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Effects of a concurrent exercise training program on low back and sciatic pain and pain disability in late pregnancy

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Objective: The aim of the present study was to explore the influence of a concurrent exercise (aerobic + resistance) training program, from the 17th gestational week (g.w.) until birth on low back and sciatic pain, and pain disability. A total of 93 pregnant women divided into exercise ($n = 49$) and control ($n = 44$) groups followed a 60-min, 3 days/week, concurrent exercise training.

Methods: Low back and sciatic pain were measured with a Visual Analogic Scale (VAS). The disability resulting from pain was assessed with the Oswestry Disability Index (ODI). Measures were performed at the 16th and 34th g.w.

Results: The exercise group increased 21.9 mm less the VAS low back (between-group differences (B): 95% CI: −33.6 to −10.2; $p < 0.001$) and 12.9 mm less the VAS sciatica score (between-group differences: 95% CI (B): −21.8 to −4.0; $p = 0.005$) than the control group. Regarding the ODI questionnaire, the exercise group increased 0.7, 0.5, and 0.7 less than the control group in pain while sleeping (between-group differences (B): 95% CI: −1.4 to −0.01; $p = 0.025$), pain while lifting weight (between-group differences (B): 95% CI: −0.9 to −0.01; $p = 0.016$), and limitations of the social life due to pain (between-group differences(B): 95% CI: −1.3 to −0.06; $p = 0.032$). Furthermore, the exercise group suffered 6.9% less pain

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than the control group in the ODI total score (between-group differences (B): 95% CI: −13.9 to 0.053; $p = 0.052$).

Conclusion: This concurrent exercise training program adapted to pregnant women improved pain compared to controls.

KEYWORDS
back pain, disability, gestation, sciatic pain, visual analogic scale

1 | INTRODUCTION

Gestation implies physiological and biomechanical modifications promoted by hormonal changes and the growing uterus (with the consequent shift of the center of gravity) that may predispose women to suffer greater pain,[1] especially during late pregnancy.[2] Some of these anatomical changes include lumbar hyperlordosis, neck flexion, hyperlaxity of the lumbar spine ligaments, and increased mobility of the sacroiliac joints.[3] Lumbopelvic pain affects most pregnant women throughout the pregnancy course.[1,2] Between 50 and 85% of women experience low back or pelvic girdle pain during pregnancy and ~25% continue to experience pain 1 year after birth.[2,4] Radiating low back pain, also called sciatic pain, is also frequent among pregnant women, with prevalence rates between 10% and 25%.[5] This painful experience may limit daily activities like standing, walking, lifting weight, sleeping, or satisfying sexual life, among others.[6,7] Further, prenatal pain has been associated with increased depression, anxiety, and stress during pregnancy,[8] which altogether can negatively affect both the mother and child's health.[9]

To reduce this pain many pregnant women consume painkillers, some of which are contraindicated in the third trimester of pregnancy.[10] Hence, it is imperative to find alternative non-pharmacological strategies aimed at reducing pain in late pregnancy. Exercise could be an optimal therapeutic approach as it decreases pain intensity and sensitivity in the general population.[11] Strong evidence confirms that greater physical fitness (whose main determinant is exercise) may prevent musculoskeletal pain and pain-related disability in pregnant women.[12] Thus, exercise training could be effective in the prevention of pain during pregnancy. To date, some authors have shown the potential of exercise during pregnancy on reducing back-pain intensity and associated disability,[13,14] including less need for analgesia.[15] Notwithstanding, systematic reviews on the topic[14,16–18] suggest that exercise exerts a small protective effect against low back pain during gestation, which might be partially justified by the scarce, equivocal, and low-quality evidence.[14,16]

There is also a lack of studies focusing on the effects of exercise on sciatic pain during pregnancy and concerning the best exercise training modality (e.g., aerobic exercise, resistance training, and concurrent exercise) for decreasing pain in this stage of women's life. Therefore, following recent research and guidelines on exercise for healthier pregnancies,[19] we propose the combination of aerobic+resistance training to potentially achieve additional benefits through different pain release pathways (i.e., benefits from aerobic[20,21] plus muscle strength[22,23] on pain prevention and modulation).

