Maternal posture and its influence on birthweight

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Keywords
Maternal and child health. Pregnancy. Birth weight. Posture. Exertion. Exercise. Activities of daily living.

Abstract

Objective
To analyze the relationship between maternal posture/physical activity and inadequate birthweight.
Methods
Prospective cohort study involving 152 pregnant women from a public low-risk antenatal care facility. Three interviews evaluating the frequency of physical activity were administered to each pregnant woman during gestation. Birthweight (inadequate when <3,000 g and adequate when ≥3,000 g) was the dependent variable and the frequency of physical activity, the independent variable. Statistical analysis was performed using logistic univariate analysis and multiple regression controlling for schooling, smoking, living with spouse, and baseline nutritional status.
Results
The practice of *walking* for at least 50 minutes during the first period of pregnancy was identified as a protective factor against inadequate birthweight (adjusted OR=0.44; 95% CI: 0.20-0.98). *Standing* for 2.5 hours or longer during the second semester of pregnancy was associated with increased risk (adjusted OR=3.23; 95% CI: 1.30-7.99). Dose-response relationships were identified for *washing clothing by hand* and *cooking* (p-value for linear trend <0.01 and 0.05, respectively). After confounder control, only *washing clothing* during the second trimester of gestation remained statistically significant.
Conclusions
Our results show the importance of medical orientation regarding posture and physical activity during antenatal care, aiming at the reduction of inadequate birthweight.

INTRODUCTION

Birthweight is the single factor with greatest influence on the general health and on the chances of survival of infants. The risk of illness and death during infancy are significant among children with *low birthweight* (below 2,500 g) and *inadequate birthweight* (below 3,000 g).[14] Recent studies show adverse effects of both low birthweight (LBW) and inadequate birthweight (IBW) in adult life, including an increased risk of metabolic disorders and cardiovascular disease.[6]

Two basic processes – working alone or in association – can lead to abnormal birthweight, namely the premature interruption of pregnancy (preterm birth) and intrauterine growth retardation. Birthweight is determined by multiple factors, including socioeconomic and nutritional status, maternal and fetal morbidity, smoking, absent or poor antenatal care, and excessive physical effort.[10,13]

Studies of the influence of physical activity and of standing for long periods of time during pregnancy have received much attention in recent literature. This is due,

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among other aspects, to these factors being potentially modifiable.[11] These studies focused initially on occupational physical activity and subsequently on daily physical activity and physical exercise. The outcomes investigated were LBW, IBW, birthweight as a continuous variable, (BW), preterm delivery (PD), and intrauterine growth restriction (IUGR). The findings of these studies are controversial. Physical activity showed no effect on IBW,[7] BW,[15,16] and PD,[7] and positive associations with LBW,[19] BW,[7] IUGR,[19] and PT.[12] Standing showed a positive association with LBW,[19] IUGR,[5,19] and PD.[18]

In a cohort study involving 1,797 pregnant women, Tuntiseranee et al[19] found associations between both physical activity and posture during pregnancy and different pregnancy outcomes (LBW, IUGR, and PD). Carrying weight or lifting heavy loads to chest height increased the odds of LBW (OR=2.5 and OR=3.5, respectively). Standing for five hours or longer was associated with greater risk of IUGR (OR=11.1). Brisk walking was weakly associated with PD.

In a prospective cohort study analyzing the daily physical activity of 7,101 women, Klebanoff et al[9] found that prolonged standing (eight or more hours a day) was associated with a small increase in the risk of BW and that moderate to intense physical effort was associated with IUGR. An interesting finding was the protective effect against PD found among pregnant women who spent more time performing light work or controlled exercise. Similar results regarding the protective effect of maintaining physical activity during pregnancy over birthweight were reported by Leiferman et al[11] in a study involving 9,089 women. Previously active pregnant women who interrupted physical activity showed an increased risk of LBW (OR=1.28) and of very low birthweight (OR=2.05).

