



Physical activity in pregnancy and adverse birth outcomes

Atividade física em gestantes e desfechos perinatais adversos ao nascimento

Actividad física en gestantes y resultados perinatales adversos al nacimiento

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Abstract

This study focused on the association between physical activity in the second trimester of pregnancy and adverse perinatal outcomes: low birth weight (LBW), preterm birth (PTB), and intrauterine growth restriction (IUGR). The study used a sample from the BRISA cohort, São Luís, Maranhão State, Brazil, which included women with singleton pregnancy, gestational age from 22 to 25 weeks confirmed by obstetric ultrasound performed at < 20 weeks, and re-interviewed in the first 24 hours postpartum (n = 1,380). Level of physical activity was measured by the International Physical Activity Questionnaire (IPAQ), short version, categorized as high, moderate, and low. A directed acyclic graph (DAG) was used to identify minimum adjustment to control confounding. High physical activity was not associated with LBW (RR = 0.94; 95%CI: 0.54-1.63), PTB (RR = 0.86; 95%CI: 0.48-1.54), or IUGR (RR = 0.80; 95%CI: 0.55-1.15). The results support the hypothesis that physical activity during pregnancy does not result in adverse perinatal outcomes.

Pregnancy; Motor Activity; Low Birth Weight Infant; Premature Infant

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Introduction

Low birth weight (LBW), preterm birth (PTB), and intrauterine growth restriction (IUGR) are associated with increased short- and long-term risks of morbidity and mortality^{1,2}. They also increase the risk of delayed neurological and cognitive development as well as non-communicable diseases (cardiovascular diseases and diabetes mellitus) in adulthood^{3,4}.

There are various risk factors for adverse perinatal outcomes ranging from classical factors such as hypertension, diabetes, and obesity⁵ to physical activity during pregnancy⁶.

The American College of Obstetrics and Gynecology (ACOG) recommends that women who were already physically active should continue their physical activity during pregnancy and encourages pregnant women to engage in at least 30 minutes of physical activity per day, three or more days per week, in the absence of clinical contraindications⁷.

Although physical activity is recommended because of its benefits for the prevention and treatment of cardiovascular diseases, gestational diabetes, and other chronic diseases, there is no consensus on the potential risks to the mother and fetus⁸. Vigorous physical activity can result in reduced blood flow to the fetus, with a consequent reduction in essential substrates for its growth, and may result in adverse perinatal outcomes^{9,10}.

Early systematic literature reviews yielded insufficient evidence on the risks and/or benefits of physical activity to the mother and fetus^{8,11}. A more recent systematic review concluded that there are still significant gaps in knowledge on the safety of intense physical activity for the fetus¹¹. This insufficient evidence may be due to the methodological difficulty in measuring gestational physical activity and to small study samples^{8,11}.

The current study thus aimed to investigate the association between physical activity in pregnant women and adverse perinatal outcomes (low birth weight, preterm birth, and intrauterine growth restriction).

Methods

Study design

This was a nested study in a cohort study entitled *Etiological Factors for Preterm Birth and Consequences of Perinatal Factors for Children's Health: Birth Cohorts in Two Brazilian Cities* (BRISA), conducted by the Federal University of Maranhão (UFMA) in partnership with the University of São Paulo (USP), in two Brazilian municipalities, São Luís, Maranhão State, and Ribeirão Preto, São Paulo State.

The BRISA cohort data from the municipality of São Luís were used in the current study. This is a convenience cohort started during the prenatal period (PRENATAL BRISA), since it was not possible to draw a random sample, because no list of pregnant women was available. In 2009-2010, 1,447 pregnant women were recruited in the waiting room at their prenatal visit or for obstetric ultrasound at three major public maternity services and public and private ultrasound laboratories. Inclusion criteria were: singleton pregnancy and gestational age confirmed by obstetric ultrasound performed at less than 20 weeks gestational age. The women were then invited to attend the Clinical Research Center (CEPEC) to answer a questionnaire. The prenatal interviews took place from the 22nd to the 25th gestational week. At childbirth, 1,381 women (95.4%) were re-interviewed in 2010-2011, with 4.6% losses. One observation was excluded because of missing values on physical activity. The total sample for analysis amounted to 1,380 women. Methodological data have been published elsewhere¹².