The purpose of the present study was to explore the influence of a concurrent exercise training program from 17th gestational week (g.w.) until birth on low back and sciatic pain, and pain disability at late pregnancy (34th g.w.).

2 | METHODS

2.1 | Study sample and design

These are secondary outcomes from the GESTAtion and FITness (GESTAFIT) project (registration number: NCT02582567), where a novel concurrent (i.e., (aerobic+resistance) exercise intervention was conducted from the 17th g.w, until birth in order to test its effects on several maternofoetal health markers). The complete methodological details of the GESTAFIT project have been published.[24] Briefly, 159 women from Granada (Spain) were recruited out of the 384 pregnant women who were informed about the project during their 12th g.w. gynecologist appointment. All interested participants who met the inclusion criteria (Table S1) signed a written informed consent before joining the study. This protocol was approved by the Ethics Committee on Clinical Research of Granada, Regional Government of Andalusia, Spain (code: GESFIT-0448-N-15).

2.2 | Randomization and blinding

The present study was initially designed as a pure randomized control trial. Nonetheless, the randomized component was partially broken in the second and third waves of participants recruitment because of some difficulties related to the adherence of control women, which represents a frequent methodological barrier in antenatal exercise research.[25] Thus, half of the women were allocated to the control/exercise group according to their convenience to attend the exercise sessions. All examiners (except for the training session's instructors who did not participate in the assessments) were blinded regarding the group allocation of the participants during the different evaluations.

2.3 | Procedures

At the 16th g.w., the first assessment for sociodemographic and clinical characteristics, anthropometry, and pain questionnaires was carried out in the "Sport and Health Research Centre, University of Granada, Spain". At the 34th g.w., a second assessment for anthropometry and pain questionnaires was conducted.

2.4 | Exercise intervention

Pregnant women into the exercise group participated in a concurrent-training program from the 17th week until birth (3 days/week, 60 min/session) consisting in a combination of aerobic-resistance exercises of moderate-to-vigorous intensity. This exercise protocol was designed by an expert multidisciplinary team, following the recommendations from the American College of Obstetrics and Gynecology. The exercise group started with an informative and movement learning phase (3 sessions). In this initial phase, fundamental basic movement patterns were taught (hip and knee dominant, pull and push movements), and theoretical explanations were provided to the participants. Subsequently, the main exercise training phase lasted from the 18th until 34th g.w. and was focused on improving or maintaining physical fitness. The final phase during the last weeks of pregnancy was focused on the pelvic mobilization (preparation for the birth). The detailed exercise sessions and protocol, along with specific exercises, can be found elsewhere.[26] The attendance to the training sessions was recorded. Each exercise session included a 10-min warm-up period with walks, mobility, and activation exercises. The main part of the first and last weekly sessions consisted of 40 min of exercises organized in two resistance circuits of 15 exercises (40″ work/20″ rest), alternating with cardiovascular blocks (concurrent training) (Figure S1). The second session of the week was focused on aerobic training through dancing, proprioceptive and coordinative circuits, and interval walks (Figure S2). The sessions finished with a 10-min cool-down period of stretching, breathing, relaxation, and myofascial relief.[26]

2.5 | Control group

Pregnant women in the control group did not participate in the training sessions and were asked to continue with their usual activities. For ethical reasons, the research team held a series of lectures to address the importance of physical activity and a healthy diet during pregnancy and to provide women with strategies to approach daily physical activity and healthy dietary habits. Both control and exercise groups attended these conferences.

2.6 | Sociodemographic and clinical data

Sociodemographic data, including age, number of children, marital status, and educational level, were collected.

2.7 | Anthropometry and body composition

Pre-pregnancy self-reported body weight was recorded, and height was assessed at 16th g.w. by using a stadiometer (Seca 22, Hamburg, Germany). Pre-pregnancy body mass index (BMI) was calculated as weight (kg) divided by squared height (m^2).

