPDS [b]						
≤12 (n=38)	−3.82 (3.42)	−1.43 (4.02)	.152	−1.70 (4.26)	−2.74 (4.46)	.374 *
>12 (n=39)	−5.16 (3.67)	−1.78 (3.40)		−4.01 (4.56)	−1.91 (4.24)	
Social support [a]						
Lo ≤17 (n=37)	−3.72 (3.42)	−0.68 (3.30)	.020	−3.06 (4.40)	−1.30 (4.24)	−.326 *
Hi >17 (n=40)	−5.55 (3.30)	−2.55 (3.44)		−2.70 (4.23)	−3.40 (4.42)	

METs=METs achieved at baseline cardiovascular stress test. All regression models testing potential moderators were adjusted for baseline physical and mental fatigue.
$P<.10$.
[a] Grouping based on median split.
[b] Grouping based on clinically meaningful established cutoff [2].
* $P<.05$.
** $P<.01$.

study entry showed greater decreases in physical fatigue with exercise compared to women who were less fit. These findings need to be interpreted cautiously given that only statistical trends were observed.

Moderators of changes in mental fatigue scores are presented in the right portion of Table 2. The intervention was effective in alleviating mental fatigue in women that entered the study later in the postpartum period (9.4 weeks postdelivery) and for women with higher depression scores (EPDS >12). Mentally fatigued women with more severe depression may best respond to interventions that require little focused attention (e.g., walking), that potentially provide distraction from stress, without further taxing cognitive resources (i.e., reading, carrying a conversation) [16,17].

Social support was not a significant moderator in the exercise group. Statistical trends were also obtained for parity and delivery mode, with multiparous women and women delivering vaginally showing somewhat larger improvements in mental fatigue with exercise.

Mediators

Given that home-based exercise had a direct effect on physical but not mental fatigue [1], only mediators for changes in physical fatigue were explored. Potential mediators were tested using guidelines provided by Baron and Kenny [18]. The mediation paths were then tested directly using Sobel's test [19,20].

Only the regression models examining perceived stress and ACLEX attained statistical significance. As illustrated in Fig. 1A, the standardized regression coefficient between exercise and perceived stress was significant (t=2.13, P<.05),

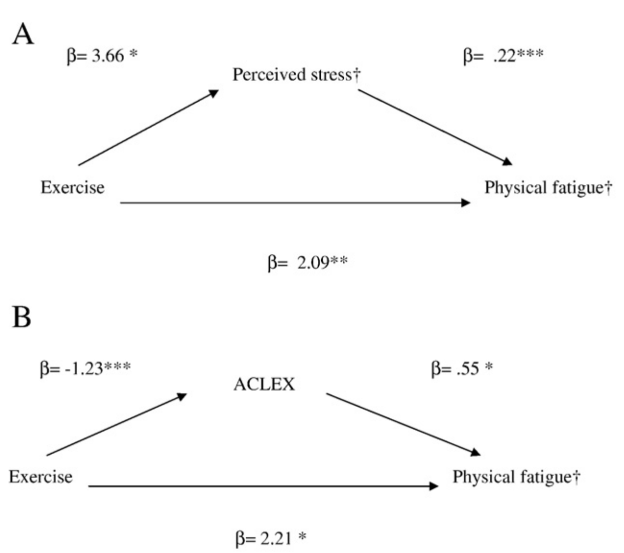

Fig. 1. Mediation paths for perceived stress (A) and exercise-related energy expenditure (B). †Change from baseline to posttreatment. *P<.05, **P<.01, ***P<.001.

as was the regression coefficient between perceived stress and change in physical fatigue (t=4.54, P<.001). After controlling for perceived stress, there was a reduction in the standardized regression coefficient for exercise from β=2.89 (P=.001) to β=2.09 (P<. 01) indicating that the effect of the intervention on physical fatigue was partially mediated by decrease in perceived stress with exercise. Sobel's test was marginally significant (z=1.93, P=.05), with 27.8% of the total effect mediated by changes in perceived stress. These results are biologically plausible given that the brain and body respond to perceived stress by an activation of the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system preparing the body to "fight or flight" [21]. Consequently, reductions in perceived stress with exercise could lead to alleviation of physical fatigue, in that the body's resources are being taxed less often.

As illustrated in Fig. 1B, the reduction in the standardized regression coefficient for exercise from β=2.89 (P=.001) to β=2.21 (P<. 01), once ACLEX was controlled for, provides initial evidence for partial mediation. Sobel's test was marginally significant (z=1.86, P=.06), with 23.52% of the total effect mediated by exercise-related energy expenditure. This finding lends some support to the argument that the observed improvements in physical fatigue were not exclusively attributable to the exercise therapist's attention and/or women's expectations that they would benefit from the intervention. The lack of a significant association between the intervention and changes in cardiorespiratory fitness indicates that the improvements did not require an accompanying significant change in fitness level. Consistent with studies demonstrating improvement in depressed mood with exercise, increasing activity levels in postpartum depressed women may effectively alleviate physical fatigue even in the absence of significant effects on cardiorespiratory fitness, (e.g., [22,23]).

Limitations

The present analyses were exploratory, with lower statistical power than the primary outcome analyses and risk for false-negative findings.

The participants in our study were highly educated and volunteered to participate in a home-based exercise program; these results may not be generalizable to populations with different demographic characteristics.

Conclusions

Home-based exercise was effective in alleviating physical fatigue in women reporting postpartum depressed mood independent of the severity of baseline depression scores as measured by the EPDS.

Women with low physical fatigue, higher mental fatigue, and more severe depressed mood showed improvements in mental fatigue with supervised home-based exercise.

Improvements in physical fatigue with exercise were partially explained by increased levels in exercise-related energy expenditure and a reduction in perceived stress.

These findings are preliminary and need to be replicated and further evaluated in future studies designed to identify mediators and mechanisms of change.

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