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Sample calculation

It was estimated that a sample of 1,092 pregnant women would have 85% power to identify rates ratios ≥ 2.0 between physical inactivity and adverse birth outcomes, assuming 6-10% prevalence of LBW, PTB, and IUGR in women that are sedentary in the second trimester, a ratio of 1:1 between exposed and unexposed infants, and 5% probability of type I two-tailed error. After a 25% increment to adjust for potential confounding, the minimum sample size was set at 1,365 pregnant women.

Questionnaires

The first questionnaire was used to establish the women's socio-demographic profile and pattern of physical activity. The second questionnaire was applied in the first 24 hours postpartum. The following variables were recorded at birth: maternal hypertension, diabetes mellitus, vaginal bleeding, urinary infection, illicit drug use, alcohol consumption, hospitalization during pregnancy, and maternal smoking. All variables were categorized as yes or no. Parity (primipara, 2 or more children) and type of delivery (vaginal, non-elective cesarean section, elective cesarean section) were also recorded.

Socio-demographic variables

The target socio-demographic variables were maternal age categorized as younger than 20 years, 20 to 34 years, and 35 years or more. Maternal schooling was categorized as less than 5, 5 to 8, 9 to 11, and 12 or more years of school. Occupation was classified as non-manual, skilled/semiskilled manual, or unskilled manual/unemployed/students). Economic class was defined according to the Criterion of Economic Classification – Brazil, elaborated by the Brazilian Association of Research Companies (ABEP) to estimate the purchasing power of urban families, categorized as A/B (highest income and education, and most household assets), C (intermediate), or D/E (lowest income and education) ¹³. Married/living with a partner and living with children were both categorized as yes or no.

Level of physical activity

Physical activity was assessed using the *International Physical Activity Questionnaire* (IPAQ) – short version ¹⁴, validated for the Brazilian population by Matsudo et al. ¹⁵. This instrument is used to obtain data on any type of physical activity. Women were asked, referring to the previous seven days, on how many days they walked and did moderate or vigorous physical activity for at least 10 minutes at a time.

Physical activity was classified in three levels – high, moderate, and low – on the basis of frequency, duration of each activity, and energy expenditure as metabolic equivalents (MET)–minutes/week. For walking, 1 MET = 3.3 x time (minutes) x day; for moderate activity, 1 MET = 4.0 x time (minutes) x day, and for high activity, 1 MET = 8.0 x time (minutes) x day. Total MET-minutes/week is calculated as the sum of partial MET-minutes/week ¹⁶.

Physical activity was considered high when practiced vigorously for at least three days, reaching at least 1,500 MET-minutes/week, or for at least seven days with any combination of walking, moderate or vigorous activity, reaching at least 3,000 MET-minutes/week. Moderate was defined as vigorous activity for at least 20 minutes for three or more days or moderate for five or more days and/or involving a walk of at least 30 minutes per day, or consisting of five or more days of a combination of walking, moderate activity, or vigorous activity reaching at least 600 MET-minutes/week. Low activity was defined as opposed to high or moderate levels of physical activity, < 600 MET-minutes/week ¹⁶.

Outcome variables

The dependent variables were: gestational age categorized in weeks as preterm (PTB < 37 weeks) or term (\geq 37 weeks); LBW (< 2,500g), and IUGR classified according to the birth weight ratio (BWR) proposed by Kramer et al. ¹⁷, calculated by dividing the newborn's weight by the sex-specific median weight for gestational age from the Canadian curve ¹⁸. Neonates were defined as not presenting IUGR when the BWR was \geq 0.85, and as presenting IUGR when BWR was < 0.85 ¹⁷. Gestational age was estimated by two criteria, i.e., date of last menstruation (DLM) and obstetric ultrasound (OU) performed before 20 weeks gestational age (GA). When GA measured by DLM differed by more or less than 10 days from the value estimated by OU, GA was calculated by DLM; when GA differed by more than 10 days between these two indicators, it was estimated by OU ¹⁹. Information on date and time of birth was obtained from the infant's medical records.