Part of the discrepancies among these results may be attributed to disparities in the measurement and classification of physical activity[16] and to lack of confounder control.

The general aim of the present study is to evaluate the influence of maternal posture and physical activity during pregnancy on birthweight among low-income pregnant women.

METHODS

We adopted a prospective cohort design and completed the follow-up of 152 mother-child pairs. The studied sample allowed us to carry out statistical analyses for outcome variable IBW but not for other outcomes of interest of lesser magnitude, such as LBW.

The cohort was composed of healthy pregnant women, aged 18 years or older, and whose follow-up began before the 17th week of pregnancy at the low-risk antenatal care service of a specialized hospital for low-income pregnant women. Given the resources available, we studied pregnant women who began antenatal care in the period between March 1997 and March 1998.

Gestational age was calculated based on the date of last menstruation and subsequently confirmed by ultrasonography performed before the 20th week of pregnancy. Thirty-nine pairs were excluded from the study: ten women with initial gestational age above 16 weeks, three with multiple pregnancies, one HIV+ woman, 17 women with early abortions, five stillbirths, one child with a congenital anomaly (hydrocephaly), and two psychological pregnancies. Of the 220 eligible women, 30.9% were lost to follow-up due to moving to different cities/states (4.5%), dropping out of antenatal care (10.0%), and lack of information on the newborn (16.4%), yielding a total 152 mother-child pairs.

The fieldwork team, composed of five female interviewers, was previously trained by a fieldwork supervisor that periodically verified questionnaires, controlling the quality of the information obtained, appointment scheduling, and absence to appointments. Strategies were implemented for the early recruitment of pregnant women and for the reduction of losses to follow-up.

Information regarding obstetric history, maternal morbidity, and the newborn were obtained from the patient charts of antenatal and neonatology facilities. Information on babies born in other hospitals were obtained from the registries of each of these facilities, which were faxed to us, or, in some cases, from the maternity card presented by the mother during a household visit.

The remaining information were obtained through interviews with the pregnant women, using pretested questionnaires. Information regarding work and physical activity were obtained at three time-points, dividing pregnancy into three periods: time-point number one (mean =16.3 weeks; standard deviation (sd) =2.9 weeks) time-point number two (mean =22.3 weeks; sd =2.1 weeks), and time-point number three (mean =35.7 weeks; sd =1.3 weeks). Only 20% of the women interviewed at the first time point were in the first trimester of pregnancy. Time points two and three corresponded exactly to the two last trimesters of pregnancy.

The outcome variable – birthweight – was obtained using a pediatric scale with 10 g precision. For purposes of statistical analysis, birthweight was

Table 1 - Distribution of pregnant women in the studied cohort and losses to follow-up, according to socioeconomic characteristics. Sao Paulo, March 1997 to October 1998.

Characteristics	Cohort N=152	Losses N=68	p
	Mean ; standard deviation		
Age (years)	24.4; 5.07	23.8; 4.60	0.40*
Height (cm)	158.7; 5.63	157.4; 6.39	0.13
Schooling (years)			0.05**
Up to 4th grade	49 (32.5)	20 (30.8)	
5th to 8th grade	53 (35.1)	33 (50.8)	
Secondary or higher	49 (32.5)	12 (18.5)	
Living with partner			0.20
Yes	117 (77.0)	46 (67.6)	
No	35 (23.0)	22 (30.9)	
Time with partner***			0.35
Less than 1 year	16 (13.7)	8 (17.4)	
1 to 2 years	30 (25.6)	7 (15.2)	
More than 2 years	71 (60.7)	31 (67.4)	
Parity			0.82
1	81 (53.3)	37 (55.2)	
2	42 (27.6)	18 (26.9)	
3	19 (12.5)	6 (9.0)	
4 or more	10 (6.6)	6 (9.0)	
Birth interval (years)****			0.31
Less than 1	4 (5.3)	3 (9.7)	
1 |— 1.5	9 (12.0)	3 (9.7)	
1.5 |— 2	8 (10.7)	7 (22.6)	
2 or more	54 (72.0)	18 (58.1)	
Nutritional status*****			0.80
Malnourished	26 (17.2)	14 (20.6)	
Eutrophic	89 (58.9)	40 (58.8)	
Overweight	22 (14.6)	7 (10.3)	
Obese	14 (9.3)	7 (10.3)	

