Published in final edited form as:

Psychosom Med. 2018 April ; 80(3): 327–332. doi:10.1097/PSY.0000000000000559.

Effects of resistance training on fatigue-related domains of quality of life and mood during pregnancy: A randomized trial in pregnant women with back pain

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Abstract

Objective—To test if the adoption of twice weekly, low-to-moderate intensity resistance training during weeks 22–34 of pregnancy can improve quality of life and mood.

Methods—A parallel group trial was conducted. Second trimester women (n=134) were randomly assigned to 12-weeks of wait list, bi-monthly pregnancy education classes, or twice weekly low-to-moderate intensity resistance training. Resistance training involved one abdominal exercise with no external load and five exercises (leg extension, leg press, arm lat pull, leg curl, and lumbar extension) with an external load that gradually progressed and the total active exercise time during each exercise session was ~17 minutes. Quality of life and mood were measured before and after the interventions using the 36-item Short Form Health Survey (SF-36) and Profile of Mood States. Intent-to-treat mixed model ANOVAs (3 Groups X 2 Times, pre- and post-intervention) tested the hypothesis that outcomes would worsen for the controls and not change or improve for the resistance training group.

Results—The Group x Time interaction ($F_{2,131}=3.144$, $\eta^2 = .046$, $p=.046$) for SF-36 vitality and subsequent simple main effects showed scores were unchanged across time after resistance training (-1.8 ± 14.8) but significantly decreased for the education (-6.44 ± 12.69 , $t=3.408$, $df=44$, $p=.001$) and wait list (-9.11 ± 14.78 , $t=4.135$, $df=44$, $p<.001$) groups while post-test vitality scores for the pregnancy group (45.9 ± 16.9) were significantly higher than the wait list (40.1 ± 16.3 , $t=1.989$, $df=87$, $p=.05$) but not the education group (42.1 ± 15.4 , $p=.27$). POMS fatigue scores showed a similar pattern.

Conclusion—Adverse changes in symptoms of energy and fatigue during pregnancy are attenuated by adopting low-to-moderate intensity resistance training.

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Conflicts of Interest: The authors report no conflicts of interest.

Trial Registration—clinicaltrials.gov identifier NCT02557893.

Keywords

Exercise; Fatigue; Mood; Pregnancy; Strength Training; Vigor; Vitality

INTRODUCTION

Pregnancy is accompanied by changes in physical and mental health that can reduce quality of life. Pregnant women experience nausea and vomiting (1), sleep disruptions (2), and changes in hormonal regulation (3) which can contribute to anxiety, depression and low energy and fatigue symptoms (4).

Physical activity levels are reduced during pregnancy (5) and physical inactivity contributes to reduced quality of life (6), including increased anxiety, depression and fatigue symptoms (7). Little is known about the association between changes in physical activity and quality of life during pregnancy. One longitudinal phone survey of 1,809 ethnically and socioeconomically diverse women receiving prenatal care in the San Francisco area found that exercise during pregnancy was associated with better quality of life, including better physical function and higher vitality scores, compared to those who were sedentary during pregnancy (8).

Only ~10% of randomized trials examining exercise effects on mental health outcomes have targeted resistance exercise training (9). The one published randomized trial of resistance training, which was conducted with pregnant women living in Sweden, found no impact of the intervention on health-related quality of life, including mental health and feelings of vitality (10). Insignificant effects may have resulted if the participants had been engaged in resistance training prior to the start of the trial, which was unclear. In addition, the participants were encouraged to engage in extra-intervention exercise and this led to an average of 66 more minutes of walking per day by the end of the trial in the resistance exercise group. This difference in walking may have confounded changes in vitality scores attributable to resistance exercise alone (11).

The investigation described here used a randomized controlled trial to examine the quality of life consequences, including effects on mood, of 12 weeks of low-to-moderate intensity resistance training adopted during the second trimester of pregnancy. Symptoms of low energy and fatigue were targeted as most likely to improve with exercise training because these symptoms so frequently emerge during pregnancy; 60–90% of women report fatigue during pregnancy (12, 13). It was hypothesized that energy and fatigue symptoms would worsen for the non-exercise control groups and not change or improve for the resistance training group.