2.8 | Pain measures

2.8.1 | Low back and sciatic pain

Low back and sciatic pain were assessed with a Visual Analogic Scale (VAS),[27] asking the participants to cross out with a mark (perpendicular line) in a 10 cm scale without references. Later, the research team measured the scale with a ruler from 0 mm (not painful at all) to 100 mm (the highest pain). VAS pain scales have been widely employed to assess back pain in pregnant women.[14,16,18]

2.8.2 | Pain disability

Pain disability was measured with the Oswestry Disability Index (ODI) questionnaire,[28] where the participants were asked about their pain intensity during daily situations, such as lifting, walking, sitting, standing, sleeping, and socializing. The total score ranges from 0 to 5. If any question does not have an adequate answer for the participant's situation, the participant may not answer the question. Then, the disability score is calculated and expressed as a percentage. Higher values describe greater functional limitations. The ODI scale has been widely previously employed in pregnant women.[14,16,18]

2.9 | Statistical analyses

Descriptive statistics (mean and standard deviation (SD) for quantitative variables and a number of women (%) for categorical variables) were employed.

The differences between the control and exercise groups on VAS low back, VAS sciatica, and ODI scores were analyzed by linear regression analyses on a per protocol-basis as previously designed.[24] Only women who attended at least 75% of the exercise sessions, and completed both baseline and follow-up assessments, were included in the present analyses. The changes (34th–16th g.w.) of these outcomes were included in the linear regression analyses as dependent variables, and the intervention group (control = 0 and exercise = 1) as independent variable. Model I was unadjusted for age, pre-pregnancy BMI, and baseline values (i.e., values at the 16th g.w.) of pain-related outcomes. Model II was additionally adjusted for gestational weight gain. Multiple imputations were performed to estimate missing data in specific pain outcomes. Subsequently, differences between the control and exercise groups on VAS low back, VAS sciatica, and ODI scores were assessed by linear regression on an intention-to-treat basis according to the CONSORT guidelines. Considering that some authors do not recommend performing imputations when more than 20% of cases are missing,[28] multiple imputations were not possible for some ODI subscales.

The statistical analysis was conducted with the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, Version 22.0; IBM Corp). The statistical significance was set at $p < 0.05$.

3 | RESULTS

Of the 159 pregnant women who were randomized into the control (n = 87) and exercise (n = 72) groups, 9 and 7 of the control and exercise groups, respectively, did not have valid data in cofounding variables (i.e., pre-pregnancy BMI). A total of 21 women did not attend 75% of the exercise sessions. Thus, the total number of women used for the per-protocol analyses was 93 divided into control (n = 44) and exercise (n = 49) groups. The flowchart of the study participants is shown in Figure S3.

Baseline characteristics of the exercise and control groups are shown in Table 1. Gestational weight gain was lower in the exercise group (p = 0.003). No differences between the control and exercise groups were observed in the rest of the socio-demographic and clinical characteristics (all, $p > 0.05$).

Table 2 shows the per-protocol basis analyses of VAS low back, VAS sciatica, and ODI score changes between pre-and post-intervention for control and exercise groups. In model I, VAS low back and VAS sciatica scores increased by 4.1 and 4.2 mm, respectively, in the exercise group from 16th to 34th g.w., whereas they increased by 26.0 and 17.1 mm, respectively, in the control group. Consequently, the exercise group increased 21.9 and 12.9 mm less than the control group in the VAS low back (between-group differences (B): 95% CI: −33.6 to −10.2 mm; $p < 0.001$) and the VAS sciatica score (between-group differences: 95% CI (B): −21.8 to −4.0 mm; p = 0.005), respectively. Regarding the ODI, pain while sleeping, lifting weight, and limitations of the social life due to pain scores increased by 0.03, 0.2, and 0.1 in the exercise group whereas it increased by 0.8, 0.7, and 1.0 in the control group, respectively. Consequently, the exercise group increased 0.7, 0.5, and 0.7 less than control group in pain while sleeping score (between-group differences (B): 95% CI: −1.4 to −0.01; p = 0.025), pain while lifting weight score (between-group differences (B): 95% CI: −0.9 to −0.01; p = 0.016), and limitations of the social life due to pain (between-group differences(B): 95% CI: −1.3 to −0.06; p = 0.032) scores. Furthermore, ODI total score increased by 5.7% in the exercise group from 16th to 34th g.w. whereas it increased by 12.6% in the control group. Consequently, the exercise group increased 6.9% less than the control group the ODI total score (between-group differences (B): 95% CI: −13.9 to 0.053%; p = 0.052). After additionally adjusting for gestational weight gains results remained the same except for ODI-limitations of the social life and ODI total score. Intention-to-treat basis analyses depicted similar results (Table S2).

