Aerobic exercise training during pregnancy reduces depressive symptoms in nulliparous women: a randomised trial

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Question: Does supervised aerobic exercise during pregnancy reduce depressive symptoms in nulliparous women? **Design**: Randomised trial with concealed allocation, blinded assessors, and intention-to-treat analysis. **Participants**: 80 nulliparous, pregnant women attending for prenatal care at one of three tertiary hospitals in Cali, Colombia. **Intervention**: The experimental group completed a 3-month supervised exercise program, commencing at 16 to 20 weeks of gestation. Each session included walking (10 min), aerobic exercise (30 min), stretching (10 min), and relaxation (10 min). The control group continued usual activities and performed no specific exercise. **Outcome measures**: The primary outcome was symptoms of depression assessed by the Center for Epidemiological Studies Depression Scale (CES-D) at baseline and immediately after the 3-month intervention. **Results**: 74 women completed the study. After the 3-month intervention, the experimental group reduced their depressive symptoms on the CES-D questionnaire by 4 points (95% CI 1 to 7) more than the control group. **Conclusions**: A supervised 3-month program of primarily aerobic exercise during pregnancy reduces depressive symptoms. **Trial registration**: NCT00872365. **[Robledo-Colonia AF, Sandoval-Restrepo N, Mosquera-Valderrama YF, Escobar-Hurtado C, Ramírez-Vélez R (2012) Aerobic exercise training during pregnancy reduces depressive symptoms in nulliparous women: a randomised trial. *Journal of Physiotherapy* 58: 9–15]**

Key words: Aerobic exercise, Pregnant women, Depression, Randomised trial, Physiotherapy

Introduction

Depression disorders have become a widespread health concern throughout the world. The worldwide prevalence of depression has been estimated at 10.4% (Andrews et al 2000). During pregnancy, depression affects 10–50% of women, with the incidence being higher in cohorts with low socioeconomic status (De Tychey et al 2005). Depression during pregnancy is more common among women with a history of depression or a family history of depression, those in single motherhood or with more than three children, cigarette smokers, low income earners, teenagers, and those in unsupportive social situations (Dietz et al 2007, Yonkers et al 2009). The importance of prenatal intervention is highlighted by studies showing that depression is associated with increased risk of prenatal and perinatal complications (Jablensky et al 2005, Nakano et al 2004). For example, depressed women are more likely to deliver prematurely (Field 2011) and they often have neonates who require intensive care for postnatal complications including growth retardation and bronchopulmonary dysplasia (Chung et al 2001). Furthermore, although pregnant women typically report significantly lower rates of tobacco, alcohol, and cannabis use than before pregnancy (Hotham et al 2008), depression increases vulnerability to caffeine, nicotine, drug, and alcohol use in pregnant women (De Tychey et al 2005, Field et al 2009). Depression is also associated with failure to eat well and seek prenatal care (Yonkers et al 2009).

Prenatal interventions for depressed pregnant women have included antidepressants, psychotherapy, alternative therapies, and physical activity (Field et al 2009, Rethorst et al 2009). In recent years, accumulating evidence has supported the popular belief that physical activity is associated with psychological health in pregnant women. Guidelines from the American College of Obstetricians and Gynecologists (Artal and O'Toole 2003) recommend regular exercise for pregnant women, including those who are sedentary, for its overall health benefits including improved psychological health. Physical activity during pregnancy appears to be beneficial to the maternal-foetal unit and may prevent the occurrence of maternal disorders, such as hypertension (Yeo et al 2000, Barakat et al 2009) and gestational diabetes (Dempsey et al 2004, Callaway et al 2010), as well as improving well-being and quality of life (Montoya Arizabaleta et al 2010). In addition, several studies over the last decade have reported that physical activity has few negative effects for many pregnant women (Alderman et al 1998, Artal and O'Toole 2003, Barakat et al 2008, Barakat et al 2009).