*Descriptive p-value for means using Student's t-test
**Descriptive p-value for association using chi-squared test
***Analysis considering only women who reported living with partner
****Excluding primiparas
*****Nutritional status classified according to initial BMI based on the cutoff points proposed by Atalah et al[2] (1997)

expressed as two categories: <3,000 g (inadequate) and ≥3,000 g (adequate).

In order to describe the frequency of preterm newborns (gestational age at birth below 37 weeks), we evaluated gestational age using the Capurro[3] method.

The questionnaire for the frequency of daily physical activities (QDPA)* was built based on a list of activities related to household work, work outside home, leisure, and physical exercise. The questionnaire, though not validated, was elaborated according to indications from the literature. We asked the pregnant woman how frequently she performed each of the activities in the preceding week (never, once to twice, 3 to 4 times, and 5 to 7 times) and recorded the time spend per day on such tasks. The variable used for the analysis of grouped physical activities was the time spent per week in minutes, defined as the product of weekly frequency and time spent, in minutes. In order to facilitate the interpretation of results, we transformed this variable into hours per day.

As to the evaluation of posture, following the recommendations of Fortier et al[5] we attempted to differentiate between static and dynamic standing postures, since these may have different physiological effects upon uteroplacental perfusion. For analysis purposes, we grouped all activities requiring standing and analyzed them separately from the activities involving walking.

Other variables studied included mother's schooling, age, nutritional status,[2] smoking, obstetric history and birth interval, marital status, and family size.

A comparison between the pregnant women analyzed and losses was performed using chi-squared test and Student's *t*-test. The crude effect of each of the variables expressing maternal physical activity and posture over birthweight was evaluated by univariate logistic regression, and the risk was expressed as odds ratios (OR). Confounder control was performed by multiple logistic regression.[8] Linear trend tests were used whenever there was an interest in testing the dose-response relationship between the studied factors.

The present project was approved by the Ethics Committee of the *Faculdade de Saúde Pública da Universidade de São Paulo*.

RESULTS

A comparison between the studied cohort and losses to follow-up showed no statistically significant dif-

*The instrument used may be obtained by request to the first author of the present article.

ference between the two groups (Table 1), with the exception of maternal schooling, which reached borderline significance. Schooling equal to or higher than eight years was more frequent in the cohort than among losses.

Of the pregnant women studied, roughly one-third had less than four years of schooling. Three-fourths of women lived with a partner and in stable relationships, and 61% of these women were with the same partner for over two years. There were approximately four persons living in each household.

Regarding obstetric characteristics, 53% of women were primiparas, and the majority of the women who had had prior pregnancies showed birth intervals longer than two years. Pregnant women began follow-up early (before week 14 in 72% of cases).

The age of the mothers in the cohort ranged from 18 to 42 years, and the frequency of pregnant women older than 35 years was 4.6%. About 13% of women weighed less than 50 kg at the beginning of pregnancy; maternal height ranged from 1.45 to 1.72 meters; and mean initial BMI[2] was 24 kg/m^2, ranging from 16 to 39 kg/m^2. Of these, 19,8% smoked during pregnancy, and one-half of these smoked more than five cigarettes per day.

In the first period, 46.8% of women worked outside home; in the second period, 41.4% were still working; and in the third period, only 29.6% of women continued to perform these activities. The type of activity/occupation was directly connected to household work – 50% of women worked as maids, cleaners, cleaning assistants, nannies, cooking assistants, and serving maids. Among the remaining activities, there was greater frequency of secretaries, office assistants, and switchbox operators (18%), followed by saleswomen and clerks (13%), waiters, dressmakers, factory workers, cashiers, restaurant managers, laboratory assistants, and nursing assistants.

