Determinants of preterm birth: Pelotas, Rio Grande do Sul State, Brazil, 2004 birth cohort

Determinantes de nascimento pré-termo na coorte de nascimentos de 2004, Pelotas, Rio Grande do Sul, Brasil

Mariângela F. Silveira [1,2]
Cesar G. Victora [2]
Aluísio J. D. Barros [2]
Iná S. Santos [2]
Alicia Matijasevich [2]
Fernando C. Barros [2]

[1] *Faculdade de Medicina, Universidade Federal de Pelotas, Pelotas, Brasil.*
[2] *Programa de Pós-graduação em Epidemiologia, Universidade Federal de Pelotas, Pelotas, Brasil.*

Correspondence
M. F. Silveira
Departamento Materno-Infantil, Faculdade de Medicina, Universidade Federal de Pelotas.
Av. Duque de Caxias 250, Pelotas, RS 96030-001, Brasil.
maris.sul@terra.com.br

Abstract

Prematurity is a leading cause of neonatal mortality and a global health problem that affects high, middle and low-income countries. Several factors may increase the risk of preterm birth. In this article, we test the hypothesis that different risk factors determine preterm birth in different income groups by investigating whether risk factors for preterm deliveries in the 2004 Pelotas (Rio Grande do Sul State, Brazil) birth cohort vary among those groups. A total of 4,142 women were included in the analysis. Preterm births were equally common among women who had spontaneous vaginal deliveries as for those with induced or operative births. In the multivariate analysis the factors that remained significantly associated with preterm birth were black skin color, low education, poverty, young maternal age, primiparity, previous preterm birth, inadequacy of prenatal care and reported hypertension. In the analyses repeated after stratification by family income terciles, there was no evidence of effect modification by income and no clear difference between the socioeconomic groups. No association between cesarean section and preterm delivery was found. Further studies are required to understand the causes of the epidemic of preterm births in Brazil.

Premature Infant; Premature Obstetric Labor; Pregnancy

Introduction

Prematurity is a leading cause of neonatal mortality, accounting for over one million deaths each year [1]. Preterm birth (< 37 weeks gestation) is a global health problem that affects high, middle and low-income countries. Over 500,000 infants are born prematurely each year in the United States, of whom nearly 10,000 die, making prematurity the leading cause of infant mortality in that country [1]. Furthermore, there was a significant reduction in the proportion of deliveries with a gestational age of 40 weeks or more between 1999 and 2002 in the USA, with a corresponding increase for gestational ages of between 34 and 39 weeks; this was observed both for births following the premature rupture of membranes and for those resulting from medical interventions [2]. Similar increases have been reported in Brazil where three birth cohorts in the city of Pelotas showed that preterm deliveries accounted for 6.3% of all births in 1982, 11.4% in 1993 and 14.7% in 2004 [3]. A recent review of Brazilian population-based studies confirmed this increase [4], which has led to a rising trend in the prevalence of low birth weight babies, and may have had contributed to the lack of success in reducing neonatal mortality in spite of improved care for preterm and low birth weight babies [5]. According to Steer [6], in some developing countries the growth of medical care has outstripped the growth of preventive public

health, with an associated increase in iatrogenic preterm births.

The main risk factors for preterm delivery have been reviewed by Kramer & Victora [7] based on the international literature. The above mentioned Brazilian population-based studies review showed that the following risk factors were identified in one or more studies: low pre-pregnancy weight; extremes of maternal age; low maternal schooling; maternal work; low family income; previous stillbirth; smoking during pregancy; insufficent maternal weight gain during pregancy; hypertension; vaginal bleeding; urinary tract infections; five or less antenatal care consultations; absence of a partner; and maternal stress [4]. High rates of caesarean sections could also play a role, but analyses of the Pelotas 2004, Rio Grande do Sul, Brazil, data showed that a rising trend in preterm deliveries was also observed among vaginal deliveries [8].

In the Pelotas data, there is a high frequency of obstetric interventions among the rich, whereas the poor are more likely to present urinary and genital infections [3]. It is therefore possible that different risk factors determine preterm birth in different income groups. In this article we test this hypothesis by investigating whether risk factors for preterm deliveries in the 2004 Pelotas cohort vary among different social groups.

Methods

Pelotas is a city located in southern Brazil, with a population of around 340,000 inhabitants. Over 99% of all deliveries take place in hospitals. From January to December 2004, a birth cohort study included all hospital births given by women who reside within the city limits. A detailed description of the methodology is given elsewhere [9]. Newborns were examined through daily visits to the five maternity hospitals. Mothers were interviewed soon after delivery using a pre-tested, structured questionnaire. Information was obtained on demographic, socioeconomic, behavioral and biological characteristics, reproductive history and health care utilization. Preterm birth was defined as the delivery of an infant with less than 37 weeks of gestational age.

