

Exercise During Pregnancy Attenuates Prenatal Depression: A Randomized Controlled Trial

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Abstract

Recent studies have estimated the prevalence of depression during pregnancy to be between 10% and 30%, which is higher than that in the postpartum period. Pharmacological treatment during pregnancy is difficult because of the possible side effects of antidepressants on the mother and the fetus. The aim of this study was to examine whether a supervised exercise program (EP) reduces depressive symptoms in pregnant women. A randomized controlled trial was designed. One hundred eighty four healthy pregnant women from Fuenlabrada Hospital were included (31.37 ± 3.62 years). Women from the exercise group (EG) participated in a supervised EP consisting of three, 55- to 60-min sessions per week throughout pregnancy. The main outcome measure was the patients' depression level

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assessed by means of the Center for Epidemiologic Studies Depression Scale (CES-D). A total of 167 pregnant women were analyzed; 90 were allocated to the EG and 77 to the control group (CG). Significant differences were found between groups at the end of the study in CES-D scores (EG: 7.67 ± 6.30 vs. CG: 11.34 ± 9.74 , $p = .005$) and in percentages of pregnant women depressed (EG: $n = 11/12.2\%$ vs. CG: $n = 19/24.7\%$, $p = .04$). Our results show that supervised physical exercise during pregnancy reduces the level of depression and its incidence in pregnant women.

Keywords

pregnancy, prenatal, depression, exercise, well-being

Introduction

The World Health Organization (WHO; 2002) estimates that depressive disorders will be the second leading cause of global disease by 2020. Depressive symptoms, such as a prolonged feeling of sadness, low self-esteem, suicidal tendencies (Melville, Gavin, Guo, Fan, & Katon, 2010), loss of interest in activities, feelings of helplessness and hopelessness, decreased energy, decision-making difficulties, sleep problems, restlessness, irritability, and changes in eating patterns (U.S. National Institute of Mental Health, 2007), are associated with an increased risk of conditions such as osteoporosis (Kahl et al., 2005), cardiovascular diseases (Meyer, Armenian, Eaton, & Ford, 2004), and dementia (Kessing & Andersen, 2004).

According to the WHO (2002), 22% of women of childbearing age have suffered from depression at some point in their lives, and pregnancy is a vulnerable time for depression compared with other periods of life (Campagne, 2004). Physical and psychological changes occur in pregnant women; for instance, pregnancy is associated with weight gain that consists of the growing fetus and increased maternal fluid and soft tissue, including fat (Lederman et al., 1997). Nausea in the first trimester, the fear of not being able to cope with a baby, a past history of psychological disorders (Austin, Priest, & Sullivan, 2008), hormonal changes, changes related to sexual interest, and anxiety about childbirth can alter a woman's emotional state.

Recent studies have estimated a prevalence of depression during pregnancy to be between 10% and 30% (Teixeira, Figueiredo, Conde, Pacheco, &

Costa, 2009), which is higher than that in the postpartum period (Lee et al., 2007).

Pharmacological treatment during pregnancy is not recommended because of the possible side effects of antidepressants on the mother and the fetus (Hammond & Crozier, 2007). Depression is more difficult to control because it is necessary to avoid possible negative effects on the fetus and mother, such as impaired cerebral development (O'Connor et al., 2002), increased risk of preterm birth or intrauterine growth restriction (Field, 2011), postpartum depression and its related complications, mother–infant bonding difficulties (Wisner et al., 2009), infant feeding difficulties and childhood overweight problems (Ertel, Koenen, Rich-Edwards, & Gillman, 2010), low birth weight, and longer hospital stays. Depression can also have an adverse impact on the cognitive, emotional, social, and behavioral development of infants (Deave, Heron, Evans, & Emond, 2008) as well as antisocial/violent behavior during adolescence (Field, 2011).

Research findings indicate that the antenatal maternal mood state impacts the in utero development of the infant, with significant associations found between levels of maternal distress during pregnancy and child behavioral outcomes (O'Connor et al., 2002). This situation provides an incentive to investigate alternative depression treatments (Hammond & Crozier, 2007). Pregnant women are likely to be depressed during their pregnancies because of the large increases in progesterone and estrogen that occur during this period, which may influence the neural structures that are known to be important in regulating mood (Poudevigne & O'Connor, 2006) by increasing the sensitivity to changes in levels of b-endorphins (Smith et al., 1990) and dopamine (Wieck et al., 1991).