4 | DISCUSSION

The main findings of the present intervention study suggest that the concurrent exercise training program developed within the GESTAFIT project improved low back and sciatic pain, as well as limitations due to pain, compared to the control group. Specifically, the exercise group had a lower increase in VAS-low back and VAS-sciatic pain than the control group through pregnancy. Regarding ODI subscales, the exercise group worsened less than the control group in pain while sleeping, pain while lifting weight, and limitations of the social life due

TABLE 1 Participants' baseline characteristics.

	All women (*n* = 93)	Control group (*n* = 49)	Exercise group (*n* = 44)
Age, years	33.4 (4.5)	33.5 (4.8)	33.3 (4.2)
Pre-pregnancy body mass index (kg/m^2)	23.6 (3.7)	23.0 (3.2)	24.2 (4.1)
Gestational weight (weight at the 34th g.w.-pre-pregnancy) (kg)	11.2 (5.0)	12.6 (5.1)	9.6 (4.4)
Percentage of attendance[a]			85.7 (7.6)
Marital status *n* (%)			
Married or with partner	55 (59.1)	29 (59.2)	26 (59.1)
Single or living alone	38 (40.9)	20 (40.8)	18 (40.9)
Educational level *n* (%)			
University studies	61 (65.6)	34 (69.4)	27 (61.4)
Non-University studies	32 (34.4)	15 (30.6)	17 (38.6)
Visual analogic scale (VAS)[b] (0–100)			
Low back pain for the last 4 weeks	20.5 (23.6)	19.0 (24.9)	22.2 (22.4)
Sciatic pain for the last 4 weeks (*n* = 48 vs 44)	10.6 (20.1)	8.1 (16.6)	13.4 (23.1)
Oswestry disability index (ODI)[b] (0–5)			
Intensity of the pain	0.2 (0.6)	0.3 (0.8)	0.1 (0.4)
Pain while standing	0.7 (0.9)	0.8 (1.0)	0.6 (0.8)
Pain while carrying out self-care activities	0.1 (0.4)	0.2 (0.4)	0.1 (0.3)
Pain while sleeping	0.2 (0.9)	0.2 (1.0)	0.1 (0.8)
Pain while lifting weight	0.6 (0.8)	0.7 (0.8)	0.5 (0.7)
Pain having sexual activities (*n* = 40 vs 44)	0.1 (0.5)	0.2 (0.7)	0.1 (0.2)
Pain while walking (*n* = 40 vs 44)	0.1 (0.2)	0.1 (0.3)	0 (0.0)
Limitations of the social life due to pain (*n* = 40 vs 44)	0.2 (0.6)	0.3 (0.7)	0.1 (0.4)
Pain while seated (*n* = 40 vs 44)	0.5 (0.8)	0.5 (0.7)	0.5 (1.0)
Pain while traveling (*n* = 40 vs 44)	0.3 (0.5)	0.3 (0.5)	0.2 (0.4)
Total score (0–100%) (*n* = 40 vs 44)	5.6 (7.4)	6.8 (8.6)	4.5 (6.0)
Illness diagnosis (yes, *n* [%])			
Chronic cervical backache	3 (3.2)	2 (4.1)	1 (2.3)
Chronic lumbar backache	4 (4.3)	3 (6.1)	1 (2.3)
Medication for pain in the last 2 weeks	18 (19.4)	10 (20.4)	8 (18.2)
Drug intake (yes, *n* [%])			
Ibuprofen	3 (3.2)	3 (6.1)	0 (0)
Paracetamol	23 (24.7)	12 (24.5)	11 (25.0)
Diazepam	2 (2.2)	1 (2.0)	1 (1.0)

Note: Values shown as mean (standard deviation) unless otherwise indicated.

[a]The percentage of attendance in intention-to-treat basis analysis was 77.7% (17.1).

[b]Greater scores indicate higher pain.

to pain. Furthermore, the exercise group increased 7% less than the control group the ODI total score.