In 2004, we used the algorithm proposed by the National Center for Health Statistics (NCHS) [10] and an estimate for gestational age based on the last menstrual period (LMP) whenever this estimate was consistent with birth weight, length, and head circumference, according to the normal curves for these parameters for each week of gestational age [11]. When LMP-based gestational age was unknown or inconsistent (9,2%), we relied on ultrasonography measures from the first trimester or when these were not available, on the clinical estimate based on the Dubowitz method [12], which was performed on all newborns by our trained interviewers. Only single births were included in the analyses.

Family income in the month prior to delivery was collected as a continuous variable (in Brazilian Reals) and terciles were constructed. We opted for terciles to ensure a sufficient number of women in the stratified analyses. Maternal schooling was grouped into 0-4, 5-8 and 9 or more complete years with approval. Ethnicity was self-classified as white, black or other. The type of prenatal care was categorized as either public (financed by the government through the Unified National Health System – SUS) or private (either financed through private health insurance or out-of-pocket payments to the provider). Additional variables included: presence of a live-in partner; parity; planned pregnancy; history of a previous preterm birth; number of antenatal visits; adequacy of antenatal care (adequate, intermediate, inadequate and no antenatal care according to the Kessner index) [13]; maternal work during pregnancy; maternal smoking during pregnancy; self-reported morbidity (anemia, hypertension, urinary tract infections, vaginal discharge); and type of delivery (induced vaginal birth, spontaneous vaginal birth and C-section).

We used the χ^2 test to compare the association between exposures and outcome, first among all pregnant women, and again after stratification by income terciles. The logistic regression analyses took into account a conceptual model that specified distal, intermediate and proximate determinants, broken down into five levels. At the first, most distal level, the variables included skin color, income and schooling; at the second level, maternal age and presence of a live-in partner; at the third, planned pregnancy, parity and previous preterm birth; the fourth level included pregnancy characteristics such as maternal work, prenatal care visits and type, smoking, anemia, hypertension, urinary tract infection, and vaginal discharge; at the fifth and most proximate level, type of delivery. Variables were entered into the model one set at a time, according to these five levels, and selected using a backward strategy. If their level of significance was below 0.20, they remained in the model as potential confounders for the next level. In the adjusted analyses presented below, effect sizes and p levels are adjusted for variables in the same or higher levels of determination, thus avoiding adjustment for potential mediating factors [14].

The analyses were initially carried out for the whole sample, and then stratified by income ter-

ciles. In the latter, adjustment was also made for family income as a continuous variable, to avoid residual confounding within each category. All analyses were performed using version 10.0 of the SPSS software (SPPS Inc., Chicago, USA).

The study protocol was approved by the Medical Ethics Committee of the Federal University of Pelotas, affiliated with the Brazilian Federal Medical Council. Written informed consent was obtained.

Results

A total of 4,244 mothers were identified, of whom 95.5% agreed to participate. Among these, 4,201 had a single live birth and among those 4,142 had information on gestational age and were included in the analysis. The preterm prevalence (< 37 weeks) was 13.7% (95%CI: 12.7-14.7).

Table 1 shows the frequencies of demographic, socioeconomic, behavioral and gestational variables in the sample. Three quarters of the women classified themselves as white; almost 60% had fewer than nine years of formal education; 19% were teenagers; and 16.4% did not have a live-in partner. One third of the women had not

Table 1

Associations between preterm birth and demographic, socioeconomic, behavioral and gestational variables.