METHODS

The design was a parallel-group randomized controlled trial. The exercise program and outcome assessments were conducted at a University in the Southeastern United States. The pregnancy education classes were held at the nearby medical center. Data collection started

in April 2006 and ended in October 2007. The investigation was designed to examine the effects of resistance exercise training on three outcome categories: self-reported quality of life (including mood as one indicator), pain and physical function outcomes. A future report is planned summarizing the physical function and pain outcomes. Safety and efficacy data with regard to the training associated increase in external load and muscular endurance have been reported elsewhere (14).

The study was announced to the community in multiple ways. Participants indicated they were informed about the study from newspaper ads (27% of those enrolled), ads in a free magazine aimed at parents (22%), word of mouth (17%), health care providers (15%), ads mailed to homes surrounding the university (10%), telephone marketing calls (5%), radio ads (3%) and an information table at a maternity and baby fair (1%).

Participants were required to be at low risk for pregnancy-related complications, between 17–38 years, between 21–25 weeks gestation and with back pain or a history of back pain. Back pain was targeted because it is a common problem in pregnancy associated with low energy and fatigue and resistance exercise training represents a plausible non-pharmacological therapy for these concerns. Excluded were those who reported regular resistance exercise training (twice per week during the past month), an orthopedic or cardiovascular limitation, a psychiatric disorder, or had in the current or a prior pregnancy any of the following: (a) two or more miscarriages, (b) premature labor, (c) placental previa, (d) poor fetal growth, (e) low pre-pregnancy body weight (BMI < 17.5), (f) a multiple birth pregnancy, (g) pre-eclampsia, (h) preterm rupture of membranes, (i) uterine growth retardation, (j) incompetent cervix/cerclage, (k) recurrent vaginal bleeding, (l) anemia or (m) diabetes. Eligible volunteers read and signed an informed consent document that had been approved by the University of Georgia Institutional Review Board before taking part in the study.

At the start of the study the principal investigator (PJO), who was not directly involved in exercise supervision or outcome testing, generated the allocation schedule using <https://www.randomizer.org> and provided it to the study administrator who enrolled participants and used the allocation schedule to assign participants to the interventions. Participants were randomized in blocks of three during gestational weeks 21–25 (median 22) after baseline outcome testing was completed. It was not possible to blind the participants from their intervention. Staff who supervised the resistance exercise training did not administer the outcomes. Pregnancy educators were blind to participants' involvement in the study.

Resistance intervention

Participants performed low-to-moderate intensity resistance exercise training twice per week for 12 weeks and, depending on availability, training was performed individually or in small groups (<4 per group). Strength training sessions were supervised by an experienced exercise specialist.

Participants warmed-up by walking on a treadmill for 5 minutes. Next, six resistance exercises were performed in a seated position in the following order: dual leg extension, dual

leg press, dual arm lat pull, dual leg curl, lumbar extensions and a standing abdominal exercise aimed at activating the transverse abdominis muscles.

Universal Gym equipment was used for the leg extension, leg press, and arm pull down exercises. Leg curls were performed using Cybex Eagle equipment. Lumbar extensions were performed using MedX equipment. For these five exercises the number of sets ($n = 2$) and repetitions per set ($n = 15$) were held constant throughout training. These exercises were performed at a low-to-moderate velocity of ~2-seconds per concentric and ~2-seconds per eccentric action. There was ~1 minute rest between sets and ~2 minutes between exercises. The total active exercise time during each exercise session was ~17 minutes

The initial external loads for the five exercises were selected to achieve low-to-moderate intensity based on ratings of perceived exertion (RPE) (15). The 6 to 20 Borg RPE scale was used. On this scale, exercise rated as a 13 (verbal anchor = “somewhat hard”) represents a moderate intensity and ratings that are 11 (“fairly light”) or less represent low intensity exercise. Participants were taught how to provide RPE at the training outset. Standardized instructions emphasized reporting the overall effort put into each 2-set task. Ratings were obtained after the second set. The external load was progressively increased based on RPE responses to each exercise; when RPE was lower in an exercise session compared to the prior session, the external load was allowed to increase in the next session by the smallest amount permitted by the machine. Across 12 weeks the external loads significantly increased by 36% to 56% (14).