Pregnancy is a time of intense physical change and emotional upheaval in many women (Hueston and Kasik-Miller 1998, Montoya Arizabaleta et al 2010). In addition to the obvious outward physical changes that accompany pregnancy, significant increases in mental health problems, including

What is already known on this topic: Depression is common among pregnant women and is associated with increased risk of prenatal and perinatal complications. Exercise is an effective therapy for depression in many other patient populations.

What this study adds: Three months of aerobic exercise training reduces the severity of symptoms of depression among pregnant women.

depression and psychosis, occur during pregnancy and in the immediate postpartum period (Watson et al 1984). Even in normal pregnancies, women experience subtle changes that may alter their ability to carry out their usual roles and may detract from their overall health-related quality of life (Hueston and Kasik-Miller 1998, Montoya Arizabaleta et al 2010). Research has shown that exercise can decrease depressive symptoms, yet an optimal exercise program for treating depression has not been established.

Therefore the research question for this study was:

> Does a 3-month supervised aerobic exercise program decrease depressive symptoms in nulliparous pregnant women?

Method

A randomised trial was conducted. Participants were recruited from the prenatal care services of three hospitals in Cali, Colombia. Women who were interested in the study were invited to a screening visit at one of the centres. Sociodemographic data were recorded and a detailed physical examination was performed by a physician to determine eligibility. After confirmation of eligibility, the women were randomly allocated to one of two groups: aerobic exercise plus usual prenatal care, or usual prenatal care only. Randomisation was performed using a permuted block design with a block size of 10 and exp:con ratios of 5:5, 6:4 or 4:6. Participants in the exercise group commenced the program when each block was completed, allowing supervised group exercise sessions comprising three to five women. Baseline measures were taken the day before the exercise program commenced and outcomes were measured the day after the program was completed. The investigator responsible for randomly assigning participants to treatment groups did not know in advance which treatment the next person would receive (concealed allocation) and did not participate in administering the intervention or measuring outcomes. The investigators responsible for assessing eligibility and baseline measures were blinded to group allocation. Participants and therapists administering the intervention were not blinded. The investigators responsible for outcome assessment were blinded to group allocation. All investigators received training before the trial and reminders during the trial regarding the protocol, the measurement procedures, and the methods and importance of maintaining blinding. Measurements were taken at baseline (Month 0, which corresponded to 16–20 weeks of gestation) and at the end of the three-month intervention period (Month 3, week 28–32 of gestation).

Participants, therapists, centres

Pregnant women were eligible for the study if they were aged between 16 and 30 years, between 16 and 20 weeks of gestation, with a live foetus at the routine ultrasound scan. They were excluded if they had participated in a structured exercise program in the past six months or had a history of high blood pressure, chronic medical illnesses (cancer, renal, endocrine, psychiatric, neurologic, infectious, or cardiovascular diseases), persistent bleeding after week 12 of gestation, poorly controlled thyroid disease, placenta praevia, incompetent cervix, polyhydramnios, oligohydramnios, miscarriage in the last 12 months, or diseases that could interfere with participation, according to the recommendations of the American College of Sports Medicine (ACSM 2009) and the American College of Obstetricians and Gynecologists (Artal and O'Toole 2003).

At each participating centre two health professionals, who volunteered, were trained to recruit and assess eligibility. During the recruitment period, the opportunity to participate in the study was offered daily to all patients at the participating centres when they attended for routine antenatal care, if they previously had been identified on the doctors' lists as being without a chronic pathology. The participating centres were required to offer routine antenatal care and have facilities to allow the conduct of a supervised exercise class.