Variables	Frequency (%) *	Preterm birth (%)	Crude analyses		Adjusted analyses **	
			OR (95%CI)	p value	OR (95%CI)	p value
Level 1						
Skin color				< 0.001		0.004
White	3,026 (73.1)	12.6	1.0		1.0	
Other	289 (7.0)	12.1	0.96 (0.66-1.38)		0.90 (0.60-1.27)	
Black	827 (20.0)	18.4	1.56 (1.27-1.92)		1.40 (1.13-1.73)	
Schooling (years)				< 0.001		0.001 ***
0-4	638 (15.6)	19.3	1.90 (1.49-2.43)		1.62 (1.23-2.13)	
5-8	1,687 (41.1)	14.4	1.34 (1.10-1.64)		1.21 (0.97-1.50)	
9 or more	1,776 (43.3)	11.1	1.0		1.0	
Family income terciles				< 0.001		0.04 ***
1	1,395 (33.7)	17.1	1.61 (1.30-2.00)		1.28 (1.00-1.64)	
2	1,352 (32.6)	12.7	1.14 (0.91-1.44)		1.00 (0.78-1.27)	
3	1,395 (33.7)	11.3	1.0		1.0	
Level 2						
Maternal age (years)				0.001		0.006
< 20	791 (19.1)	18.0	1.53 (1.12-2.09)		1.44 (1.04-1.98)	
20-34	2,797 (67.6)	12.7	1.02 (0.78-1.35)		1.01 (0.76-1.33)	
35 or more	552 (13.3)	12.5	1.0		1.0	
Live-in partner				0.18		0.97
No	678 (16.4)	15.3	1.17 (0.93-1.48)		1.01 (0.79-1.28)	
Yes	3,464 (83.6)	13.4	1.0		1.0	
Level 3						
Planned pregnancy				0.55		0.85
No	2,725 (65.8)	13.9	1.06 (0.88-1.28)		1.02 (0.84-1.24)	
Yes	1,416 (34.2)	13.3	1.0		1.0	
Parity				0.04		< 0.001
Parous	2,498 (60.3)	12.8	1.0		1.0	
Primiparae	1,643 (39.7)	15.1	1.21 (1.01-1.25)		1.50 (1.20-1.88)	
Previous preterm birth				< 0.001		< 0.001
None	4,038 (94.2)	14.6	1.0		1.0	
1 or more	249 (5.8)	28.1	2.29 (1.71-3.06)		2.88 (2.09-3.97)	

(continues)

Table 1 (continued)

Variables	Frequency (%) *	Preterm birth (%)	Crude analyses OR (95%CI)	p value	Adjusted analyses ** OR (95%CI)	p value
Level 4						
Work during pregnancy				0.01		0.65
No	2,473 (59.7)	14.8	1.25(1.04-1.50)		1.02 (0.83-1.25)	
Yes	1,668 (40.3)	12.2	1.0		1.0	
Prenatal care				< 0.001		< 0.001
Adequate	1,791 (43.2)	8.7	1.0		1.0	
Intermediate	1,280 (30.9)	18.1	2.34 (1.88-2.90)		2.17 (1.71-2.74)	
Inadequate	1,000 (24.1)	15.8	1.98 (1.56-2.51)		1.75 (1.34–2.28)	
No prenatal care	71 (1.7)	32.4	5.06 (3.00-8.54)		3.72 (2.05-6.76)	
Public prenatal care				0.001		0.99
No	784 (19.0)	10.1	1.0		1.0	
Yes	3,353 (81.0)	14.6	1.52 (1.18-1.96)		1.00 (0.74-1.36)	
Smoking				0.005		0.08
No	3,003 (72.5)	12.8	1.0		1.0	
Yes	1,139 (27.5)	16.2	1.31 (1.09-1.59)		1.19 (0.97.1-47)	
Reported hypertension				< 0.001		< 0.001
No	3,154 (76.3)	12.5	1.0		1.0	
Yes, untreated	640 (15.5)	14.1	1.15 (0.90-1.47)		1.08 (0.84-1.39)	
Yes, treated	340 (8.2)	24.1	2.23 (1.70-2.92)		2.27 (1.70-3.02)	
Reported urinary tract infection				0.003		0.29
No	2,596 (62.9)	12.9	1.0		1.0	
Yes, untreated	147 (3.6)	23.1	2.02 (1.36-3.02)		1.42 (0.92-2.17)	
Yes, treated	1,385 (33.6)	13.9	1.08 (0.90-1.31)		1.05 (0.86-1.29)	
Reported vaginal discharge				0.04		0.20
No	2,201 (53.2)	13.5	1.0		1.0	
Yes, untreated	666 (16.1)	16.7	1.28 (1.01-1.63)		1.17 (0.91-1.51)	
Yes, treated	1,268 (30.7)	12.5	0.92 (0.75-1.13)		0.81 (0.73-1.13)	
Level 5						
Type of delivery				0.08		0.09
Vaginal spontaneous	1,473 (42.1)	15.2	0.98 (0.78-1.23)		0.66 (0.42-0.99)	
Vaginal induced	291 (8.3)	9.6	0.62 (0.41-0.96)		1.02 (0.82-1.26)	
Cesarean section	1,735 (49.6)	13.9	1.0		1.0	

* The number of women for whom information was available varies because of missing data;

** All analyses are adjusted for variables at the same or higher levels of determination that were associated with the outcome at a p level < 0.2;

*** p value for linear trend.

planned the pregnancy and 40% were primiparae. Almost 10% of the multiparae reported a previous preterm birth. During the pregnancy, 40% of the mothers worked; 98% had at least one antenatal care consultation; 81% attended public antenatal services; and 28% smoked. The caesarean section rate was 49.6%.