For the abdominal exercise, the standing participants were taught to exhale then to attempt to draw in their belly button toward their spine as if they were trying to button up pants that were too tight in the waist. The duration of each repetition was ~8 seconds. Initially two sets of eight repetitions were performed and progression across weeks involved an increase in the number of sets to a median of five sets. There was a rest period of ~1 minute between sets.

Education

Maternity nurses taught six bimonthly pregnancy education classes (~20 per class, ~60 minutes each) which covered several topics including information about what to expect during normal labor and delivery, common interventions during delivery (medications, induction, Cesarean delivery), parenting skills needed for baby care, breastfeeding, baby and child cardiopulmonary resuscitation, typical child development and communicating with infants. No physical activity education was included in the curriculum. The pregnancy education participants formed an attention control group.

Wait list control

Wait list participants were tested on the outcomes during their pregnancy and were eligible to participate in a post-partum supervised exercise program. The wait list participants formed a no treatment control group.

Questionnaires

Pre-intervention outcomes were assessed during gestational weeks 19 to 24 and post-intervention outcomes were measured the week after the 12-week intervention period.

The Short Form Health Survey (SF-36) was used to measure eight aspects of health related quality of life. The questionnaire contains 36 questions that measures physical functioning, role limitations due to physical health, bodily pain, general health status, vitality, social functioning, role limitations due to emotional problems, and mental health during the prior month. There is a large body of evidence supporting the validity of the SF-36 measures (16).

The Profile of Mood States (POMS) questionnaire measured tension, depression, anger, vigor, fatigue and confusion. The POMS contains 65 adjectives (e.g., relaxed, sad, annoyed, energetic, weary, muddled) that describe feelings that people experience. The intensity of feelings is scaled in five categories: not at all (scored as 0), a little [1], moderately [2], quite a bit [3], and extremely [4]. Participants indicated how they had been feeling during the “past week including today.” There is a large body of evidence supporting the validity of the POMS measures (17). Outcomes were not changed after the trial commenced.

Statistical Analysis

Based on an *a priori* statistical power analysis that assumed a two-sided hypothesis, an alpha error of 5%, a beta error of 20%, an estimated correlation across two repeated measures of 0.65 and a desire to detect an interaction effect size (standardized mean difference) of 0.60, the trial was designed to recruit 135 participants so that after expected dropouts, data from at least 30 subjects per group would be available for analysis (18).

Questionnaire data were entered into an Excel spreadsheet and checked for accuracy. Data were imported into IBM SPSS Statistics version 22 and analyzed. Baseline data were compared with one-way ANOVAs and follow-up t-tests. A conservative intent-to-treat approach was used with missing values replaced with the last value carried forward method, thus all participants (cf., Figure 1) were included in all analyses. To test the hypothesis that outcomes would worsen for the controls and improve or not change for the resistance exercise training group, mixed model ANOVAs (3 Groups X 2 Times (pre- and post-intervention) were conducted and statistical significance was based on two-tailed P-values. Partial eta squared (η^2) provided an ANOVA-based effect size. Interactions were decomposed by using t-tests to examine simple main effects for time and group. Unless otherwise indicated, data in text and tables are presented as means and SD.

RESULTS

Volunteers were screened and enrolled from April 2006 to July 2007 as depicted in Figure 1. Follow up occurred from July 2006 to October 2007. Forty-four participants were allocated to resistance exercise training, 45 to pregnancy education and 45 to wait list. Baseline demographic characteristics of the participants are provided in Table 1. Group characteristics were comparable except that the resistance exercise training group was significantly taller than the pregnancy education group ($t=2.791$; $p=.007$).

Exercise session attendance was 78.4 (14%), ranged from 40 to 100%, and 82% of participants attended more than 70% of the scheduled exercise sessions. No musculoskeletal injuries or other adverse events occurred and potentially problematic symptoms (e.g., dizziness) were infrequent and reported elsewhere (14).