About one-half of women (52.7%) did not have help from other persons for their own housework (housecleaning, laundry, and other activities).

The prevalence of newborns with inadequate birthweight was 34.8% and with low birthweight, 7.2%. The studied cohort had a mean birthweight of 3,128 g (sd=513 g). The frequency of preterm births in this cohort was 5.3%, and mean gestational age was 39.2 weeks (sd=1,3 weeks).

There was a predominance of male newborns (52.6%). 30.3% of deliveries were by caesarean section.

Median time spent in standing position decreased slightly as pregnancy progressed, falling form two hours per day during the first and second periods to one hour and forty-five minutes in the third period.

A similar trend was observed with respect to walking. Median time spent on this activity fell from 17-18 minutes per day during the first two periods to 15 minutes in the third period. About 60% of women walked less than 30 minutes per day. Roughly one-fourth of women did not perform this activity, showing an increasing trend between the first and third periods.

The results presented in Table 2 suggest a protective effect for women who walked at least 50 minutes per day during the first period (OR=0.43; 95% CI: 0.19-

Table 2 - Univariate analysis of the influence of walking and standing during pregnancy on birthweight. Sao Paulo, March 1997 to October 1998.

Variable	Period	N	Frequency of Inadequate birthweight %	OR [95% CI (OR)]	p_t
Walking (minutes per day)					
1st	Never	38	47.4	1	
	<50	79	27.8	0.43 [0.19; 0.96]	
	≥50	33	39.4	0.72 [0.28; 1.86]	0.76
2nd	Never	32	46.9	1	
	<50	76	32.9	0.56 [0.24; 1.29]	
	≥50	34	29.4	0.47 [0.17; 1.30]	0.18
3rd	Never	40	32.5	1	
	<50	64	34.4	1.09 [0.47; 2.52]	
	≥50	28	32.1	0.98 [0.35; 2.76]	0.66
Standing (hours per day)					
1st	<1.5	51	31.4	1	
	1.5 ⎮— 2.5	45	37.8	1.33 [0.57; 3.09]	
	≥2.5	54	37.0	1.29 [0.57; 2.89]	0.55
2nd	<1.5	41	24.4	1	
	1.5 ⎮— 2.5	52	28.9	1.25 [0.50; 3.19]	
	≥2.5	49	51.0	3.23 [1.30; 7.99]	<0.01
3rd	<1.5	38	28.9	1	
	1.5 ⎮— 2.5	53	32.1	1.16 [0.47; 2.87]	
	≥2.5	41	39.0	1.57 [0.61; 4.03]	0.34

p_t: Descriptive p-value for linear trend

Table 3 - Univariate analysis of the influence of daily activities requiring standing during the second period of pregnancy on birthweight. Sao Paulo, March 1997 to October 1998.

Variable (times per week)	N	Frequency of Inadequate birthweight %	OR	[95% CI (OR)]	p_t
Sweeping the house					
Never	14	42.9	1		
1-2	13	23.1	0.40	[0.08; 2.12]	
3-4	16	37.5	0.80	[0.19; 3.46]	
5-7	99	35.4	0.73	[0.23; 2.27]	0.98
Washing clothing by hand					
Never	33	27.3	1		
1-2	69	26.1	0.94	[0.37; 2.40]	
3-4	19	57.9	3.67	[1.12; 12.05]	
5-7	21	57.1	3.56	[1.12; 11.29]	<0.01
Ironing					
Never	61	32.8	1		
1-2	62	33.9	1.05	[0.50; 2.22]	
3-4	12	41.7	1.46	[0.41; 5.19]	
5-7	7	57.1	2.73	[0.56; 13.40]	0.22
Cooking					
Never	19	21.1	1		
1-4	35	28.6	1.50	[0.40; 5.64]	
5-7	88	40.9	2.60	[0.80; 8.47]	0.05

p_t: Descriptive p-value for linear trend

0.96). In the second trimester of pregnancy, *standing* for more than two-and-a-half hours per day was identified as a risk factor for inadequate birthweight. We found a statistically significant trend towards increased risk with increases in standing time, with a p-value for linear trend below 0.01. Based on this finding, we considered it pertinent to analyze each of the components of this variable individually.