The results of the unadjusted analyses of factors associated with preterm birth are displayed in Table 1. Black skin color, low schooling, low income, teenage pregnancy, primiparity, and previous preterm delivery were significantly associated with increased risk. Women who did not work during pregnancy displayed a greater risk than those who worked. Adequacy of prenatal care and – among those who attended – use of public services also led to higher risk. Smokers were more likely than non-smokers to deliver preterm babies. Reported morbidity, including hypertension, urinary tract infections, and vaginal discharge were all associated with preterm birth, but whereas for hypertension the highest risk group was women who were treated for this condition – possibly the most severe cases – for urinary infections and vaginal discharge those at highest risk were the untreated. In the crude

analyses, there were no significant associations between preterm birth and having a live-in partner; and having planned the pregnancy.

Preterm births were equally common among women who had spontaneous vaginal deliveries and among those with induced or operative births. Because hypertension was common in the sample, and because it might have led to induced or operative deliveries, these analyses were repeated after excluding women with reported hypertension. This led to a significant association between type of delivery and preterm birth, with vaginal delivery leading to a 40% increase in prematurity compared to caesarean births (OR = 1.39; 95%CI: 1.10-1.76).

Results from the multivariate analyses are also reported in Table 1. Explanatory variables were included in blocks, according to a conceptual model of the hierarchy between possible determinants. Black skin color, low education and poverty remained significantly associated with the outcome even when adjusted for one another. All other models were adjusted for these confounders. When demographic variables were included, maternal age remained significant but having a live-in partner was dropped. Among the reproductive variables, primiparity and a previous preterm delivery remained significant but having planned the pregnancy was excluded. Among variables that refer to the index pregnancy, after adjustment for socioeconomic, demographic and reproductive variables, the two only significant variables were reported hypertension, with a two-fold increase for women who received treatment for this condition; and adequacy of prenatal care with women with no prenatal care having the greater risk of preterm birth. Finally, type of delivery was not associated with preterm birth after adjustment, either in the whole sample or after excluding hypertensive women. In our study women with reportedly treated hypertension – a probable sign of disease severity – had a higher risk to preterm birth, especially caused by medical intervention.

Because risk factors might vary among women of different socioeconomic position, all analyses were repeated after stratification by family income terciles (Table 2). In these analyses, data

Table 2

Multivariate analysis of the association between preterm birth and demographic, socioeconomic, behavioral and gestational variables, stratified by income terciles *.

Variables	Poorest tercile OR (95%CI)	Intermediate tercile OR (95%CI)	Richest tercile OR (95%CI)
Level 1			
Skin color			
White	1.0	1.0	1.0
Other	0.89 (0.52-1.51)	0.94 (047.-1.88)	0.81 (0.36-1.80)
Black	1.41 (1.04-1.91)	1.40 (0.96-2.02)	1.41 (0.84-2.36)
p value	0.05	0.19	0.35
Schooling (years)			
0-4	1.67 (1.09-2.55)	1.32 (0.82-2.11)	1.76 (0.80-3.87)
5-8	1.17 (0.79-1.74)	1.01 (0.70-1.46)	1.53 (1.04-2.2)
9 or more	1.0	1.0	1.0
p value	0.03	0.46	0.05
Level 2			
Maternal age (years)			
< 20	1.24 (0.75-2.06)	1.56 (0.86-2.83)	1.65 (0.85-3.17)
20-34	0.87 (0.55-1.39)	1.14 (0.67-1.93)	1.08 (0.68-1.73)
35 or more	1.0	1.0	1.0
p value	0.09	0.20	0.27
Live-in partner			
No	1.14 (0.82-1.59)	1.09 (0.69-1.70)	0.62 (0.33-1.15)
Yes	1.0	1.0	1.0
p value	0.42	0.72	0.13

(continues)

Table 2 (continued)