Past studies have supported the antidepressant effects of exercise in the general population (Martinsen, 2008) and in pregnant women (Orr, James, Garry, & Newton, 2006). However, more randomized controlled trials (RCTs) are needed to determine the actual effect of physical exercise on the treatment of depressive disorders in pregnant women. Scientific evidence has shown that exercise during pregnancy does not cause adverse effects on mother and fetus, even improving psychological factors (Barakat, Pelaez, Montejo, Luaces, & Zakythinaky, 2011).

It was hypothesized that pregnant women who exercise during their pregnancies would score lower on the Center for Epidemiologic Studies Depression Scale (CES-D) than sedentary pregnant women and that the depression prevalence in the exercise group (EG) would be lower. In this context, the aim of the present study was to assess whether a supervised

and specific physical exercise program (EP) can reduce depressive symptoms in pregnant women.

Material and Method

The present study was an RCT (NCT 01696201). Pregnant women living in Madrid, Spain, and who underwent ultrasound examination at limit 12 weeks of pregnancy were invited to participate. A total of 167 participants who agreed to participate were randomly allocated between two groups: 90 to the EG and 77 to the control group (CG). All of the patients had uncomplicated and singleton gestations, and their mean age was 31.37 ± 3.62 years. Written informed consent was obtained from each participant. The study was approved by the Research Ethics Committee of Hospital Universitario de Fuenlabrada (Madrid, Spain) and was conducted according to the ethical guidelines of the Declaration of Helsinki, which was last modified in 2008.

Women presenting any type of absolute obstetrical contraindication to exercise as suggested by American College of Obstetricians and Gynecologists (2002) were excluded. Other exclusion criteria were as follows: not planning to give birth in the obstetrics department of the study hospital, not receiving medical follow-up throughout the pregnancy, participating in another physical activity program, or having a high level of pregestational physical exercise (four or more times per week). Because participating in another structured EP was an exclusion criterion, this was verified in EG at the beginning of the study. Women in the CG confirmed (via telephone interview) that they did not participate in a structured EP throughout their pregnancies.

For allocation of the participants, a computer-generated list of random numbers was used. Randomization process (sequence generation, allocation concealment, and implementation) was made for three different authors in order to facilitate blinding of process and outcomes assessment (hospital personnel), intervention (EP) was made by a qualified fitness specialist, due type of intervention blinding of participants was not possible.

Sample Size

To detect a reduction of 15% in women with depression in late pregnancy, with a two-sided 5% significance level and a power of 80%, a sample size of 75 pregnant per group was necessary, given an anticipated dropout rate of 15% (Moher, Dulberg, & Wells, 1994; Schulz & Grimes, 2005).

Intervention

Women who were randomly assigned to the EG were invited to participate in a supervised physical conditioning program that included three, 55- to 60-min sessions per week that began between 9 and 12 weeks of gestation and continued until the end of the third trimester (Weeks 39 and 40).

Every session started with 5–8 min of walking and static stretching of most muscle groups to warm up. This warm-up was followed by an aerobic dance section and specific exercises that targeted the major muscle groups in the legs, buttocks, and abdomen to stabilize the lower back (25 min); balancing exercises were also included (10 min). Every session concluded with pelvic floor muscle training (10 min) and a cooldown period (5–8 min). Exercises that involved the Valsalva maneuver, extreme stretching, joint overextension, ballistic movements, and jumping were specifically avoided. Furthermore, the exercises were performed in the supine position for no longer than 2 min.

Light- to moderate-intensity aerobic activity was prescribed, with the goal of achieving a 55–60% maximal heart rate (HR). To allow the participants to identify the intensity required for the aerobic exercise, the HR was shown on a poster after being calculated individually for each woman based on the trimester, physical condition, and age using the Karvonen's formula (Goldberg, Elliot, & Kuehl, 1988). The intensity was also adjusted based on the Borg scale ratings (O'Neill, Cooper, Mills, Boyce, & Hunyor, 1992). All of the subjects wore a HR monitor (Accurex Plus, Polar Electro OY, Finland) during the training sessions to ensure that the exercise intensity was light to moderate.

To maximize patient safety and adherence to the training program and its efficacy, all of the sessions were supervised by a qualified fitness specialist (working with groups of 10–12 subjects), with the assistance of an obstetrician, and accompanied by music; the exercises were performed in the University Hospital of Fuenlabrada in a spacious, well-lit room under favorable environmental conditions (altitude 600 m, temperature 19–21°C, and humidity 50–60%). An adequate intake of calories and nutrients was ensured for each participant before the start of the exercise session. Women in the CG did not exercise during this period; they received the usual information provided by their midwives or health care professionals.