Intervention

Participants in the experimental group were invited to participate in three 60-min exercise classes per week, starting between week 16 and 20 of gestation and continuing for 3 months. All subjects wore a heart-rate monitor during the training sessions to ensure that exercise intensity was moderate to vigorous (Ramírez-Vélez et al 2009, Ramírez-Vélez et al 2011b). Sessions consisted of walking (10 min), aerobic exercise (30 min), stretching (10 min), and relaxation (10 min). Aerobic activities were prescribed at moderate to vigorous intensity, aiming for 55–75% of maximal heart rate and adjusted according to ratings on the Borg scale (Borg 1982). Adherence to the exercise program was encouraged by the physiotherapist who supervised the exercise sessions. In order to maximise adherence to the training program, all sessions were: supervised by a physiotherapist and a physician, conducted in groups of three to five women, accompanied by music, and performed in a spacious, air-conditioned room.

The control group received no exercise intervention, did not attend the exercise classes, and did not take part in a home exercise program. Both groups continued with their normal prenatal care (1 session per week for 3 months) and physical activity.

Outcome measures

One day before beginning the exercise program and immediately after the 3-month exercise period finished, all women were assessed for symptoms of depression using the Center for Epidemiological Studies-Depression Scale (CES-D). The 20-item scale has adequate test-retest reliability, internal consistency, and concurrent validity (Wells et al 1987). Test-retest reliability over a one-month period on this sample was 0.79, suggesting some short-term stability of depressive symptoms. A score of 16 on the CESD is considered the cut-point for depression (Radloff and Rae 1979).

Data analysis

We sought to detect a between-group difference in the change in the CES-D score of 4 points as we considered this a clinically important improvement in depressive symptoms. Assuming that the standard deviation in this score would be 6, similar to that observed in a similar sample of women during pregnancy (Carter et al 2000), a total sample size of 74 would provide 80% power to detect a difference of 4 points as statistically significant. We recruited additional participants to allow for withdrawals. Data were entered in an electronic database by investigators at the time of assessment. Random checks of data entry

Table 1. Baseline characteristics of participants, therapists, and centres.

Characteristic	Study completers (n = 74)		Lost to follow-up (n = 6)	
	Exp (n = 37)	Con (n = 37)	Exp (n = 3)	Con (n = 3)
Participants				
Age *(yr)*, mean (SD)	21 (3)	21 (3)	21 (2)	21 (2)
Gestation *(wk)*, mean (SD)	18 (2)	17 (1)	18 (1)	17 (1)
Marital status, n (%)				
Single	11 (30)	17 (46)	1 (33)	2 (66)
Married/de facto	26 (70)	20 (54)	2 (66)	1 (33)
Ethnicity, n (%)				
African Colombian	2 (5)	6 (16)	1 (33)	2 (66)
Mestize	35 (95)	31 (84)	2 (66)	1 (33)
Socioeconomic level, n (%)				
Stratum 1 (range 1–3)	35 (95)	31 (84)	2 (66)	1 (33)
Stratum 2 (range 4–6)	2 (5)	6 (16)	1 (33)	2 (66)
Education, n (%)				
None	2 (5)	3 (8)	1 (33)	0
Primary	5 (14)	7 (19)	0	1 (33)
Secondary	25 (68)	24 (65)	1 (33)	1 (33)
Technical	4 (11)	3 (8)	1 (33)	1 (33)
University	1 (3)	0	0	0
Occupation, n (%)				
Student	9 (24)	5 (14)	3 (100)	2 (66)
Housewife	28 (76)	32 (86)	0	1 (33)
Location, n (%)				
Urban	35 (95)	33 (89)	1 (33)	3 (100)
Rural	2 (5)	4 (11)	2 (66)	0
Therapists, n participants (%)				
A	10 (27)	10 (27)	1 (33)	1 (33)
B	10 (27)	9 (24)	1 (33)	1 (33)
C	9 (24)	8 (22)	1 (33)	1 (33)
D	8 (22)	10 (27)	0	0
Centres, n participants (%)				
1	12 (32)	13 (35)	1 (33)	1 (33)
2	12 (32)	12 (32)	2 (66)	1 (33)
3	13 (35)	12 (32)	0	1 (33)

Exp = experimental group, Con = control group

were performed and corrections made where possible by phoning participants for confirmation. The normality of the distribution of scores was confirmed with the Kolmogorov-Smirnov test. We then used the unpaired t-test to estimate the between-group difference. The significance level was set at $p < 0.05$. Analysis was according to the principle of intention-to-treat.