Quality of life scores before and after the interventions and associated effect sizes are provided in Table 2. At baseline, the quality of life scores of the groups did not differ significantly. Group x Time effects were insignificant for physical function ($p=.72$), role physical ($p=.95$), bodily pain ($p=.53$), general health ($p=.72$), social functioning ($p=.64$), role emotional ($p=.52$), and mental health ($p=.74$) but significant for vitality ($F_{2,131}=3.144$, $\eta^2=.046$, $p=.046$) as shown in Figure 2. Simple main effects showed vitality scores were unchanged across time after resistance training (-1.82 ± 14.06 , $t=.858$, $df=43$, $p=.40$) but significantly decreased for the education (-6.44 ± 12.69 , $t=3.408$, $df=44$, $p=.001$) and wait list (-9.11 ± 14.78 , $t=4.135$, $df=44$, $p<.001$) groups while post-test vitality scores for the pregnancy group (45.9 ± 16.9) were significantly higher than the wait list (40.1 ± 16.3 , $t=1.989$, $df=87$, $p=.05$) but not the education group (42.1 ± 15.4 , $p=.27$). Among participants in the resistance exercise group, the change in vitality was weakly correlated with attendance ($r=.14$, $p=.38$). The resistance training group had 2-fold to 4-fold more women report increased vitality compared to the pregnancy education and wait list groups.

Mood scores before and after the interventions are provided in Table 3. At baseline, the mood scores of the groups did not differ significantly. Group x Time effects were insignificant for tension ($p=.11$), depression ($p=.24$), anger ($p=.37$), confusion ($p=.49$) and vigor ($p=.69$) and approached significance for fatigue ($F_{2,131}=3.029$, $\eta^2=.044$, $p=.052$) as shown in Figure 3. Simple main effects showed fatigue scores were unchanged across time after resistance training (-0.43 ± 4.57 , $p=.53$) but significantly increased for the education (1.44 ± 3.96 , $t=2.445$, $df=44$, $p=.019$) and wait list (1.56 ± 4.27 , $t=2.446$, $df=44$, $p=.019$) groups while post-test fatigue scores for the pregnancy group (6.70 ± 4.26) were significantly lower than the wait list (8.64 ± 4.89 , $t=2.126$, $df=87$, $p=.036$) but not the education group (7.67 ± 3.71 , $p=.28$). Among participants in the resistance exercise group, the change in vitality was weakly correlated with attendance ($r=-.06$, $p=.72$). The resistance training group had 2-fold to 3-fold more women report reduced fatigue compared to the pregnancy education and wait list groups.

DISCUSSION

The primary finding of this investigation is that low-to-moderate intensity resistance training, performed during weeks 22 to 34 of pregnancy, attenuated feelings of fatigue that increased over time in two non-exercise comparison groups. This observation is consistent with dozens of randomized trials, conducted with sedentary non-pregnant adults and medical patients, showing that the adoption of regular physical activity, regardless of mode, is associated with better feelings of fatigue and vitality when compared to non-exercise control conditions (11).

Contrary to the current findings, a prior study conducted in Sweden of 12-weeks of resistance exercise training with pregnant women did not find any improvement in any

domains of quality of life compared to a control group provided with home exercise instructions (10). Several factors may explain why the fatigue effects observed here were not found in the prior study. These include that the women in the present trial were adopting a strength training program which started 9 weeks later in gestation, and they performed exercise at a low-to-moderate perceived intensity which may be more effective for improving feelings of fatigue for some groups, rather than a moderate-to-vigorous intensity (19). Different cultural values, expectations and prior physical activity patterns also may have contributed to the different outcomes in each study (20, 21). Although baseline data for the SF-36 variables were not presented in the Petrov-Fieril paper (10), the participants in the present study may have been more fatigued at baseline than the Swedish participants described in the Petrov-Fieril report which could have contributed to the different findings. When the baseline data from all three groups in this study were combined and compared to SF-36 norms from 275 non-pregnant U.S. women aged 25–34 (16), the participants on average had worse physical function (norm= 89.1 ± 18.7 ; $d=0.95$), role physical (norm= 86.7 ± 28.0 ; $d=0.99$), bodily pain (norm= 79.6 ± 18.7 ; $d=0.89$) and vitality scores (norm= 58.04 ± 20.9 ; $d=0.47$).