Measures

The CES-D was administered to all of the women at the beginning (weeks 9–12) and end (weeks 38 and 39) of their pregnancies. The CES-D is commonly used during pregnancy (Robledo-Colonia, Sandoval-Restrepo, Mosquera-Valderrama, Escobar-Hurtado, & Ramírez-Vélez, 2012). It was developed by the National Institute of Mental Health and has been validated in various populations. It is a structured, self-administered questionnaire that comprises 20 items to assess the different aspects of depressive symptomatology. Each response is scored from 0 (*never*) to 3 (*all the time*) according to the frequency of the symptoms. The score is the sum of the 20 weighted items, and the maximum total score is 60. If more than 4 items are missing, the test cannot be considered. A threshold of 16 (≥ 16) is considered to indicate depression.

Pregnancy outcomes, such as maternal weight gain, recommended weight gain according to pregestational body mass index (BMI), birth weight, gestational age, Apgar score, and type of delivery, were taken from the medical records at delivery. Recommended weight gain for underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$), normal weight ($\text{BMI} \geq 18.5\text{--}24.9 \text{ kg/m}^2$), overweight ($\text{BMI} \geq 25\text{--}29.9 \text{ kg/m}^2$), and obese ($\text{BMI} \geq 30 \text{ kg/m}^2$) is 12.5–18, 11.5–16, 7–11.5, and 5–9 kg, respectively (Rasmussen & Yaktineeds, 2009).

Statistical Analyses

Student's unpaired *t*-test was used to examine the differences in the descriptive characteristics between the intervention and the CGs, pregnancy outcomes except type of delivery and weight gain, according to recommendations (Rasmussen & Yaktineeds, 2009), and CES-D scores. Student's paired *t*-test was used to assess the effect of the EP. The results are presented as the means \pm standard deviation. An interim analysis was made to assure the safety of the intervention during the trial ($N = 50$). The levels of significance maintained an overall *p* value of .05 and were calculated according to the O'Brien-Fleming stopping boundaries (Pocock, 1992).

For the evaluation of delivery type and other maternal characteristics (e.g., parity, smoking status, educational level, prepregnancy BMI, and maternal weight gain, according to recommendations), one-way analysis of variance and chi-square (χ^2) test were used; *p* values of $\leq .05$ indicated statistical significance. Cohen's *d* was used to determinate the effect size. An effect size ranging from 0 to 0.20 was considered a small effect size, 0.20–0.50 was a moderate effect size, and over 0.5 was a large effect size (Cohen, 1992).

Results

Approximately 229 pregnant women were interviewed at the first prenatal visit. The results regarding adherence to the protocol were as follows: 11 women in the EG were lost to follow-up because of discontinued intervention ($n = 4$), the risk of premature labor ($n = 1$), pregnancy-induced hypertension ($n = 1$), and personal reasons ($n = 5$). Six participants in the CG were excluded from the study because of discontinuous intervention ($n = 3$), preinduced hypertension ($n = 2$), and personal reasons ($n = 1$). A total of 167 participants were included in the analysis (Figure 1).

Maternal Characteristics and Depression Scores

Personal data were collected from each participant during the first visit. The maternal characteristics were similar between the groups (Table 1).

Depression scores: Differences between groups. Women started the study with similar CES-D scores (EG: 9.87 ± 8.9 vs. CG: 9.38 ± 8.10 , $t_{165} = 0.36$, $p = .71$). Significant differences were found between the groups in CES-D scores at the end of the study (EG: 7.67 ± 6.30 vs. CG: 11.34 ± 9.74 , $t_{126} = 2.83$, $p = .005$). The effect size was small ($d = 0.46$).

The percentage of women who were pregnant depressed in each group at baseline were similar (EG: $n = 22/24.4\%$ vs. CG: $n = 17/22.1\%$, $p = .85$); however, in late pregnancy, significant differences between the study groups were found ($n = 11/12.2\%$ vs. CG: $n = 19/24.7\%$, $p = .04$).