It is widely documented that pain negatively affects the quality of life during pregnancy,[6] and it is also associated with anxiety and depression levels;[8,28] thus, all kind of safe pain-prevention and pain-release strategies are specially welcome in this physiological period. Pain usually increases throughout gestation,[1] and musculoskeletal problems are common complaints, especially during late pregnancy.[2] Low back pain generally begins in early pregnancy, and it seems to continue and increase until late pregnancy in almost 75% of pregnant women.[6] Similarly, in the present study, pain increased as the course of pregnancy progressed, with women scoring almost doubly at the 34th g.w. However, pain increased in a lower range in the exercise group. we have contrasted that this

TABLE 2 Per-protocol analyses showing the association of the changes on Visual Analogic Scale and the Oswestry Disability Index from 16th to 34th with the intervention group (control or exercise group) in pregnant women.

			Model I				Model II			
	Changes within control group Post-Pre	**Changes within exercise group Post-Pre**	β	**B**	**Between-group difference (95% CI)**	***p***	β	**B**	**Between-group difference (95% CI)**	***p***
Visual analogic scale (VAS)[a], (0–100 mm)										
Low back pain for the last 4 weeks (n = 49 vs 44)	26.0 (4.0)	4.1 (4.2)	−0.339	−21.897	−33.605 to −10.189	**<0.001**	−0.300	−19.383	−31.509 to −7.256	**0.002**
Sciatic pain for the last 4 weeks (n = 48 vs 44)	17.1 (3.0)	4.2 (3.2)	−0.294	−12.912	−21.799 to −4.025	**0.005**	−0.269	−11.807	−21.140 to −2.475	**0.014**
Oswestry Disability Index (ODI)[a], (0–5)										
Intensity of the pain (n = 48 vs 38)	0.3 (0.2)	0.4 (0.2)	0.042	0.112	−0.444 to 0.668	0.690	0.017	0.047	−0.534 to 0.628	0.873
Pain while standing (n = 48 vs 38)	0.3 (0.1)	0.5 (0.2)	0.107	0.235	−0.171 to 0.640	0.253	0.140	0.307	−0.111 to 0.726	0.148
Pain while carrying out self-care activities (n = 48 vs 38)	0.3 (0.1)	0.2 (0.1)	−0.091	−0.125	−0.425 to 0.175	0.410	−0.071	−0.097	−0.409 to 0.214	0.537
Pain while sleeping (n = 47 vs 38)	0.8 (0.2)	0.03 (0.2)	−0.223	−0.736	−1.375 to −0.096	**0.025**	−0.248	−0.819	−1.483 to −0.156	**0.016**
Pain while lifting weight (n = 47 vs 38)	0.7 (0.1)	0.2 (0.2)	−0.242	−0.515	−0.932 to −0.099	**0.016**	−0.212	−0.452	−0.887 to −0.017	**0.042**
Pain having sexual activities (n = 22 vs 21)	1.0 (0.3)	0.3 (0.3)	−0.290	−0.829	−1.744 to 0.087	0.075	−0.297	−0.849	−1.910 to 0.212	0.113
Pain while walking (n = 22 vs 21)	0.6 (0.1)	0.2 (0.1)	−0.216	−0.351	−0.779 to 0.077	0.105	−0.231	−0.374	−0.876 to 0.128	0.140
Limitations of the social life due to pain (n = 22 vs 21)	0.8 (0.2)	0.1 (0.2)	−0.302	−0.667	−1.272 to −0.062	**0.032**	−0.271	−0.600	−1.306 to 0.105	0.093
Pain while seated (n = 22 vs 21)	1.0 (0.2)	0.6 (0.2)	−0.186	−0.334	−0.909 to 0.241	0.247	−0.181	−0.324	−0.983 to 0.335	0.326

TABLE 2 (Continued)

	Changes within control group Post-Pre	Changes within exercise group Post-Pre	Model I				Model II			
			β	B	Between-group difference (95% CI)	*p*	β	B	Between-group difference (95% CI)	*p*
Pain while traveling (n = 22 vs 21)	0.5 (0.2)	0.3 (0.2)	−0.118	−0.063	−0.622 to 0.386	0.637	−0.052	−0.098	−0.682 to 0.485	0.735
Oswestry disability index (ODI)[a] total score, (0–100%) (n = 18 vs 17)	12.6 (2.3)	5.7 (2.4)	−0.302	−6.917	−13.888 to 0.053	**0.052**	−0.250	−5.732	−13.792 to 2.327	0.158