Statistical analysis

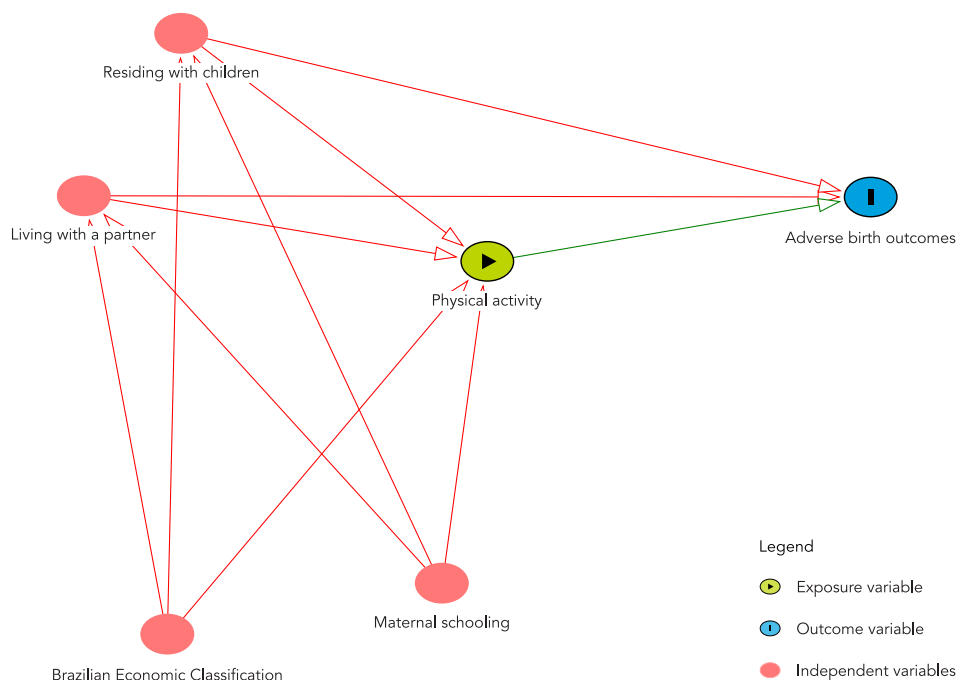
Data were analyzed using Stata, version 12.0 (StataCorp LP, College Station, USA). Descriptive analyses were performed with estimates of absolute and percent frequencies. Frequencies were compared between groups by the chi-square test. Associations between physical activity and three different outcomes (LBW, PTB, and IUGR) were estimated by Poisson multiple regression models with robust estimation of variance ²⁰. Rates ratios (RR) and 95% confidence intervals (95%CI) were used as measures of association. Physical activity was treated as an ordinal variable categorized in three levels: low, moderate, and high. Moderate physical activity was taken as the reference. Sensitivity analysis was also performed to check for consistency, where physical activity was treated as a continuous variable (minutes or MET-minutes/week) or divided into tertiles, quartiles, or quintiles. To check for possible non-linearity, a quadratic term was also added to the models, where physical activity was treated as a continuous variable.

A directed acyclic graph (DAG) was constructed to identify a minimum set of confounding adjustment in the DAGitty program (Figure 1) ²¹. Interrelations between variables were constructed based on Takito & Benicio's theoretical hierarchical model ²². Models were then adjusted for maternal schooling, economic class, living with partner, and living with children.

The study was approved by the Institutional Review Board of the University Hospital of UFMA

Figure 1

Directed acyclic graph of the association between physical activity during pregnancy and adverse birth outcomes.



(protocol n. 223/2009) and all women gave written informed consent to participate.

Results

In the study sample, consisting of 1,380 pregnant women, most were 20-34 years of age (80.1%), had 9-11 years of schooling (75.7%), were married or living with a partner (79.5%), were not living with children (57.6%), were primiparous (51.5%), delivered vaginally (49.8%), belonged to middle class C (66.5%) and had a family head engaged in unskilled manual labor or unemployed (72.4%). Drug use was reported by 1.5%, 22.2% consumed alcohol, 4.3% smoked, 16.8% had hypertension, 3% diabetes, 28% were diagnosed with urinary tract infection, 10.9% reported vaginal bleeding, and 11.9% were hospitalized some time during the pregnancy. Levels of physical activity were: 39.7% low, 42.8% moderate, and 17.5% vigorous (Table 1).

No statistically significant association was observed between high (RR = 0.94; 95%CI: 0.54-1.63) or low level of physical activity (RR = 0.88;

95%CI: 0.57-1.35; $p = 0.833$) and LBW, taking moderate as the reference. Neither was there any statistically significant association between high physical activity (RR = 0.86; 95%CI: 0.48-1.55) or low physical activity (RR = 0.82; 95%CI: 0.53-1.26; $p = 0.640$) and prematurity. High physical activity (RR = 0.80; 95%CI: 0.55-1.15) and low physical activity (RR = 0.92; 95%CI: 0.71-1.19; $p = 0.456$) were not associated with IUGR (Table 2).