Variables	Poorest tercile OR (95%CI)	Intermediate tercile OR (95%CI)	Richest tercile OR (95%CI)
Level 3			
Planned pregnancy			
No	1.06 (0.77-1.47)	0.87 (0.61-1.24)	1.0 (0.70-1.43)
Yes	1.0	1.0	1.0
p value	0.72	0.45	1.0
Parity			
Parous	1.0	1.0	1.0
Primiparae	1.71 (1.18-2.49)	1.43 (1.02-2.01)	1.64 (1.13-2.39)
p value	0.005	0.04	0.009
Previous preterm birth			
None	1.0	1.0	1.0
1 or more	3.03 (1.82-5.04)	2.46 (1.39-4.34)	3.32 (1.82-6.04)
p value	< 0.001	0.002	< 0.001
Level 4			
Work during pregnancy			
No	1.02 (0.72-1.45)	1.12 (0.78-1.61)	0.93 (0.64-1.35)
Yes	1.0	1.0	1.0
p value	0.90	0.53	0.71
Prenatal care			
Adequate	1.0	1.0	1.0
Intermediate	2.21 (1.45-3.35)	2.23 (1.48-3.37)	2.14 (1.43-3.20)
Inadequate	1.98 (1.28-3.04)	1.44 (0.91-2.28)	2.01 (1.17-3.43)
No prenatal care	3.25 (1.41-7.33)	6.92 (2.26-21.23)	4.41 (0.83-23.27)
p value	< 0.001	< 0.001	0.001
Public prenatal care			
No	1.0	1.0	1.0
Yes	1.21 (0.52-2.83)	1.11 (0.55-2.23)	0.93 (0.62-1.39)
p value	0.65	0.78	0.71
Smoking			
No	1.0	1.0	1.0
Yes	1.09 (0.80-1.48)	1.24 (0.87-1.78)	1.27 (0.80-2.00)
p value	0.61	0.23	0.31
Reported hypertension			
No	1.0	1.0	1.0
Yes, untreated	0.80 (0.51-1.23)	1.49 (0.98-2.25)	1.10 (0.66-1.82)
Yes, treated	2.74 (1.78-4.22)	2.07 (1.18-3.63)	1.89 (1.10-3.26)
p value	< 0.001	0.02	0.09
Reported urinary tract infection			
No	1.0	1.0	1.0
Yes, untreated	1.35 (0.74-2.46)	2.04 (0.97-4.31)	1.07 (0.35-3.26)
Yes, treated	1.11 (0.81-1.53)	1.18 (0.83-1.69)	0.81 (0.54-1.21)
p value	0.56	0.16	0.57
Reported vaginal discharge			
No	1.0	1.0	1.0
Yes, untreated	1.14 (0.77-1.70)	1.15 (0.73-1.81)	1.29 (0.80-2.09)
Yes, treated	0.98 (0.69-1.40)	0.92 (0.62-1.36)	0.84 (0.56-1.26)
p value	0.77	0.69	0.30
Level 5			
Type of delivery			
Vaginal spontaneous	1.20 (0.85-1.70)	0.93 (0.64-1.37)	0.79 (0.51-1.22)
Vaginal induced	0.68 (0.33-1.40)	0.43 (0.20-0.94)	1.98 (0.47-2.02)
Cesarean section	1.0	1.0	1.0
p value	0.20	0.07	0.54

* All analyses are adjusted for variables at the same or higher levels of determination than were associated with the outcome at a p level < 0.2.

within each tercile were adjusted for income (as a continuous variable) because of the possibility of residual confounding. Although some of the associations reported for the whole sample lost significance in the stratified analyses, largely due to the reduction in power because of smaller sample sizes, there was no evidence of effect modification by income (all interaction terms had p levels greater than 0.24) and the direction and magnitude of the effect estimates remained mostly unchanged.

Discussion

Our study's strengths include its population basis, the very low rate of non-response and the detailed measurement of preterm rates using multiple measures. The study also had its limitations: information on morbidity – hypertension, urinary tract infection and vaginal discharge – was self-reported, rather than drawn from a review of antenatal records. However, such records are kept in more than 50 clinics that provide antenatal care in the city, making it difficult, if not impossible, to review them. Also, our study has an observational design, and for some of the conditions being studied – particularly morbidity – results from randomized trials of clinical treatment provide much stronger evidence of causality. Therefore, the main purpose of our analyses of such risk factors was to verify whether the trial results can be confirmed by the observational analyses, and to estimate the magnitude of these associations in different socioeconomic groups.

Black skin color, low education and poverty remained significantly associated with preterm delivery. In the United States, black women present substantially higher rates than white women, even after adjustment for schooling, thus suggesting that socioeconomic factors can not fully account for racial differences [15]. Hitti et al. [16], using the data of the Vaginal Infections and Prematurity Study, a large prospective cohort study conducted between 1984 and 1989, found that 6.4% of African Americans, 3.8% of Hispanics, and 4.4% of whites had a preterm delivery of a low-birthweight infant. The proportion of preterm births associated with lower genital tract infection was 21% among African Americans and 5% among whites. This increase appears to be related to an increased prevalence of lower genital tract infection, and also to an increased risk of preterm delivery in the context of lower genital tract infection [16]. Low income and low schooling have also been identified as risk factors for prematurity. These associations are likely mediated through behavioral factors such as smoking and physical activity, as well as through psychosocial processes such as stress, discrimination, and lack of social support [15]. In our study, being black was significantly associated with preterm birth even after adjustment for morbidity.