Results

Flow of participants, therapists, centres through the study

Eighty participants were recruited to the study. The baseline characteristics are presented in Table 1. Forty participants were allocated to the experimental group and 40 to the control group. Figure 1 outlines the flow of participants through the trial and the reasons for loss to follow-up.

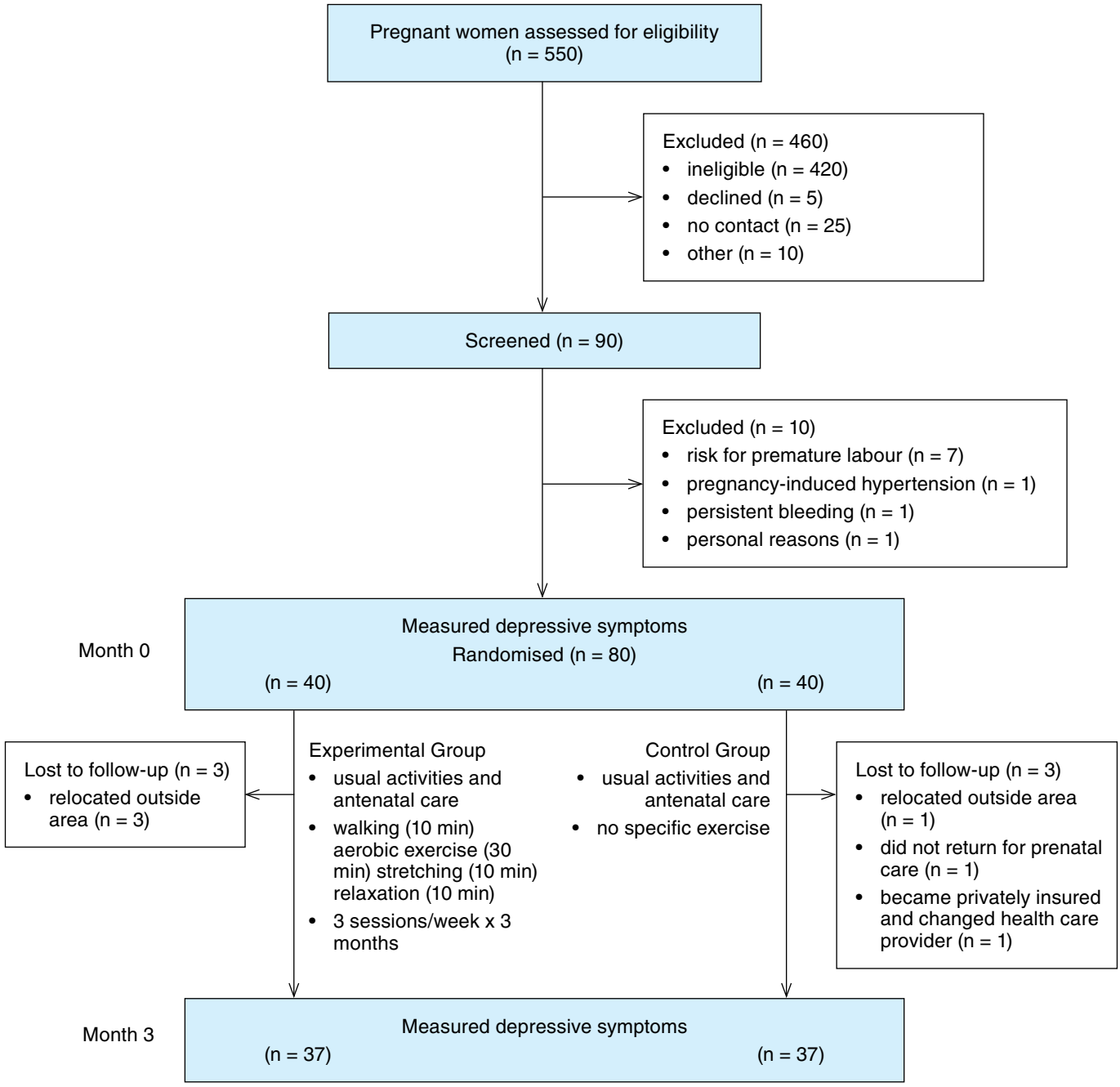

Figure 1. Design and flow of participants through the study.

A qualified, registered physiotherapist and a medical doctor with four years of experience in exercise programs, supervised all exercise sessions. In addition, the physiotherapist received further training in the specific exercise program for this study.

The study was conducted at three hospitals specialising in antenatal care, which were located in different regions of Cali, Colombia (Hospital Cañaveralejo, Centro de Salud Siloe, and Centro de Salud Melendez), with a combined throughput of 1200 pregnant women per year.

Compliance with the trial method

Three participants in the experimental group and three in the control group withdrew from the study before the 3-month assessment. In all cases the withdrawals were due to reasons unrelated to the intervention. Experimental participants received on average 28.9 out of 36 (SD 3.2) sessions over the 3 months. No adverse events occurred during or after the exercise in any participant.

Effect of intervention

Group data are presented in Table 2 and individual data in Table 3 (see eAddenda for Table 3). At 3 months, the supervised aerobic exercise program reduced depressive symptoms significantly more in the experimental group than the control group. The between-group difference in improvement was 4 points (95% CI 1 to 7) on the 20-point CES-D score.

Table 2. Mean (SD) of groups, mean (SD) difference within groups, and mean (95% CI) difference between groups for depressive symptoms by (CES-D)

	Groups				Difference within groups		Difference between groups
	Month 0		Month 3		Month 3 minus Month 0		Month 3 minus Month 0