Taking low physical activity as the reference, there were no associations between moderate or vigorous physical activity and LBW, PTB, or IUGR. No associations were observed between physical activity treated as a continuous variable, either in minutes or in MET-minutes/week, and adverse birth outcomes. A quadratic term for MET-minutes/week was non-significant. Even when considering physical activity in MET-minutes/week divided in tertiles, quartiles or quintiles, no association between physical activity and adverse birth outcomes was detected (Table 2).

Table 1

Socioeconomic, clinical, and lifestyle characteristics of pregnant women studied in the city of São Luís, Maranhão State, Brazil, 2009-2011.

Variable	n	%
Schooling (years)		
≥ 12	158	11.7
9-11	1,045	75.8
5-8	157	11.4
0-4	19	1.4
Occupation		
Non-manual	223	16.2
Skilled/Semiskilled manual	157	11.4
Unskilled manual/Unemployed/Students	1,000	72.5
Economic class		
A-B	249	18.0
C	919	66.6
D-E	212	15.34
Maternal age (years)		
20-34	1,116	80.9
≥ 35	95	6.9
< 20	169	12.3
Living with a partner		
No	282	20.4
Yes	1,098	79.6
Living with children		
Yes	585	42.4
No	795	57.6
Parity		
1	711	51.5
≥ 2	660	48.5
Type of delivery		
Vaginal	687	49.8
Non-elective cesarean section	382	27.7
Elective cesarean section	311	22.5
Drug use		
No	1,357	98.5
Yes	20	1.5
Alcohol		
No	1,073	77.8
Yes	307	22.2
Maternal smoking		
No	1,321	95.7
Yes	59	4.3
Hypertension		
No	1,147	83.2
Yes	232	16.8
Diabetes		
No	1,338	97.0
Yes	41	3.0
Urinary infection		
No	994	72.0
Yes	385	28.0
Vaginal bleeding		
No	1,229	89.1
Yes	150	10.9
Hospitalization		
No	1,215	88.1
Yes	164	11.9
Physical activity		
Low	548	39.7
Moderate	591	42.8
High	241	17.5

Table 2

Adjusted analysis of the association between physical activity and preterm birth, low birth weight, and intrauterine growth restriction. São Luís, Maranhão State, Brazil, 2009-2011.

Variables	Low birth weight			Preterm birth			Intrauterine growth restriction		
	RR	95%CI	p-value	RR	95%CI	p-value	RR	95%CI	p-value
Physical activity			0.833			0.640			0.456
Moderate	1.00			1.00			1.00		
Low	0.88	0.57-1.35		0.82	0.53-1.26		0.92	0.71-1.19	
High	0.94	0.54-1.63		0.86	0.48-1.54		0.80	0.55-1.15	
Physical activity			0.833			0.640			0.456
Low	1.00			1.00			1.00		
Moderate	1.14	0.74-1.76		1.22	0.80-1.88		1.09	0.84-1.41	
High	1.07	0.61-1.89		1.05	0.58-1.92		0.87	0.60-1.26	
Physical activity (continuous)			0.995			0.485			0.087
MET	0.99	0.99-1.00		1.00	0.99-1.00		0.99	0.99-1.00	
Physical activity (continuous)									
MET	1.00	0.99-1.00	0.715	1.00	0.99-1.00	0.245	1.00	0.99-1.00	0.904
MET ²	1.00	1.00-1.00	0.586	1.00	1.00-1.00	0.271	1.00	1.00-1.00	0.266
Physical activity (continuous)			0.589			0.909			0.098
Minutes	0.99	0.99-1.00		0.99	0.99-1.00		0.99	0.99-1.00	
Physical activity (tertiles)			0.934			0.652			0.254
First	1.00			1.00			1.00		
Second	0.97	0.60-1.56		1.03	0.63-1.70		1.04	0.79-1.38	
Third	0.91	0.57-1.47		1.23	0.76-1.97		0.81	0.60-1.10	
Physical activity (quartiles)			0.916			0.634			0.451
First	1.00			1.00			1.00		
Second	0.99	0.58-1.72		1.21	0.70-2.10		1.07	0.77-1.49	
Third	0.84	0.47-1.48		0.96	0.53-1.73		1.02	0.74-1.42	
Fourth	0.99	0.58-1.71		1.32	0.76-2.28		0.81	0.57-1.16	
Physical activity (quintiles)			0.776			0.648			0.571
First	1.00			1.00			1.00		
Second	0.69	0.37-1.31		1.13	0.62-2.08		1.23	0.85-1.78	
Third	1.03	0.56-1.87		1.09	0.58-2.07		1.15	0.78-1.69	
Fourth	0.95	0.52-1.73		0.82	0.41-1.63		1.11	0.76-1.63	
Fifth	0.89	0.48-1.62		1.35	0.74-2.49		0.90	0.60-1.36	

95%CI: 95% confidence interval; MET: metabolic equivalents; RR: rate ratio.