Teenage pregnancy remained significantly associated with preterm birth even after adjustment for skin color, schooling and income. Several studies have identified young maternal age as an important risk factor for preterm birth, although it is not known whether the increased risk is due to biological immaturity or to an increased prevalence of other risk factors associated with their generally poor socioeconomic condition [15]. We did not find an excess risk among women who did not have a live-in partner, unlike other studies [15], probably because this association is explained by socioecomic characteristics rather than the presence of a partner per se.

In a study of African American women in the United States, those with unplanned pregnancies were 1.8 times more likely to deliver a preterm infant [15]. We did not confirm this association in our study. On the other hand, there was a threefold increase in the preterm rate for women who had a previous preterm birth, an association that is confirmed by the literature [15].

Primiparae were about 50% more likely to deliver preterm than other women. A US study found that primiparae are at increased risk of both medically indicated and spontaneous preterm birth, and its authors proposed a risk assignment to include three groups: low-risk (prior term birth), intermediate risk (primiparity), and high-risk (prior preterm birth) [17].

The association between work during pregnancy and preterm birth disappeared after adjustment, as was the case in most studies on this topic. Maternal work at night or in standing positions have been associated with preterm birth, but public health policies restricting maternal occupational risks or work activities have had little impact on individual risks of preterm birth [18].

Inadequate prenatal care was related to prematurity. Although prenatal care may provide a platform for delivering effective interventions against preterm delivery, the effectiveness of prenatal care for preventing prematurity has yet to be demonstrated conclusively. Given the serious doubt about the effects of prenatal care on reducing the risk of preterm birth, it seems an unlikely mediator of socioeconomic disparities in preterm birth [15].

A higher risk of preterm birth among women who attended public, rather than private antenatal care, was observed in the crude analyses, but was no longer significant after adjustment for socioeconomic factors and previous obstet-

ric history. A study from Tanzania found that the quality of prenatal care was better in the private than the public sector [19].

Smoking was associated with adverse pregnancy outcomes, even after adjustment. The literature shows a modest, dose-dependent association between smoking, preterm birth and stillbirth [15,20]. This effect may be stronger for early preterm delivery (< 35 weeks) than for late preterm birth [21,22]. Because smoking during pregnancy has become increasingly associated with low socioeconomic position, residual confounding is a possible explanation for positive findings [15].

In relation to morbidity, several maternal conditions are associated with an increased risk of preterm birth. Because of the observational nature of our study and the fact that morbidity information is mostly based on maternal reports, our findings may be affected by misclassification. Hypertension may cause fetal growth restriction and also increase the risk of preeclampsia and, thus, the risk of preterm birth, even when treated [15]. In our study women with reportedly treated hypertension – a probable sign of disease severity – had a higher risk of preterm birth, especially caused by medical intervention, as the only causal treatment is delivery [23]. On the other hand, treatment of urinary tract infections [24] is known to reduce the risk of preterm delivery, and this was confirmed in our study, where the risk was only raised for women who reported untreated infections. Regarding genital infections, observational studies relying on laboratory findings consistently show an association with preterm births [25]. However, results from treatment trials are mixed [26]. We found that reported untreated vaginal discharge was associated with higher risk than women who did not report such a symptom, or those whose discharge was treated. It should be noted that our findings of a higher risk for women with untreated urinary and genital infections in the crude analyses were somewhat reduced and lost significance after adjustment, but still remained in the expected direction.

Type of delivery was not associated with preterm birth, either in the whole sample or after excluding hypertensive women. The role of medical intervention in preterm births requires further studies. A Brazilian study shows that the highest rates of preterm birth are seen in relatively affluent areas, where cesarean sections are more frequent [27]. However, a population study failed to identify an association with type of delivery [28]. Villar et al. [29] in the 2005 WHO global survey on maternal and perinatal health, studied all women delivering in a 3-month period in 120 hospitals from eight countries in Latin America. Their ecological analysis, using the hospitals as the study units, reduced the potential bias resulting from individual studies in which high-risk pregnancies are more likely to lead both to preterm delivery and to cesarean sections. After adjustment for the risk profile of women admitted to each hospital, there was no association between cesarean sections and preterm birth [29]. In Pelotas, as the cesarean section rates increased from 28% in 1982 to 45% in 2004, preterm rate rose from 5.6% to 17.1% [3] but we failed in finding an association between these two events.

