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CLINICAL ARTICLE

Leisure time physical activity during pregnancy and preterm birth in Brazil

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Abstract

Objective: To investigate the relationship between leisure time physical activity (LTPA) during pregnancy and preterm birth. *Methods:* A cross-sectional, population-based study evaluated LTPA during pregnancy in 4147 mothers using data from the 2004 Pelotas Birth Cohort Study. Gestational age was determined by last menstrual period, or when not available, by ultrasound or the Dubowitz method. Type of LTPA, length of usual session, and frequency were determined for each trimester. *Results:* A total of 14.6% of all births were considered preterm. Only 13.3% of women reported engaging in LTPA during pregnancy. After adjusting for confounders, LTPA in all 3 trimesters (prevalence ratio [PR] 0.55; 95% confidence interval [CI] 0.32–0.96), LTPA in the third trimester (PR 0.50; 95% CI 0.31–0.80), and minimum LTPA (≥90 min/week) in the third trimester (PR 0.58; 95% CI 0.34–0.98) showed a protective association with preterm birth in the adjusted analysis. *Conclusion:* LTPA, especially throughout pregnancy and in the third trimester, was associated with a lower chance of preterm birth.

1. Introduction

Preterm birth is a worldwide public health concern, with low-income countries facing major challenges to overcome the problem [1]. The short- and long-term consequences for the neonate are well described in the literature [2–5]. Globally, almost 1 million neonates die each year from preterm birth [6].

The risk factors for preterm birth are poverty, advanced age, ethnicity, very low body mass index, smoking during pregnancy, and pregnancy-related diseases [7]. Some factors, such as maternal age, genetics, and ethnic origin are unchangeable, while characteristics such as income and education are difficult to change. Although behavioral changes are not easy to implement, they may contribute to the prevention of adverse pregnancy outcomes; for example, smoking is a well-known risk factor for low birth weight and other pregnancy-related problems [8] and women who smoke are strongly advised to stop during pregnancy [9]. Leisure time physical activity (LTPA) is a potential protective factor for preterm birth, which could be encouraged if proven to be beneficial. Guidelines suggest that women with no contraindications to exercise should be advised to engage in aerobic and strength-training activities during pregnancy [10,11].

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Table 1 Demographic, socioeconomic, behavioral, and pregnancy-related variables of the participants and distribution of preterm birth (n = 4147)

Variables	%	Preterm birth (%)	Prevalence ratio (95% CI)	*P* value
Age, y				0.001
12–19	19.1	19.0	1.41 (1.19–1.67)	
20–34	67.6	13.5	1.00	
35–46	13.3	13.4	0.99 (0.79–1.26)	
Family income (quintiles)				<0.001
1 (lowest)	20.4	19.4	1.00	
2	20.3	15.8	0.81 (0.66–1.00)	
3	19.3	13.3	0.68 (0.54–0.85)	
4	20.4	12.8	0.66 (0.53–0.82)	
5 (highest)	19.6	11.3	0.58 (0.46–0.74)	
Ethnicity				0.003
White	73.1	13.6	1.00	
Black/mixed/other	26.9	17.3	1.27 (1.09–1.49)	
Education, y (n = 4106)				<0.001
0–4	15.6	19.3	1.00	
5–8	41.2	15.5	0.80 (0.66–0.97)	
9–11	33.2	12.3	0.63 (0.51–0.78)	
≥12	10.1	11.3	0.59 (0.43–0.80)	
Single mother				0.41
Yes	16.4	15.6	1.00	
No	83.6	14.4	0.92 (0.76–1.12)	
Number of births				0.78
0 (primipara)	39.6	15.3	1.02 (0.86–1.20)	
1	26.2	12.8	1.00	
≥2	34.2	15.0	0.85 (0.70–1.04)	
Prepregnancy BMI (n = 2833)				0.31
Underweight	7.3	18.8	1.48 (1.09–2.02)	
Normal	63.4	12.7	1.00	
Overweight	20.4	15.2	1.19 (0.95–1.50)	
Obese	8.9	11.2	0.88 (0.61–1.27)	
Smoking				0.14
Yes	27.5	15.9	1.13 (0.96–1.32)	
No	72.5	14.1	1.00	
Birth interval, mo (n = 3907)				0.006
<24	9.1	23.6	1.95 (1.56–2.43)	
≥24	48.8	12.1	1.00	
Primiparas	42.1	15.3	1.26 (1.07–1.49)	
Onset of prenatal care (n = 4007)				<0.001
1st trimester	72.4	12.5	1.00	
2nd trimester	25.0	17.9	1.43 (1.21–1.68)	
3rd trimester	2.6	19.1	1.52 (1.01–2.81)	
Hypertension in pregnancy				0.003
Yes	23.7	17.5	1.28 (1.09–1.50)	
No	76.3	13.6	1.00	
Risk for spontaneous abortion				0.05
Yes	10.7	17.7	1.25 (1.00–1.55)	
No	89.3	14.2	1.00	
3rd trimester vaginal bleeding				0.001
Yes	6.4	21.6	1.53 (1.20–1.95)	
No	93.6	14.1	1.00	
Employment details				0.14
Standing job				
Yes	22.6	13.0	0.87 (0.72–1.05)	
No	77.4	15.0	1.00	
Heavy-lifting job				0.97
Yes	8.3	14.6	1.00 (0.77–1.31)	
No	91.7	14.5	1.00	