Note: Values shown as mean (standard error). Model I was adjusted for baseline values, age and pre-pregnancy body mass index. Model II was additionally adjusted for gestational weight gain (i.e., weight at the 34th gestational week-pre-pregnancy weight). Mean results show the differences between post-pre intervention (i.e., 34th gestational week-16th gestational week) after adjusting for baseline values, age and pre-pregnancy body mass index for each variable, with negative values indicating a reduction in the post evaluation compared to pre-evaluation. β, standardized regression coefficient; B, nonstandardized regression coefficient; Bold values indicates $p < 0.05$.

[a]Greater scores indicate higher pain.

concurrent exercise-training program decreased low back pain by 22% and sciatic pain by 13% in comparison with the control group.

Overall, systematic reviews and meta-analyses,[14,17,18] have concluded that exercise during pregnancy can be useful at preventing or decreasing low back, pelvic girdle, lumbopelvic pain, and some pain-related disabilities. However, a recent meta-analysis[16] stood out that prenatal exercise (i.e., aerobic, yoga, specific strengthening, general strengthening or a combination of different types of exercise) did not reduce low back, pelvic girdle, or lumbopelvic pain during pregnancy.[16] Nonetheless, exercise seems to strongly prevent new episodes of sick leave due to lumbopelvic pain during pregnancy,[14] and we have confirmed that our concurrent exercise training protocol also reduced pain-related limitations while sleeping and lifting weight, and limitations of social life due to pain. Notwithstanding, these findings must be confirmed by further research as these reviews included few studies, and most of them were uniquely focused on pelvic and core muscle-stabilizing exercises, or low volume and intensity aerobic activities, whereas we developed a multicomponent exercise training program. In this sense, to highlight is the similar supervised intervention performed by Haakstad and Bø,[29] where the authors developed a 60 min exercise session that consisted of 35 min of aerobic training followed by 15 minutes of strength training, at least twice per week, for a minimum of 12 weeks. Contrary to our findings, they found no differences between the intervention and control group in low back pain, which could be partially explained by the shorter duration of the program, and the lower time dedicated to resistance training within their exercise protocol. On the contrary, in agreement with our study, no negative effects of the intervention were reported.[29] Unfortunately, no studies so far have reported the influence of prenatal exercise on sciatic pain to confirm or contrast our positive findings.

Some studies have also drawn attention to the inadequate use of painkillers during pregnancy, which included the intake of contraindicated drugs, self-prescription of painkillers, or taking more than the recommended dose for pregnancy.[10] In this context, exercise during pregnancy might struggle pain without the use of painkillers, or through lower doses, which could reduce fetal exposure to the risks associated with these drugs. In fact, in a recent study performed in pregnant women, the median usage of Paracetamol as an analgesic to control back pain in the control group was 500 mg higher than in the exercise group.[15]