Resistance training had no significant effect on improving self-reported SF-36 physical function or role physical scores which is consistent with the one prior study of resistance training with pregnant women (10). The SF-36 physical function questions focus on whether the individual perceives “a lot”, “a little” or no limitations while the role physical scores query about problems with work or daily activities using a yes or no format. Scales with more than two or three categories can be more sensitive to measuring change and there is a need for studies that objectively measure physical function in pregnant women (22).

Resistance training had no significant effect on improving POMS anxiety or depression mood states or the SF-36 mental health variable, which consists solely of anxiety and depression questions. While this is consistent with the prior resistance training study with women undergoing an uncomplicated pregnancy (10), when the baseline data from all three groups in this study were combined (79.3 ± 12.4) and compared to SF-36 norms from 275 non-pregnant U.S. women aged 25–34 (72.5 ± 18.6), (16) the participants on average had better mental health scores ($d=0.37$). Thus, a floor effect may have limited any improvements in anxiety or depression with resistance training. Yoga studies with pregnant women without elevated baseline anxiety or depression symptoms also found no symptom improvements (23).

There were several potential limitations of the present study. The resistance training and health education groups were not matched for contact time, and therefore it is unclear if the frequency of the social interaction and subsequent social support received by the exercise group could be a contributing factor to the positive results experienced by the resistance training group compared to non-exercise controls. Multiple statistical tests were performed without the commonly employed Bonferroni adjustment. (24), we report the upper limit of alpha as 0.14 as a recommended alternative (25). Attrition was higher in the non-exercise groups (24% to 29%) compared to the exercise group (5%). Although attrition of greater than 20% is not uncommon in trials, one analysis of 71 randomized trials showed it occurred in 18% of trials (26), the differential attrition in the present study could have biased the

findings. For example, we cannot rule out that women perceiving improved energy and fatigue in response to resistance exercise training were more motivated to continue compared to those in the non-exercise study arms or that expectation/placebo effects were greater for the exercise group (27). Participants in the non-exercise study arms were offered a post-partum exercise program that did not include data collection and was devised to help with adherence in these arms but only a handful of participants took advantage of the opportunity. The design of the investigation did not provide information about the generalizability of the results (random selection from a defined population was not used and women without back pain, or not at increased risk for back pain, were excluded from participating), thus, the external validity of the findings is uncertain. Additionally, while adherence was tracked for the resistance training group, attempts to keep the nurse educators blinded to study enrollment did not allow for objective measurement of attendance in the pregnancy education classes. Future studies might benefit by including complementary objective measures of fatigue such as increased errors or slowed reaction time across time during tests of sustained attention.

Low-to-moderate resistance exercise appears to be safe and effective for increasing strength and improving fatigue; however, the present investigation should be independently replicated before clinicians can recommend, with complete confidence, strength training to combat fatigue among pregnant women. Crucial future research needs include examining the feasibility and efficacy of strength training for pregnant women of different sociodemographic groups than the primarily middle class white sample studied here.

In summary, increases in feelings of fatigue and reductions in vitality from weeks 22–34 of pregnancy were attenuated by low-to-moderate intensity resistance training adopted by sedentary women characterized by low energy and fatigue at baseline.

Acknowledgments

Source of Funding: The National Institutes of Health provided financial support for the research.

Glossary

ANOVA	analysis of variance
BMI	body mass index
PE	pregnancy education
POMS	profile of mood states
RE	resistance exercise
RPE	rating of perceived exertion
SF-36	short form health survey
WL	wait list

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Figure 1.
Participant flow through the trial.

Figure 2.

Mean (and SE) vitality scores before and after 12-weeks of resistance exercise (n=44), pregnancy education (n=45) and wait list (n=45) groups. Vitality scores decreased significantly over time for the education and wait list groups but not the exercise group. At the post-test vitality scores were significantly higher for the exercise group compared to the wait list group.

Table 1

Baseline demographic characteristics of the participants (mean±SD)

	Resistance Exercise (n = 44)	Pregnancy Education (n = 45)	Wait List (n = 45)
Variable			
Age (years)	28 ± 5	29 ± 4	29 ± 4
Height (cm)	169 ± 5	166 ± 8	168 ± 6
Weight (kg)	75 ± 16	74 ± 14	78 ± 13
Body mass index	26 ± 6	27 ± 5	28 ± 5
Ethnicity (% sample):			
White	89%	90%	89%
Black	11%	6%	7%
Hispanic	0%	2%	2%
Other	0%	2%	0%

SF-36 quality of life component scores before and after the interventions (mean $\pm$ SD) and associated partial eta-squared effect size values.