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CI, confidence interval.

Previous studies have suggested that women who engage in LTPA are less likely to deliver prematurely [12] and a recent review [13] highlighted the benefits of LTPA for prevention of pre-eclampsia and gestational diabetes.

The aim of the present study was to explore the relationship between the potential benefits of LPTA during pregnancy and preterm birth.

2. Materials and methods

The research was carried out in Pelotas, Southern Brazil, which has a population of approximately 330 000; more than 99% of all deliveries in the city take place in hospitals. The study was carried out as part of the 2004 Pelotas Birth Cohort Project, a longitudinal study designed to evaluate long-term maternal–child outcomes. All 5 maternity hospitals in the city were visited daily from January 1 through December 31, 2004. Women were interviewed within 24 hours of delivery with a pretested structured questionnaire and their neonates were examined by trained nutritionists supervised by a pediatrician. A detailed description of the methodology used in the 2004 Pelotas Birth Cohort Project has been published previously [14]. The study was approved by the Ethics Committee of the Medical School of the Federal University of Pelotas. Written informed consent was obtained from the women before the questionnaires were conducted.

The perinatal questionnaire covered socioeconomic and demographic variables, lifestyle, physical activity, reproductive history, characteristics of pregnancy, and pregnancy-related diseases.

Family income for the month preceding delivery was categorized (quintiles). Women living without a partner, or who were single, widowed, or divorced were classified as a single mother. Education level in terms of complete years of formal education was categorized as 0–4, 5–8, 9–11, and ≥12 years. Age of the women was defined in complete years at the time of delivery: <20, 20–34, and 35–46 years. Ethnicity was classified by the interviewer as white or black/mixed by observation.

The women's height and prepregnancy weight were used to calculate prepregnancy body mass index (BMI, calculated as weight in kilograms divided by height in meters squared). When available, prepregnancy weight was obtained from the records taken at the first prenatal visit. If prenatal records were unavailable, the women were asked to recall their prepregnancy weight. Prepregnancy BMI was categorized as: <18.5 (underweight); 18.5–24 (normal); 25–30 (overweight); and ≥30 (obese). The number of previous viable pregnancies (0, 1, and 2 or more) and the interval between the last delivery and the current birth (categorized as <24 months or ≥24 months) were self-reported by the women;

Table 2 Distribution of preterm birth and crude prevalence ratios according to leisure time physical activity variables (n=4147)

Variables	%	Preterm birth (%)	Prevalence ratio (95% CI)	*P* value
Any LTPA during pregnancy				0.003
Yes	13.3	10.4	0.68 (0.53–0.88)	
No	86.7	15.2	1.00	
LTPA in all 3 trimesters				0.003
Yes	4.4	7.1	0.48 (0.28–0.81)	
No	95.6	14.9	1.00	
LTPA in 1st trimester				0.01
Yes	10.6	10.5	0.70 (0.53–0.93)	
No	89.4	15.0	1.00	
LTPA in 2nd trimester				0.07
Yes	8.8	11.4	0.76 (0.57–1.03)	
No	91.2	14.9	1.00	
LTPA in 3rd trimester				<0.001
Yes	6.7	6.8	0.45 (0.29–0.70)	
No	93.3	15.1	1.00	
LTPA≥90 min/week in 3 trimesters				0.07
Yes	3.0	8.9	0.61 (0.34–1.07)	
No	97.0	14.7	1.00	
LTPA≥90 min/week in 1st trimester				0.15
Yes	8.2	11.8	0.80 (0.59–1.08)	
No	91.8	14.8	1.00	
LTPA≥90 min/week in 2nd trimester				0.14
Yes	6.2	11.4	0.77 (0.54–1.09)	
No	93.8	14.8	1.00	
LTPA≥90 min/week in 3rd trimester				0.006
Yes	4.6	7.9	0.53 (0.32–0.87)	
No	95.4	14.9	1.00	
Minutes of LTPA (terciles)				0.005
1	3.5	9.7	0.63 (0.38–1.05)	
2	5.1	10.8	0.71 (0.48–1.05)	
3	4.7	10.4	0.68 (0.45–1.04)	
Inactive women	86.7	15.2	1.00	