Note: models adjusted for maternal schooling, economic class, living with a partner, and living with children.

Discussion

The present study did not show any association between women's level of physical activity during the second trimester of pregnancy and adverse perinatal outcomes (LBW, PTB, and IUGR), regardless of level of activity, i.e., low or high, taking moderate as the reference. The findings are similar to those of a study in North Carolina from 2004 to 2007²³, in which pregnant women responded to a questionnaire by telephone, providing information on their physical activity in various domains (leisure-time, job-related, housework, and child and adult care), with no association detected between high physical activity in the first trimester and LBW or PTB.

The study also agrees with results of population-based surveys that failed to identify physical activity as a risk factor for adverse perinatal outcomes^{24,25}. Two population-based cohort studies in 79,692 pregnant women in Denmark²⁴ between 1996 and 2002 and in 61,098 pregnant women in Norway²⁵ between 2000 and 2006 also showed no positive association between physical activity during pregnancy and prematurity. Instead, the studies actually showed a reduction of preterm delivery among women who had practiced some type of exercise during the second and third trimesters. The Norwegian study also showed a protective effect (OR = 0.82; 95%CI: 0.73-0.91) against prematurity in women that exercised 3 to 5 times a week.

The results also agree with a randomized study of 105 sedentary primiparous pregnant women (mean age: 30.7 ± 4.0 years and pre-gestational body mass index (BMI): 23.8 ± 4.3), which concluded that aerobic and resistance exercises are not associated with preterm birth²⁶. It should be noted that the women in the study were sedentary and therefore had no previous physical conditioning. Another study, which included pregnant women with hypertension and/or previous preeclampsia, showed similar results, namely no increased risk of adverse maternal and neonatal outcomes, notably hypertensive complications, preterm birth, and low birth weight among women who had exercised during pregnancy²⁷. In addition, a systematic review indicated that physical activity during pregnancy had a protective effect against preeclampsia²⁸.

However, a cohort study in India in 546 rural pregnant women, assessing physical activity in various domains (job-related, leisure-time, caregiving, or housework) and during the three gestational trimesters detected an association between the highest tertile of physical activity and LBW²⁹.

A systematic review indicated that most studies did not detect an association between physical activity during pregnancy and LBW or PTB, but that some studies found an association between specific activities (e.g., climbing stairs or standing for long periods) and low birth weight and preterm birth¹¹. Our study did not ask pregnant women about specific physical activities. However, few women in our sample reached very high activity levels, and most physical activity in our sample probably involved household chores³⁰. Thus, based on our data it seems that physical activity during pregnancy is not harmful to the fetus.

In the current study, a high percentage of pregnant women (60.3%) were physically active in the second trimester. A large share of these women (42.8%) reported moderate physical activity according to ACOG recommendations that might result in benefits for maternal-fetal health⁷, i.e., walking at least 30 minutes on 5 or more days a week.

A cross-sectional study in the city of Rio Grande, Rio Grande do Sul State, Brazil, in 2007 in a sample of 2,557 pregnant women showed that 32.8% were physically active³¹. The study excluded activities at school, on the job, and in the household, which may explain the lower percentage of physical activity compared to our study. In Pelotas, Rio Grande do Sul State, only 12.9% of a sample of 4,471 pregnant women practiced some type of leisure-time physical activity in any trimester of pregnancy³², indicating the impor-

tance of considering on-the-job physical activity in pregnant women.

Until the 1990s, physical activity was discouraged for pregnant women⁷. Today there has been a change, with moderate physical activity recommended⁷, so that more women are physically active during pregnancy³¹. However, more pregnant women may be considered sedentary if physical activity is defined as planned exercising; in addition, a more sedentary routine may tend to increase in the third trimester³² due to lack of time, fatigue, and discomfort with progression of the pregnancy³³ or a feeling of insecurity during physical activity³⁴. Some studies indicate that pre-gestational physical exercise is an important predictor of higher levels of physical activity during pregnancy^{32,35}.