Depression scores: Intragroup differences between first and third trimester. The EP had a significant positive effect in EG on CES-D scores between the first and third trimesters (T1: 9.87 ± 8.9 vs. T3: 7.67 ± 6.30 , $t_{89} = 3.35$, $p = .001$). The effect size was small ($d = 0.29$). However, CES-D scores in the CG worsened between first and third trimesters (T1: 9.38 ± 8.10 vs. T3: 11.34 ± 9.74 , $t_{76} = 2.09$, $p = .039$). The effect size was small ($d = 0.22$). Similarly, there were significantly fewer depressed women (CES-D score ≥ 16) in the EG between the first and the third trimesters (T1: $n = 22/24.4\%$ vs. T3: $n = 11/12.2\%$, $\chi^2 = 29.97$, $p = .0009$), the effect size was moderate 0.57, whereas this percentage was slightly increased in the CG between the first and the third trimesters (T1: $n = 17/22.1\%$ vs. T3: $n = 19/24.7\%$). The present study showed that pregnant women in the EG were less likely to develop depression in the

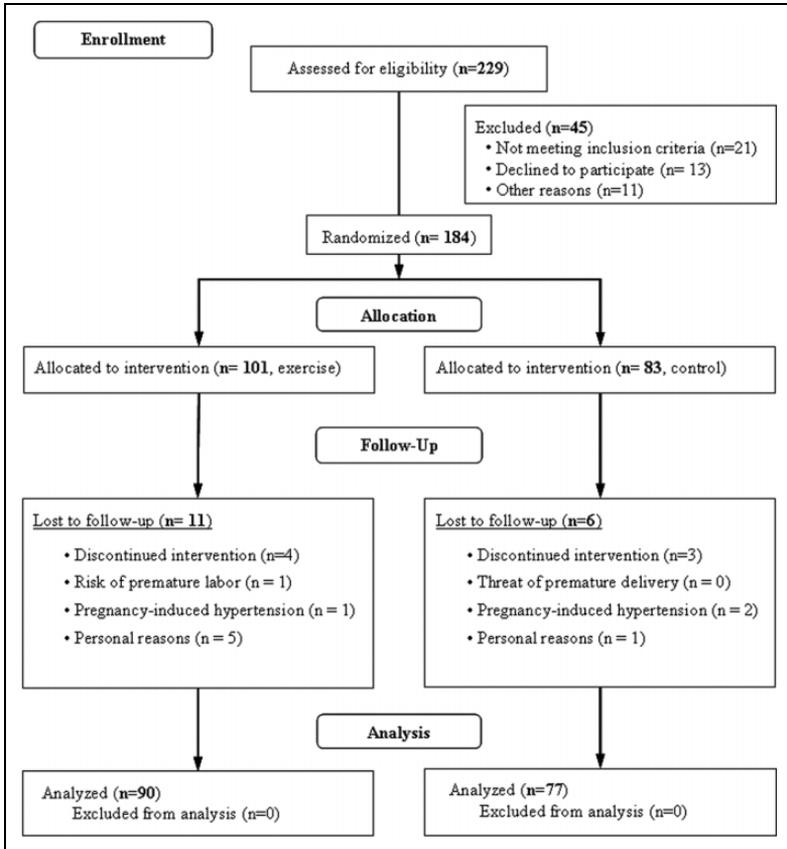


Figure 1. CONSORT 2010 flow diagram of the study participants.

third trimester than women in the CG (odds ratio, OR = 0.42; 95% confidence interval, CI, [0.18, 0.96]; risk ratio = 0.49; 95% CI [0.25, 0.97]).

Maternal and Fetal Outcomes

The EP had no negative effect on maternal and fetal outcomes. Nevertheless, the number and percentage of women with excessive weight gain during pregnancy according to Institute of Medicine recommendations was significantly higher in the CG than in the EG (EG $n = 12/13.25\%$ vs. CG $n = 20/26.7\%$, $c^2 = 4.50$, $p = .034$) with a small effect size of 0.16.

Table 1. Maternal Characteristics, Depression Scores, and Pregnancy Outcomes.