Our original hypothesis was that risk factors for preterm births would vary according to the three socioeconomic groups. For example, we expected poor antenatal care to be a stronger risk factor among the poor, and cesarean sections to play a role in the better off. Against this hypothesis, our stratified analyses were remarkably consistent. We also calculated tercile-specific attributable risks for all variables that were significant in the overall adjusted analyses, and no clear differences between the socioeconomic groups emerged (data available upon request).

In summary, the confounder-adjusted analyses of the whole sample showed significant associations between preterm delivery and the following risk factors: black skin color, low education, low income, young maternal age, primiparity, previous preterm delivery, adequacy of prenatal care and reported hypertension. Contrary to our expectations, cesarean section was not associated with preterm delivery, and the risk factors did not vary among socioeconomic groups. Further studies are required to understand the causes of the epidemic of preterm births in Brazil. These studies, unlike our own, should recruit women during pregnancy and use laboratory tests and physical examinations to document morbidity in a more reliable way. Better documentation of indications for medical interventions such as induction and cesarean sections is also needed.

Resumo

A prematuridade é uma grande causa de morte neonatal e um problema de saúde global, afetando países de alta, média e baixa renda. Vários fatores podem aumentar o risco de parto pré-termo. Neste artigo, testamos a hipótese de que diferentes fatores de risco determinem o parto pré-termo em diferentes grupos de renda, investigando como fatores de risco para prematuridade na coorte de nascimentos de 2004 de Pelotas, Rio Grande do Sul, Brasil, variam entre estes grupos. Foram incluídas na análise 4.142 mulheres. Os nascimentos pretermo foram igualmente comuns entre mulheres com partos vaginais e com partos induzidos ou cesáreas. Na análise multivariada, a cor negra, baixa educação, baixa renda, idade materna jovem, primiparidade, parto pré-termo anterior, cuidado pré-natal inadequado, e relato de hipertensão na gestação permaneceram significativamente associados com prematuridade. Nas análises estratificadas por tercis de renda familiar não houve evidência de modificação de efeito por renda, não sendo identificados diferentes padrões de risco entre os grupos sócio-econômicos. Não foi encontrada associação entre o parto cesáreo e prematuridade. Mais estudos são necessários para entender as causas da epidemia de partos pré-termo no Brazil.

Prematuro; Trabalho de Parto Prematuro; Gravidez

Contributors

M. F. Silveira, C. G. Victora and F. C. Barros participated in the analysis and write up of the article. A. J. D. Barros, I. S. Santos and A. Matijasevich contributed to the data collection, analysis and article write up.

Acknowledgments

The research was funded by the World Health Organization (HQ/04/072979), by the Brazilian Council for Scientific and Technological Development (CNPq; 476727/2003-0), by the National Health Foundation (MS/FNS 4589/04) and by Pastoral da Criança.

References

1. Lawn J, Cousens S, Zupan J. Four million neonatal deaths: Where? When? Why? Lancet 2005; 365:891-900.
2. Davidoff MJ, Dias T, Damus K, Russell R, Bettegowda VR, Dolan S, et al. Changes in the gestational age distribution among U.S. singleton births: impact on rates of late preterm birth, 1992 to 2002. Semin Perinatol 2006; 30:8-15.
3. Barros FC, Victora CG, Matijasevich A, Santos IS, Horta BL, Silveira MF, et al. Preterm births, low birth weight, and intrauterine growth restriction in three birth cohorts in Southern Brazil: 1982, 1993 and 2004. Cad Saúde Pública 2008; 24 Suppl 3:S390-8.
4. Silveira MF, Santos IS, Barros AJD, Matijasevich A, Barros FC, Victora CG. Aumento da prematuridade no Brasil: uma revisão de estudos de base populacional. Rev Saúde Pública 2008; 42:957-64.
5. Victora CG. Intervenções para reduzir a mortalidade infantil pré-escolar e materna no Brasil. Rev Bras Epidemiol 2001; 4:63-9.
6. Steer PJ. The epidemiology of preterm labour: why have advances not equated to reduced incidence? BJOG 2006; 113 Suppl 3:1-3.
7. Kramer MS, Victora CG. Low birth weight and perinatal mortality. In: Semba RS, Bloem MW, editors. Nutrition and health in developing countries. Totowa: Humana Press; 2001. p. 57-69.