	Exp (n = 37)	Con (n = 37)	Exp (n = 37)	Con (n = 37)	Exp	Con	Exp minus Con
CES-D points	16 (8)	17 (7)	10 (6)	16 (8)	–5 (5)	–1 (8)	–4 (–1 to –7)

Exp = experimental group, Con = control group, CES-D = Center for Epidemiological Studies Depression Scale

Discussion

A recent systematic review of the effect of exercise on antenatal depression found a small number of observational studies linking regular physical activity to improved self-esteem and reduced symptoms of anxiety and depression during pregnancy (Shivakumar et al 2011). However, no randomised controlled trials were identified by this review. Therefore, we believe this is the first randomised trial to assess the effect of a supervised aerobic exercise program on depressive symptoms in nulliparous pregnant women.

Our study showed that three months of aerobic exercise reduces symptoms of depression in pregnant women. In our clinical experience, we consider that a reduction of 4 points on the CES-D resulting from this intervention is clinically important. However, no threshold has been established empirically for the amount of improvement in the CES-D score that pregnant women typically feel makes aerobic training worthwhile. Our estimate of the average effect of the training had some uncertainty, with a 95% CI ranging from 1 to 7 points. Therefore, even if 4 points is a valid estimate for the smallest worthwhile effect, we must acknowledge that it is uncertain whether the statistically significant effect of aerobic exercise is clinically worthwhile. Nevertheless, aerobic exercise training during pregnancy is associated with other clinical benefits such as the prevention of maternal hypertension (Yeo et al 2000, Barakat et al 2009) and gestational diabetes (Dempsey et al 2004, Callaway et al 2010), as well as improved well-being and quality of life (Ramírez-Vélez 2011a, Montoya Arizabaleta et al 2010). Therefore, physiotherapists can prescribe aerobic exercise during pregnancy for its range of benefits, now knowing that it will also reduce the severity of any depressive symptoms.