The current study's strengths were its large sample size, low percentage of losses and refusals, and more precise calculation of gestational age based on a combination of gestational ultrasound before the 20th week and date of last menstruation.

The study's limitations include use of the short version of the IPAQ to assess physical activity. The short version does not distinguish between domains of physical activity (job-related, leisure-time, caregiving, or housework). In addition, physical activity was assessed only once in the second trimester, so it was not possible to verify the level throughout the pregnancy. Finally, no objective measure of physical activity was employed, which may produce measurement bias. Although objective measures of physical activity are less prone to error when compared to questionnaires³⁶, they are still rarely used in population-based studies with large samples because of their high cost and complex logistics. Since data are collected on several days, close monitoring is required to avoid dropouts and supervise correct machine positioning. However, the IPAQ has been properly validated in the Portuguese language¹⁵ and has been used previously to measure physical activity in pregnant women^{37,38}. It is used internationally because it affords good stability, low cost, and acceptable accuracy in population studies¹⁴. Furthermore, the results of the reproducibility study of type test / retest support the use of IPAQ to assess physical activity levels in different populations¹⁴.

Based on the current study's findings, physical activity of any level during the second trimester of pregnancy is not associated with adverse perinatal outcomes such as low birth weight, premature birth, or intrauterine growth restriction.

Contributors

A. S. Rêgo contributed to the conception, elaboration, analysis, and final version for publication. M. T. S. B. Alves, C. C. C. Ribeiro, M. A. Barbieri, and A. A. M. Silva collaborated in the data analysis and final draft. R. F. L. Batista participated in the data analysis. H. Bettiol, V. C. Cardoso, and F. H. F. Loureiro contributed to the final draft.

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Resumo

Investigou-se a associação entre atividade física durante o segundo trimestre gestacional e os desfechos perinatais adversos: baixo peso ao nascer (BPN), nascimento pré-termo (NPT) e restrição de crescimento intrauterino (RCIU). Foi utilizada amostra da coorte BRISA, São Luís, Maranhão, Brasil, que incluiu mulheres com gravidez única, idade gestacional de 22 a 25 semanas confirmada por ultrassonografia obstétrica realizada com < 20 semanas, reentrevistadas nas primeiras 24 horas após o parto (n = 1.380). O nível de atividade física foi medido pelo Questionário Internacional de Atividade Física (IPAQ), versão curta, e categorizado em alto, moderado e baixo. Gráfico acíclico direcionado (DAG) foi utilizado para identificar ajuste mínimo para o controle de confundimento. Nível alto de atividade física não foi associado ao BPN (RR = 0,94; IC95%: 0,54-1,63), NPT (RR = 0,86; IC95%: 0,48-1,54) ou RCIU (RR = 0,80; IC95%: 0,55-1,15). Os resultados fortalecem a hipótese de que a prática de atividade física na gestação não parece resultar em desfechos adversos ao nascimento.

Gravidez; Atividade Motora; Recém-Nascido de Baixo Peso; Prematuro

Resumen

Se investigó la asociación entre actividad física durante el segundo trimestre gestacional y los desenlaces perinatales adversos: bajo peso al nacer (BPN), nacimiento pretérmino (NPT) y restricción de crecimiento intrauterino (RCIU). Se utilizó una muestra de la cohorte BRISA, São Luís, Maranhão, Brasil, que incluyó mujeres con un embarazo único, edad gestacional de 22 a 25 semanas, confirmada por ultrasonografía obstétrica realizada con < 20 semanas, reentrevistadas en las primeras 24 horas tras el parto (n = 1.380). El nivel de actividad física fue medido por el Cuestionario Internacional de Actividad Física (IPAQ), versión corta, y categorizado en alto, moderado y bajo. El gráfico acíclico dirigido (DAG) se utilizó para identificar un ajuste mínimo para el control de confundidores. Un nivel alto de actividad física no se asoció al BPN (RR = 0,94; IC95%: 0,54-1,63), NPT (RR = 0,86; IC95%: 0,48-1,54) o RCIU (RR = 0,80; IC95%: 0,55-1,15). Los resultados fortalecen la hipótesis de que la práctica de actividad física en la gestación no parece resultar en desenlaces adversos al nacimiento.

Embarazo; Actividad Motora; Recién Nacido de Bajo Peso; Prematuro

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