Table 2

Variable	Resistance Exercise (n=44)		Pregnancy Education (n=45)		Wait List Control (n=45)		Effect size (η^2)
	Pre	Post	Pre	Post	Pre	Post	
Physical function	70.8 $\pm$ 16.1	61.9 $\pm$ 21.9	72.2 $\pm$ 18.1	61.9 $\pm$ 21.1	70.8 $\pm$ 17.1	58.7 $\pm$ 18.8	.005
Role physical	63.0 $\pm$ 38.2	40.2 $\pm$ 38.8	53.8 $\pm$ 34.7	33.2 $\pm$ 33.8	59.7 $\pm$ 32.4	39.1 $\pm$ 35.2	.001
Bodily pain	66.4 $\pm$ 18.3	62.0 $\pm$ 17.6	62.1 $\pm$ 15.1	53.6 $\pm$ 15.4	60.4 $\pm$ 18.6	53.9 $\pm$ 14.6	.01
General health	77.0 $\pm$ 15.6	77.2 $\pm$ 14.3	77.9 $\pm$ 15.1	76.4 $\pm$ 15.2	78.6 $\pm$ 13.4	78.5 $\pm$ 12.5	.005
Vitality	47.7 $\pm$ 16.4	45.9 $\pm$ 19.9	48.5 $\pm$ 14.5	41.9 $\pm$ 15.1	49.2 $\pm$ 15.0	39.9 $\pm$ 16.5	.046
Social functioning	87.0 $\pm$ 15.5	80.0 $\pm$ 17.8	84.5 $\pm$ 17.4	76.2 $\pm$ 21.9	85.1 $\pm$ 14.9	80.3 $\pm$ 16.7	.01
Role emotional	81.4 $\pm$ 29.0	85.7 $\pm$ 26.0	88.6 $\pm$ 24.2	87.9 $\pm$ 19.7	85.2 $\pm$ 27.7	83.0 $\pm$ 28.7	.01
Mental health	79.0 $\pm$ 10.6	78.7 $\pm$ 10.1	79.6 $\pm$ 11.7	79.6 $\pm$ 10.5	79.4 $\pm$ 11.5	78.0 $\pm$ 12.5	.005

Table 3

Profile of Mood State scores (mean $\pm$ SD) before and after the interventions and associated partial eta-squared effect size values

Mood State	Resistance Exercise (n=44)		Pregnancy Education (n=45)		Wait List Control (n=45)		Effect size (η^2)
	Pre	Post	Pre	Post	Pre	Post	
Tension	2.32 $\pm$ 2.45	2.18 $\pm$ 2.00	2.36 $\pm$ 2.09	2.27 $\pm$ 2.34	2.20 $\pm$ 1.87	2.93 $\pm$ 2.30	.034
Depression	1.91 $\pm$ 2.57	1.50 $\pm$ 2.09	1.69 $\pm$ 2.20	1.71 $\pm$ 2.23	1.76 $\pm$ 1.92	2.07 $\pm$ 2.34	.021
Anger	4.20 $\pm$ 2.01	3.57 $\pm$ 2.45	4.07 $\pm$ 2.26	3.69 $\pm$ 2.22	4.04 $\pm$ 1.77	3.78 $\pm$ 2.05	.006
Vigor	8.11 $\pm$ 4.28	6.54 $\pm$ 4.46	7.82 $\pm$ 3.37	6.78 $\pm$ 3.82	7.42 $\pm$ 3.49	5.84 $\pm$ 2.83	.006
Fatigue	7.14 $\pm$ 4.09	6.70 $\pm$ 4.26	6.22 $\pm$ 3.53	7.67 $\pm$ 3.71	7.09 $\pm$ 4.25	8.64 $\pm$ 4.49	.044
Confusion	3.82 $\pm$ 2.29	3.48 $\pm$ 2.36	3.98 $\pm$ 1.64	3.89 $\pm$ 1.68	3.69 $\pm$ 1.82	3.87 $\pm$ 1.73	.011