Abbreviations: LTPA, leisure time physical activity; CI, confidence interval.

primiparas were classified in a third category. Women were defined as smokers if they reported smoking at least one cigarette per day during any trimester of pregnancy. Information on morbidities during pregnancy such as pregnancy-induced hypertension, risk for spontaneous abortion, and vaginal bleeding during the third trimester of pregnancy was obtained. Whether the women were employed during pregnancy and details of their job (for example standing for long periods or heavy lifting) were also assessed.

The dependent variable was preterm birth, defined as delivery before 37 weeks of gestation. Gestational age was calculated using the first day of the last normal menstrual period or estimated by obstetric ultrasound obtained before 20 weeks of gestation when the former was unreliable or unavailable. If both menstrual and ultrasound data were unavailable, the Dubowitz estimate of gestational age was used [15]. Births with unknown gestational age or implausible birth weight for gestational age accounted for 3.1% (n = 140) of all births and were excluded from the gestational age-specific analysis based on the Alexander criteria [16].

LTPA was evaluated retrospectively at the perinatal interview. Women were asked about physical activity as follows: "Now let's talk about physical exercise that you did before and during pregnancy. We are interested in leisure activities, regardless of work, household, or school activities. Regardless of your household or job activities, did you do any kind of physical activity?" The question was formulated to include the trimester before pregnancy and for each trimester of pregnancy, collecting activity type, weekly sessions, and usual length of session. The present study did not investigate specific exercise type and this has been published elsewhere [17].

Since there are no guidelines concerning the minimum amount of exercise per week that pregnant women should carry out, to establish dichotomous variables a cutoff point of 90 minutes was considered the minimum weekly amount of physical activity. This decision was based on the idea that it was an amount of activity easily sustained by pregnant women who were active for 30 minutes, 3 times a week.

Based on the gestational period and amount of physical activity (in minutes) a series of binary variables were created as follows: (1) Any LTPA during pregnancy: if the woman reported any LTPA during pregnancy, regardless of trimester, frequency, or duration; (2) LTPA in all 3 trimesters: if the woman reported any LPTA throughout the entire pregnancy; (3) LTPA in the first, second, or third trimesters: if the woman reported any LTPA during the first, second, or third trimester regardless of frequency or duration; (4) Minimum LTPA in all 3 trimesters: if the mother reported an average of at least 90 minutes/week throughout the entire pregnancy; (5) Minimum LTPA in the first, second, or third trimesters: if the woman reported an average amount of at least 90 minutes/week of LTPA during the first, second, or third trimester; and (6) Minutes of LTPA: the amount of physical activity (minutes) performed during the entire pregnancy was divided into terciles, with a fourth category for inactive women.

All analyses were conducted using Stata version 9.2 (Stata Corporation, College Station, TX, USA). Refusal rate in the study was less than 1%. Only single live births were included; twin births accounted for about 1% of the births and were excluded from the study.

Crude and adjusted analyses were carried out using Poisson regression with robust variance. This type of analysis was adopted because it provides direct estimates of prevalence ratios without leading—as is the case with logistic regression—to overestimations when dealing with cross-sectional analyses of high-prevalence binary outcomes. Categorical variables were analyzed by linear trend tests and dichotomous exposures were tested by Fisher exact test. The significance level was set at 5%, although variables significant at 20% were kept in the multivariate analysis to control for confounding.

Variables were entered in the model by blocks, level by level, and a backward selection followed. The first level (social variables) encompassed family income, education, and ethnicity, while the second level (biological variables) included the women's age. The third level (gestational variables) was comprised of risk for spontaneous abortion, bleeding in the third trimester, pregnancy-induced hypertension, onset of prenatal care, birth

Table 3 Risk factors associated with preterm birth estimated by Poisson regression with robust variance