Observational studies of risk factors for depression during pregnancy cannot determine causation. However, it is possible that some of the factors identified may enter into a reinforcing cycle with depression. For example, low levels of physical activity, self-care ability, and antenatal support are associated with depression in pregnant women (Demissie et al 2011). Low levels of physical activity may reduce cardiovascular fitness and affect motivation to stay healthy physically, mentally, and emotionally. This could be exacerbated by the lack of energy often experienced by pregnant women. Lower ability to self-care during pregnancy may increase musculoskeletal or other physical barriers to exercise. The impact of depression can exacerbate an unhealthy lifestyle, resulting in prenatal and perinatal complications, which in turn can lead to more severe depression. The information that exercise reduces depression during pregnancy may therefore be useful in motivating pregnant women to exercise during pregnancy and in breaking these cycles of reinforcement between depression and overall fitness.

The results of this study are consistent with several previous studies of the effect of structured exercise on depression in other populations. A systematic review by Rethorst and colleagues (2009) reported that aerobic exercise at a dose consistent with public health recommendations (ie, at least 30 minutes of moderate intensity physical activity on most, preferably all, days of the week) is an effective monotherapy for symptoms of depression. Results from review articles and meta-analyses also indicate an inverse relationship between physical activity and depressive symptoms (Paluska and Schwenk 2000, Rethorst et al 2009, Carek et al 2011). In Rethorst's meta-analysis (2009), the effect of exercise was also examined specifically in individuals with clinical depression or depression resulting from mental illness. The results showed that exercise programs were effective in decreasing depressive symptoms among clinically depressed individuals and individuals with depression resulting from mental illness.

Another study by Craft (2007) compared the effects of two exercise programs on physical activity, depressive symptoms, body composition, and fitness. Thirty-two sedentary women with a diagnosis of depression were randomised to either a clinic-based or a home-based exercise program for three months. The results showed that both exercise programs were associated with reductions in depressive symptoms and increased physical activity participation. Neither exercise program impacted body composition or fitness. The authors concluded that both clinic-based and home-based exercise programs can benefit women with depressive symptoms.

During pregnancy, symptoms are an important contributor to poor health status, while in the postpartum period a lack of social support is the most consistent predictor of poor health outcomes (Hueston and Kasik-Miller 1998). The recommended levels of physical activity were positively associated with reduced depressive symptoms. In particular, social functioning, and mental health are critically affected by the recommended level of physical activity (Brown et al 2003).

Our estimate of the effect of aerobic exercise on depression is likely to be valid because the study design incorporated features such as concealed allocation and intention-to-treat analysis in order to minimise the potential for bias in the results. Only one outcome was measured so the risk of Type

I error was low. The required sample size was calculated *a priori* and was attained, with little attrition from the study cohort during the trial period. Nevertheless, our findings should be considered within the context of the limitations of the study design. One limitation was that the therapists and participants were not blinded. Further studies may be needed to explore the relationships among psychological status, physical function, and quality of life during pregnancy with depressive symptoms (Brown et al 2000, Ramírez-Vélez et al 2011a, Montoya Arizabaleta et al 2010). Investigation of other intervention components, such as behaviour therapy, is also needed (Field et al 2009, Rethorst et al 2009). In addition, future randomised controlled trials should study the effects of exercise in pregnancy among women with low pre-pregnancy physical activity.

Physiotherapists should advise pregnant women that aerobic exercise training during pregnancy reduces the severity of symptoms of depression. It is unclear whether the effect on depression alone is large enough for pregnant women to feel it justifies the time, effort and cost of the exercise regimen. However, the effect on depression is supplemented by preventive effects on maternal hypertension and gestational diabetes, as well as improved well-being and quality of life. ■

eAddenda: Table 3 available at JoP.physiotherapy.asn.au

Ethics: The University of Valle Research Ethics Committee approved this study (Res-021/010-UV). Informed consent was gained from all participants before data collection began.

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