We found a statistically significant trend towards increase in the risk of IBW as the frequency of activities *washing clothing by hand* and *cooking* increased (Table 3). *Washing clothing by hand* more than three times per week, averaging 80 minutes per day, is associated with an average 3.5-fold increase in the risk of having a baby with IBW. It is important to mention that a high frequency of *cooking* (more than five times per week) was observed in 62% of women, with a mean duration of 74 minutes per day.

Activities such as *sweeping the house* and the *yard* (the latter not presented) showed no influence on birthweight, probably due to the brief duration of such activities. Approximately 50% of pregnant women swept the house in less than 15 minutes and did not sweep the yard at all.

The variables that showed statistically significant associations with inadequate weight were adjusted through multiple logistic regression for the following variables: smoking, initial nutritional status, living with a partner, and schooling (Table 4). We found that *walking* up to 50 minutes per day during the first period of pregnancy remains as a protective factor for IBW, and that *standing* for more than two-and-a-half hours during the second trimester remains as a risk factor. The multiple logistic regression analysis of variables *washing clothing by hand* and *cooking* in the second trimester confirmed the statistical significance of the former. The trend towards increased risk of IBW along with increases in the weekly frequency of *cooking* lost statistical significance after multiple analysis (p for linear trend =0.19).

DISCUSSION

The present study analyzed the influence of posture and physical activity on inadequate birthweight among pregnant women who completed follow-up at a public low-risk antenatal care facility for low-income women in the Municipality of Sao Paulo.

Several procedures were adopted in order to minimize the occurrence of potential biases and to ensure the internal validity of the study. The concern with losses to follow-up, present from the very beginning, directed the adoption of measures aimed at minimizing losses. The percentage of losses was high (30.9%), especially because of the difficulty in obtaining information about the newborn when delivery did not take place at the maternity linked to the antenatal care service. A comparison between studied women and losses did not detect significant differences between the two groups in terms of reproductive history, anthropometrical variables, and presence of a partner. Concerning schooling, a borderline significant difference was detected (p=0.05).

It is plausible to assume, however, that the influence of posture and physical activity during gestation on birthweight does not suffer a modifying effect due to schooling, especially among low-income mothers attending public antenatal care facilities. In the studied sample, we did not detect an interaction

Table 4 - Multiple analyses of the influence of the performance of three physical activities on birthweight. Sao Paulo, March 1997 to October 1998.

Variable	Category	OR	[CI 95% (OR)]	p
First period of pregnancy				
Walking*	Never	1		
	<50 min/day	0.44	[0.20; 0.98]	0.04
	≥50 min/day	0.72	[0.28; 1.86]	0.50
Second trimester				
Standing**	<1.5 h/day	1		
	1.5 ⎮— 2.5 h/day	1.29	[0.51; 3.28]	
	≥2.5 h/day	3.23	[1.30; 7.99]	<0.01[pt]
Segundo trimester of pregnancy				
Weekly frequency of standing activities				
Washing clothing by hand***	<3	1		
	3+	3.49	[1.59; 7.64]	<0.01
Cooking***	Never	1		
	1-4	1.76	[0.45; 6.94]	
	5-7	2.29	[0.67; 7.75]	0.19[pt]

Pt: Descriptive p-value for linear trend
*Model 1: walking, smoking, schooling, living with partner, and initial nutritional status
**Model 2: standing, smoking, schooling, living with partner, and initial nutritional status
***Model 3: washing clothing by hand, cooking, smoking, schooling, living with partner, and initial nutritional status

between schooling, study variables, and the outcome (analyses not shown). Therefore, it is not probable that the difference in terms of schooling between studied sample and losses has compromised the internal validity of the present study.