8. Barros FC, Victora CG, Barros AJ, Santos IS, Albernaz E, Matijasevich A, et al. The challenge of reducing neonatal mortality in middle-income countries: findings from three Brazilian birth cohorts in 1982, 1993, and 2004. Lancet 2005; 365:847-54.
9. Barros AJ, Santos IS, Victora CG, Albernaz EP, Domingues MR, Timm IK, et al. Coorte de nascimentos de Pelotas, 2004: metodologia e descrição. Rev Saúde Pública 2006; 40:402-13.
10. Martin JA, Hamilton BE, Sutton PD, Ventura SJ, Menacker F, Munson ML. Births: final data for 2003. Natl Vital Stat Rep 2005; 54:1-116.
11. Fenton TR. A new growth chart for preterm babies: Babson and Benda's chart updated with recent data and new format. BMC Pediatr 2003; 3:13-23.
12. Dubowitz LM, Dubowitz V, Golberg C. Clinical assessment of gestational age in the newborn infant. J Pediatr 1970; 77:1-10.
13. Kessner DM, Singer J, Kalk CE, Schlesinger ER. Infant death: an analysis by maternal risk and health care. v. 1. Washington DC: Institute of Medicine; 1973.
14. Victora CG, Huttly SR, Fuchs SC, Olinto MT. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. Int J Epidemiol 1997; 26:224-7.
15. Institute of Medicine. Preterm birth: causes, consequences, and prevention. Washington DC: National Academy Press; 2007.
16. Hitti J, Nugent R, Boutain D, Gardella C, Hillier SL, Eschenbach DA. Racial disparity in risk of preterm birth associated with lower genital tract infection. Paediatr Perinat Epidemiol 2007; 21:330-7.
17. Ananth CV, Peltier MR, Getahun D, Kirby RS, Vintzileos AM. Primiparity: an "intermediate" risk group for spontaneous and medically indicated preterm birth. J Matern Fetal Neonatal Med 2007; 20: 605-11.
18. Pompeii LA, Savitz DA, Evenson KR, Rogers B, McMahon M. Physical exertion at work and the risk of preterm delivery and small-for-gestational-age birth. Obstet Gynecol 2005; 106:1279-88.
19. Boller C, Wyss K, Mtasiwa D, Tanner M. Quality and comparison of antenatal care in public and private providers in the United Republic of Tanzania. Bull World Health Organ 2003; 81:116-22.
20. Fretts RC. Etiology and prevention of stillbirth. Am J Obstet Gynecol 2005; 193:1923-35.
21. Burguet A, Kaminski M, Abraham-Lerat L, Schaal JP, Cambonie G, Fresson J, et al. The complex relationship between smoking in pregnancy and very preterm delivery. Results of the Epipage study. BJOG 2004; 111:258-65.
22. Fantuzzi G, Aggazzotti G, Righi E, Facchinetti F, Bertucci E, Kanitz S, et al. Preterm delivery and exposure to active and passive smoking during pregnancy: a case-control study from Italy. Paediatr Perinat Epidemiol 2007; 21:194-200.
23. Koopmans CM, Bijlenga D, Aarnoudse JG, van Beek E, Bekedam DJ, van den Berg PP, et al. Induction of labour versus expectant monitoring in women with pregnancy induced hypertension or mild preeclampsia at term: the HYPITAT trial. BMC Pregnancy Childbirth 2007; 7:14.
24. Smaill F, Vazquez JC. Antibiotics for asymptomatic bacteriuria in pregnancy. Cochrane Database Syst Rev 2007; (2):CD000490.
25. Lamont RF, Sawant SR. Infection in the prediction and antibiotics in the prevention of spontaneous preterm labour and preterm birth. Minerva Ginecol 2005; 57:423-33.
26. McDonald HM, Brocklehurst P, Gordon A. Antibiotics for treating bacterial vaginosis in pregnancy. Cochrane Database Syst Rev 2007; (1):CD000262.
27. Silva AA, Bettiol H, Barbieri MA, Pereira MM, Brito LG, Ribeiro VS, et al. Why are the low birthweight rates in Brazil higher in richer than in poorer municipalities? Exploring the epidemiological paradox of low birthweight. Paediatr Perinat Epidemiol 2005; 19:43-9.
28. Aragão VM, Silva AA, Aragão LF, Barbieri MA, Bettiol H, Coimbra LC, et al. Risk factors for preterm births in Sao Luís, Maranhão, Brazil. Cad Saúde Pública 2004; 20:57-63.
29. Villar J, Valladares E, Wojdyla D, Zavaleta N, Carroli G, Velazco A, et al. Caesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and perinatal health in Latin America. Lancet 2006; 367:1819-29.

Submitted on 08/Oct/2008
Final version resubmitted on 06/Mar/2009
Approved on 27/Oct/2009