Variables	Prevalence ratio (95% CI)	P value
Level 1 (Social)		
Family income (quintiles)		0.003
1 (lowest)	1.00	
2	0.83 (0.67–1.01)	
3	0.73 (0.58–0.91)	
4	0.72 (0.57–0.91)	
5 (highest)	0.70 (0.54–0.92)	
Ethnicity		0.08
White	1.00	
Black/mixed/other	1.15 (0.98–1.36)	
Education, y		0.02
0–4	1.00	
5–8	0.84 (0.69–1.03)	
9–11	0.73 (0.58–0.92)	
≥12	0.72 (0.51–1.03)	
Level 2 (Biological) [a]		
Age, y		0.02
12–19	1.31 (1.10–1.57)	
20–34	1.00	
35–46	1.02 (0.81–1.29)	
Level 3 (Gestational) [b]		
Birth interval		0.05
<24 months	1.74 (1.35–2.23)	
≥24 months	1.00	
Primiparas	1.27 (1.03–1.57)	
Onset of prenatal care		0.05
1st trimester	1.00	
2nd trimester	1.22 (1.02–1.47)	
3rd trimester	1.07 (0.69–1.64)	
Risk for spontaneous abortion		0.04
Yes	1.30 (1.03–1.65)	
No	1.00	
Hypertension in pregnancy		0.009
Yes	1.26 (1.06–1.50)	
No	1.00	
3rd trimester vaginal bleeding		0.03
Yes	1.34 (1.02–175)	
No	1.00	

[a] Variables controlled for family income, ethnicity, and education.
[b] Variables controlled for family income, ethnicity, education, and maternal age.

interval, and smoking during pregnancy. The fourth level (lifestyle variables) included information regarding employment and LTPA variables. The LTPA variables were entered one at a time in a model, including all previous significant predictors of preterm birth, and were not adjusted for each other.

3. Results

A total of 4295 women were interviewed, and information on LTPA was obtained for 4147 women. The prevalence of preterm birth for the overall sample was 14.6%.

Table 4 Leisure time physical activity variables associated with preterm birth estimated by Poisson regression with robust variance

Variables [a]	Prevalence ratio (95% CI)	*P* value
Level 4 (Lifestyle) [b]		
Any LTPA during pregnancy		0.07
Yes	0.77 (0.59–1.02)	
No	1.00	
LTPA in all 3 trimesters		0.04
Yes	0.55 (0.32–0.96)	
No	1.00	
LTPA in 1st trimester		0.14
Yes	0.80 (0.59–1.07)	
No	1.00	
LTPA in 2nd trimester		0.52
Yes	0.90 (0.66–1.23)	
No	1.00	
LTPA in 3rd trimester		0.004
Yes	0.50 (0.31–0.80)	
No	1.00	
LTPA ≥ 90 min/week in 1st trimester		0.59
Yes	0.92 (0.67–1.26)	
No	1.00	
LTPA ≥ 90 min/week in 2nd trimester		0.54
Yes	0.89 (0.61–1.29)	
No	1.00	
LTPA ≥ 90 min/week 3rd trimester		0.04
Yes	0.58 (0.34–0.98)	
No	1.00	
LTPA ≥ 90 min/week in all 3 trimesters		0.21
Yes	0.68 (0.37–1.24)	
No	1.00	
Minutes of LTPA (terciles)		0.10
1	0.73 (0.44–1.22)	
2	0.82 (0.56–1.29)	
3	0.73 (0.46–1.14)	
Inactive women	1.00	

[a] All physical activity variables were controlled for the variables in the hierarchical levels above: family income, ethnicity, education, maternal age, birth interval, onset of prenatal care, and pregnancy-related morbidities.

[b] Physical activity variables were entered one by one in the regression model.

Crude analysis (Table 1) revealed that preterm birth was highly associated ($P<0.001$) with family income and education, and that ethnicity, age, and gestational characteristics (timing of prenatal care and birth interval) were also associated with preterm birth, as were pregnancy complications such as hypertension, risk for spontaneous abortion, and third trimester vaginal bleeding. Preterm birth was more frequent among women with only a basic education, black/mixed ethnicity, younger or poorer women, or those with an interpartal interval of less than 24 months. When considering pregnancy-related health problems, preterm birth was most common among hypertensive women, those with a high risk for spontaneous abortion, and women who experienced third trimester vaginal bleeding. Occupational risk factors such as jobs that required standing for long periods or heavy lifting were not associated with preterm birth.

The prevalence of any LTPA during pregnancy was only 13.3%, while LTPA during the 3 trimesters was reported by 4.4% of women. Ten variants of physical activity indicators were studied (Table 2), and 6 were associated with preterm birth in the crude analysis: any LTPA during pregnancy ($P=0.003$); LTPA during all 3 trimesters ($P=0.003$); LTPA in first trimester ($P=0.01$); LTPA in the third trimester ($P<0.001$); more than 90 minutes of LTPA in the third trimester ($P=0.006$); and minutes of LTPA (in terciles) ($P=0.005$).