In the present study, we employed the instrument considered by us as the most adequate for achieving the goals established. We also took great care to train interviewers adequately.

We were able to compare the distribution of schooling among the studied women and the total population of pregnant women of the city of Sao Paulo by referring to the *Sistema de Declaração de Nascidos Vivos* (System for Information on Live Births – SINASC).[13] As expected, we found lower levels of schooling among the women in our cohort than among the totality of women who gave birth in the Municipality of Sao Paulo in 1998 (χ^2=5.57; p=0.06).

Regarding the anthropometrical characteristics of the women in our cohort, mean weight at the onset of pregnancy was 60kg, mean height was 1.59 m, and mean BMI was 23.8 kg/m^2. These values are similar to the results of the 1996 *Pesquisa Nacional sobre Demografia e Saúde* (National Demography and Health Survey) for Brazilian women.[4]

The distribution of birthweights found in the present study is similar to that described for the totality of births taken place in the Municipality of Sao Paulo in 1998, based on analyses of the SINASC database.[13] However, it is unfavorable when compared to the distribution of birthweights among children born in a city in Sweden (Gothenburg, 1972-1973).[13] The frequency of preterm births in the city of Sao Paulo in 1998 was similar to that found in the present study (6.0% and 5.3%, respectively).

Concerning external validity, we assume that the results obtained are applicable to pregnant women with similar characteristics who are clients of public antenatal facilities in other large Brazilian urban centers.

As to the factors under investigation, recent recommendations regarding physical activity for the improvement of individual and collective health, and more specifically for the prevention of and rehabilitation from cardiovascular disease, include the accumulation of at least 30 daily minutes of light to moderate physical activity, preferably every day of the week.[1] Even though such recommendations are not specific for our population of interest, we found that *walking* for up to 50 minutes per day (22 minutes, in average) during the first period of gestation showed a protective effect over inadequate birthweight (OR=0.44; 95% CI: 0.20-0.98). In the second trimester, a protective effect of *walking* can also be seen, but without statistical significance.

Sternfeld[17] in a review of the literature on the subject, indicates that for each of the potential physiological problems related to physical exercise during pregnancy – such as uteroplacental blood flow, hyperthermia, substrate availability (blood glucose), and the liberation of catecholamines that might induce uterine contractions – there are compensatory mechanisms that protect the fetus in healthy women with normal pregnancies and who are used to a certain level of physical effort.

In the cohort studied, we identified a significant trend towards increased risk of *inadequate birthweight* with prolonged standing, especially when over two-and-a-half hours per day. This finding is in agreement with a study by Fortier et al[5] which identified a similar trend.

Several studies have shown associations between

prolonged standing and *low birthweight*,[5,7,19] IUGR,[19] and preterm delivery.[12,18]

Hatch et al[7] identified a combined effect of prolonged standing and workload during the third trimester, which corresponded to a 215 g decrease in birthweight. In the present study, we observed a median reduction in birthweight of 270 g among women who remained standing for longer periods during the second trimester (data not shown). Tuntiseranee et al[19] also confirmed a higher frequency of IUGR among Thai women who remained in standing or squatting position for over five hours per day (OR=11.1).

In the present study, the analysis of each activity included in *standing* identified a trend towards increased risk of IBW for *washing clothes by hand* and *cooking*.

The results of the present study indicate that counseling on physical activity must be emphasized during antenatal care, especially among women who do not have assistance for their own housework and/or who remain standing for long periods. These findings also indicate a need for cohort studies with larger sample sizes, so as to allow for the identification of the effects of physical activity on other outcomes such as low birthweight, intrauterine growth restriction, and preterm birth.

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