Despite the exact mechanisms to explain exercise-induced hypoalgesia are still unclear, there are potential factors that might explain this lower pain through the concurrent exercise program. First, it is widely demonstrated that aerobic exercise reduces pain sensitivity across all types of pain,[11] even in populations without chronic pain.[11] One of these mechanisms is the activation of the endogenous opioid system[11] as aerobic exercise may promote the liberation of beta-endorphins, inducing positive changes in pain sensitivity or analgesia.[30,31] For instance, a recent study[20] has contrasted that aerobic exercise-related enhancements in endogenous pain inhibition, in part endogenous opioid-related, likely contributed to chronic low back pain reduction.[20] Similarly, the hypoalgesic mechanism of aerobic exercise based on cycling seems to involve the enhancement of the central descending inhibitory function.[21] Second, increasing tissue oxygenation as a result of aerobic exercise may diminish peripheral and central sensitization, therefore reducing pain intensity.[32] Third, since a growing body of evidence implicated the amygdala as a critical node in emotional affective aspects of chronic pain, a study performed in mice has suggested that voluntary running may promote pleasant emotion and hypoalgesia through plastic changes in the amygdala.[33] Fourth, also in rats exposed to voluntary running, a recent study has proposed that the therapeutic efficacy of exercise in low back pain is mediated, at least in part, at the epigenetic level.[34] Fifth, our exercise protocol promoted lower excessive gestational weight gain (data under review), which has been associated with greater low back pain during pregnancy.[35] Indeed, in the statistical model II, additionally adjusted for gestational weight gains, the exercise improvements were attenuated, and differences in ODI total score and social limitations due to pain disappeared. Sixth, exercise during pregnancy promotes psychological well-being, decreasing stress, anxiety, and depression levels,[36] and this better emotional status might be associated with less pain perception.[37] Lastly, the improved muscle function induced by resistance training has been associated with lower low back pain in pregnancy.[22] For instance, core muscle strengthening (also performed in the present study exercise program) in patients with low back pain after caesarean section decreased low back pain intensity and disability. The anti-inflammatory role of myokines[38] such as irisin might also have partially promoted this analgesic effect.[39,40] Therefore, the combination of aerobic exercise with resistance training can provide additional effects on pain prevention through different relief pathways.[41] In agreement with this hypothesis, our group previously contrasted in this study sample that greater overall physical fitness and its components (mainly cardiorespiratory fitness and muscle strength) were associated with less bodily, low back, and sciatic pain, and reduced pain disability during pregnancy.[14] A recent study has also found that women with greater muscular strength suffer less low back and bodily pain probably through improvements in the musculoskeletal system and balance.[23]

4.1 | Limitations and strengths

This study has some limitations that must be underlined. First, due to the lack of a control group with no stimulus at all to compare the real efficacy of our intervention (i.e., counseling talks with ergonomic advices were given to all the participants), results should be interpreted cautiously. Second, specific pre-pregnancy pain problems not related to the exclusion criteria were not registered.[24] Third, this study may have incurred on selection biases due to the broken randomization component but this is unlikely to have been a determining factor in the quality of the study. Regarding strengths, the exercise group followed a novel and supervised concurrent exercise that combines aerobic + resistance training, which has been proved to be more effective to improve physical and mental health during this period.[19] Also constitutes a strength the relatively large sample size of pregnant women involved, despite the loss of sample in the ODI questionnaire. Further, we adjusted the models for potential confounders such as maternal age, educational status, and pre-pregnancy BMI, and we show a second statistical model further adjusted for gestational weight gains. Moreover, the exercise program attendance rate was high (86%), which may strengthen our findings. Finally, our main findings remained similar after the intention-to-treat basis analyses, which may indicate a strong influence of this exercise protocol even with a lower assistance rate to the sessions.

5 | PERSPECTIVE

This concurrent exercise-training program resulted in clinically significant improved low back and sciatic pain and limitations due to pain. The addition of well-structured exercise was safe and effective even for previously physically inactive women to decrease pain across pregnancy. As we know from previous studies, reducing pain during this period provides additional benefits on maternal mental health[8] and health-related quality of life,[42] which can positively affect both the mother and child's physical and mental health.[9] The effects of concurrent exercise before and during pregnancy on pain relief should be studied in future RCTs.

6 | CONCLUSION

This concurrent exercise protocol developed from 17th g.w. until birth may attenuate low back and sciatic pain during pregnancy (i.e., from 16th to 34th g.w). Moreover, the exercise group showed better scores than the control group in pain while sleeping and while lifting weight, and limitations of the social life due to pain. Altogether, these findings reinforce the usefulness of this concurrent protocol for pain management during pregnancy, even with lower rates of attendance (as confirmed by the intention to treat analyses). Therefore, we propose a combination of aerobic+resistance training for a middle-late pregnancy with lower low back and sciatic pain, and disabilities due to pain.

AUTHOR CONTRIBUTIONS

VAA carried out the conception and design of the study and participated in the collection and interpretation of the data, performed statistical analysis, and wrote the manuscript. NMJ, MFA, PAM, ICR, and LBG participated in collection of the data, reviewed the manuscript and provided critical comments.

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CONFLICT OF INTEREST STATEMENT

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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