After multivariate analysis (Table 3), family income ($P=0.003$), women's education level ($P=0.02$), and age ($P=0.02$) remained associated with preterm birth. The pregnancy-related morbidities that remained associated even after adjustment were hypertension ($P=0.009$), risk for spontaneous abortion ($P=0.04$), and third trimester vaginal bleeding ($P=0.03$). The onset of prenatal care and interpartal interval showed borderline associations ($P=0.05$)

Both crude and adjusted analyses showed the protective effect of all LTPA variables on preterm birth, although after adjustment (Table 4) only 3 LTPA variables remained significant: LTPA in all 3 trimesters ($P=0.04$); LTPA in the third trimester ($P=0.004$); and minimum LTPA in the third trimester ($P=0.04$). Any LTPA during pregnancy, LTPA in the first trimester, and minutes of LTPA were no longer associated with preterm birth in the adjusted analysis. Prevalence ratios related to the variables that remained significant in the multivariate model had their magnitude of effect reduced by 10% on average after adjustment.

4. Discussion

Preterm birth is a public health problem even in high-income countries [7]. In the present study's setting, it appears that the problem of preterm birth is growing [18]. The consequences of prematurity are well known, and infant mortality is likely the most severe outcome [6].

The present study addressed the issue of preterm birth associated with LPTA in a population sample from Southern Brazil. The strategy of including all births in a town during a one-year period strengthened the representability of our sample, avoiding selection bias.

The results ruled out any detrimental effects with regard to gestational age and physical activity. Protective associated effects were found among women who were active during pregnancy. In agreement with previously published papers

[19,20], the present study showed a higher preterm birth rate among mothers who were poor, younger, of black/mixed ethnicity, and who had fewer years of formal education.

Two limitations of the study were that information on physical activity was collected retrospectively and the intensity of activity was not measured. We believe that the information provided by new mothers about their usual behavioral patterns during pregnancy was reliable, especially considering the focus of our study, which was to measure LTPA based on the average length of weekly sessions.

There are two obstacles to measuring the intensity of physical activity. Firstly, standard intensity parameters such as heart rate or maximum oxygen consumption (VO2max) are not suitable for pregnant women [21], and even if we could use one of these parameters, it would only be feasible within small samples. A simple and reasonable parameter that, according to the literature, could be used is the Borg Scale, which is based on self-perception of effort [21]. However, the method of our research would not allow us to perform a sound evaluation of the accuracy based on retrospective information because the women were not aware of the study during pregnancy.

A limitation of any study on physical activity and preterm birth is that women whose previous pregnancies resulted in preterm birth are more likely to avoid physical efforts, as advocated by many physicians. Biological characteristics that contributed to a previous preterm birth may persist and are associated with recurrence of preterm birth. This particular group of women would therefore have a higher chance of preterm birth due to biological factors and after following medical advice would be considered physically inactive, resulting in a group of sedentary women at higher risk for preterm birth.

It should also be noted that women who are active during the third trimester or during the entire pregnancy represent a very specific group of women who are willing to exercise and likely to adopt several other healthy habits that may influence many aspects of the outcome of their pregnancy that cannot be controlled in an epidemiological study. To confirm that we were not making a comparison between healthy active women and women with health problems that could be contraindications to exercise, we excluded women with pregnancy-induced hypertension, bleeding, or risk for spontaneous abortion from the sample. We then performed the same analysis (data not shown) and found similar effects as measured by the prevalence ratios.

A physiological explanation for the association found between preterm birth and LTPA is that one of the causes of preterm birth is pre-eclampsia [22] and exercise is known to be an effective measure to protect against hypertension [23].

Depression and anxiety are often considered to be risk factors for preterm birth [24]. Even though we might address reverse causality, lifestyles that include recreational physical activities are usually associated with lower levels of such psychological problems [25].

Because no harm or risk increase was detected among women who exercised, and physical activity throughout life is considered a healthy behavior, physical activity during pregnancy should be encouraged during prenatal care visits. Women who present with warning signs or absolute contraindications to exercise, such as persistent third trimester bleeding, premature labor, ruptured membranes, or uncontrolled hypertension should be monitored closely.

Clinical research approaches, randomized controlled trials, and investigation of physiological mechanisms are recommended to better understand the relationship between physical activity and gestational age, and to determine the optimal intensity, duration, frequency, and type of exercise that can be performed safely during pregnancy.

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