Variable	EG (n = 90)	CG (n = 77)	p
Age, years	31.08 ± 3.39	31.66 ± 3.86	.30
BMI at the start the study	23.47 ± 3.47	24.30 ± 4.42	.17
Pre-pregnancy BMI, n/%			
<18	0/0	1/1.3	.23
18–24.9	64/71.1	50/64.9	
25/29.9	22/24.2	17/22.1	
>30	4/4.4	9/11.7	
Parity, n/%			
No previous gestation	54/60	41/53.2	.47
One previous gestation	34/37.8	32/41.6	
Two or more previous gestation	2/2.2	4/5.2	
Smoking during pregnancy, n/%			
No	78/86.6	64/83.1	.64
Yes	10/11.1	12/15.5	
CES-D scores at Trimester 1	9.87 ± 8.9	9.38 ± 8.10	
CES-D scores at Trimester 3	7.67 ± 6.30	11.34 ± 9.74	.005*
PWD ^a at Trimester 1, n/%	22/24.4	17/22.1	.85
PWD ^a at Trimester 3 n/%	11/12.2	19/24.7	.04*
Maternal weight gain, kg	11.850 ± 4.19	13.890 ± 10.23	.08
MWG-IOM, n/%			
Excessive weight gain	12/13.25	20/26.7	.03*
Adequate weight gain	77/86.5	55/73.3	
Gestational age, days	276.67 ± 8.85	274.87 ± 16.28	.36
Type of delivery, n/%			
Normal	64/71.1	45/58.4	.21
Instrumental	12/13.3	13/16.9	
Cesarean section ^b	14/15.6	19/24.7	
Birth weight, g	3153.68 ± 434.66	3236 ± 415.40	.21
Birth length, cm	49.44 ± 2.19	49.72 ± 2.03	.39
Head circumference, cm	34.17 ± 1.40	34.48 ± 1.47	.17
Apar score 1 min	8.75 ± 1.28	8.78 ± 1.25	.88
Apar score 5 min	9.79 ± 0.53	9.81 ± 0.61	.81

Note. MWG-IOM = maternal weight gain during pregnancy according IOM recommendations; BMI = body mass index; CES-D = Center for Epidemiological Studies Depression Sscale; CG = control group; EG = exercise group; IOM = Institute of Medicine.

^aPWD = Pregnant women with depression (CES-D score ≥ 16).

^bElective and emergency.

*Significant at level $p = .05$.

Discussion

The main finding of our study was that supervised, moderate exercise performed during pregnancy attenuates prenatal depression. Furthermore, the overall health status of the infant is unaffected, as reflected by the results of the widely used Apgar score. Additionally, regular exercise during pregnancy was not found to have any negative effects on the main pregnancy outcomes. The physical EP had a significant, positive effect not only by decreasing the CES-D mean scores between groups but also on the percentage of pregnant women who were identified as depressed (16 points or more). The CES-D scores and the level of depression increased in the sedentary pregnant women who were not physically active during pregnancy. Moreover, the regular physical EP decreased the risk of developing depression in the third trimester and reduced the likelihood of developing pregnancy-related depression (OR = 0.42; 95% CI [0.18, 0.96]).

Some researchers have found the same results regarding the effectiveness of regular exercise during pregnancy in improving depressive symptoms (Craft, Freund, Culpepper, & Perna, 2007; Robledo-Colonia et al., 2012). However, the lack of physical activity is found to be associated with an increase in depressive symptoms in many studies of nonpregnant women (Wise, Adams-Campbell, Palmer, & Rosenberg, 2006).

This positive association between physical exercise and depression could be explained by several biological mechanisms. After performing physical activity, the increase in body temperature may increase the temperature in certain regions of the brain and create a feeling of relaxation (DeVries, 1981). Additionally, an increase in β -endorphins usually occurs following exercise, which produces positive feelings and a sense of well-being. It is also possible that physical activity leads to an increase in brain neurotransmitters, such as serotonin, dopamine, and norepinephrine, the availability of which is often decreased with depression (Craft & Perna, 2004). Note that these mechanisms have not yet been observed in pregnant women.

The decreased depression level in the EG could be associated with an increase in patient body satisfaction (Boscaglia, Skouteris, & Wertheim, 2003). This association has been demonstrated in other studies (Mehta, Siega-Riz, & Herring, 2010). Rauff and Downs (2011) demonstrated that body image satisfaction is an important psychological determinant of the development of depressive symptoms in pregnant women.

Promoting an active lifestyle in pregnant women could help them avoid excessive weight gain and increase their body image satisfaction, both of

which are directly associated with common depression symptoms in pregnant women.

Conclusion

The completion of a supervised physical EP throughout the entire pregnancy improved the level of depression and its incidence in pregnant women without having any negative impacts on maternal and fetal outcomes. Furthermore, exercise helps to control excessive weight gain during pregnancy.

What This Study Adds

Many observational studies have reported that activities performed during leisure periods improve certain psychological parameters. However, only one clinical trial has studied the effects of programmed and supervised exercise during pregnancy. The novel topic we addressed in this study is of medical relevance, given the potential medical complications and deterioration in quality of life that are associated with prenatal depression. The strength of this study is the use of an RCT design to examine the effects of physical exercise and the addition of new results and conclusions from an experimental point of view.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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