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Keywords

Infant, low birth weight[#]. Infant premature[#]. Labor[#]. Cesarean section[#]. Socioeconomic factors. Risk factors. Marital status. Diagnosis of health situation in specific groups. – Preterm birth. Vaginal delivery.

Abstract

Objective

To identify risk factors for low birth weight (LBW) among live births by vaginal delivery and to determine if the disappearance of the association between LBW and socioeconomic factors was due to confounding by cesarean section.

Methods

Data were obtained from two population-based cohorts of singleton live births in Ribeirão Preto, Southeastern Brazil. The first one comprised 4,698 newborns from June 1978 to May 1979 and the second included 1,399 infants born from May to August 1994. The risks for LBW were tested in a logistic model, including the interaction of the year of survey and all independent variables under analysis.

Results

The incidence of LBW among vaginal deliveries increased from 7.8% in 1978–79 to 10% in 1994. The risk was higher for: female or preterm infants; newborns of non-cohabiting mothers; newborns whose mothers had fewer prenatal visits or few years of education; first-born infants; and those who had smoking mothers. The interaction of the year of survey with gestational age indicated that the risk of LBW among preterm infants fell from 17.75 to 8.71 in 15 years. The mean birth weight decreased more significantly among newborns from qualified families, who also had the highest increase in preterm birth and non-cohabitation.

Conclusions

LBW among vaginal deliveries increased mainly due to a rise in the proportion of preterm births and non-cohabiting mothers. The association between cesarean section and LBW tended to cover up socioeconomic differences in the likelihood of LBW. When vaginal deliveries were analyzed independently, these socioeconomic differences come up again.

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Descritores

Baixo peso ao nascer[#]. Prematuros[#]. Trabalho de parto[#]. Cesárea[#]. Fatores socioeconômicos. Fatores de risco. Estado civil. Diagnóstico da situação de saúde em grupos específicos. – Nascimento pré-termo. Parto vaginal.

Resumo

Objetivo

Identificar fatores de risco para o baixo peso ao nascer (BPN) entre nascidos vivos de parto vaginal e verificar se o desaparecimento da associação entre BPN e fatores socioeconômicos foi devido ao confundimento pela cesariana.

Métodos

Foram estudadas duas coortes de base populacional de recém-nascidos únicos de parto vaginal em Ribeirão Preto, Sudeste do Brasil. A primeira incluiu 4.698 crianças nascidas entre junho de 1978 e maio de 1979 e a segunda 1.399 crianças nascidas entre maio e agosto de 1994. Os riscos de BPN foram testados num modelo de regressão logística, incluindo interações entre ano da pesquisa e todas as variáveis independentes em análise.

Resultados

A incidência de BPN entre partos vaginais aumentou de 7,8% em 1978/79 para 10% em 1994 para crianças do sexo feminino, para os primogênitos, para nascidos de mães sem companheiro, para nascidos de mães que fizeram menor número de consultas pré-natais ou com menos anos de estudo e para nascidos de mães fumantes. A interação entre ano do parto e idade gestacional indicou que o risco de BPN entre os nascidos prematuros caiu de 17,8 para 8,7 em 15 anos. A média do peso ao nascer reduziu-se mais entre os filhos de famílias mais qualificadas, que tiveram o maior aumento nos nascimentos pré-termo e nas mães sem companheiro.

Conclusões

O BPN entre partos vaginais aumentou principalmente devido ao incremento nos nascimentos pré-termo e nas mães sem companheiro. A associação entre cesariana e BPN tendeu a encobrir as diferenças socioeconômicas na probabilidade do BPN. Na análise dos partos vaginais isoladamente, as diferenças socioeconômicas reapareceram.

INTRODUCTION

Low birth weight (LBW) is the main factor determining neonatal and perinatal survival and it is also associated with many adverse outcomes in newborns (Kramer,¹⁰ 1987). In recent years, it has been shown that the LBW rate has decreased in many parts of the world due to improvements in health care and improving life standards (Chike-Obi et al,⁶ 1996).

In contrast, the LBW rate has increased in some cities of Brazil in the last years. In Pelotas, Southern Brazil, there was an increase from 9% in 1982 to 9.8% in 1993 (Horta et al,⁹ 1996).

In previous studies, it was shown an increase in the LBW rate in Ribeirão Preto, Southeastern Brazil, from 7.2% in 1978–79 to 10.6% in 1994 and a rise in the preterm birth rate from 7.6% in 1978–79 to 13.6% in 1994. These changes occurred despite improvements in many risk factors associated with LBW and preterm birth (Silva et al,¹⁵ 1998; Bettiol et al,⁴ 1999).

Three main factors were found to be associated with the increase in LBW rate: preterm birth, maternal smoking and cesarean section delivery (Silva et al,¹⁵ 1998). Socioeconomic differences in the risk of LBW

were attenuated. The increase in the cesarean section delivery rate explains only partially the increasing trend seen for LBW rate. To explore these relationships, to avoid confounding due to cesarean section, a restricted analysis of risk factors for LBW among live births by vaginal delivery was conducted, since the likelihood of cesarean section was greater for better-off families. The purpose was to analyze risk factors for LBW among vaginal deliveries and to verify if socioeconomic differences really decreased or if they artificially disappeared due to confounders.

METHODS

Ribeirão Preto is a regional center in the Northeastern region of the State of S. Paulo, Brazil. Its per capita income is one of the highest in the country, about US\$ 5,800 per year. The main economic activities in the region are sugar cane industry, trading, services and financing. The urban population was 461,427 inhabitants in 1994, increasing by 45% in the last 15 years (Barbieri et al,² 1989; Bettiol et al,³ 1998).

From 1978 on, at least 98% of all births in the city took place in maternity hospitals (Barbieri et al,² 1989). Two surveys were carried out in the maternity hospitals in 1978–79 and 1994. The 1978–79 survey

started in June 1978 and ended in May 1979 (6,750 births). The 1994 one was a four-month survey, including infants born from May to August (2,846 births). The analysis was restricted only to singleton live births by vaginal delivery for families residing in the municipality (4,698 deliveries in 1978–79 and 1,399 in 1994) to avoid selection bias and potential confounding due to multiple gestations. Mothers were interviewed soon after delivery using a standardized questionnaire after their consent. Trained personnel obtained newborn weights using weekly-calibrated scales with 10-g precision. Newborns were weighed naked immediately after delivery. Non-response due both to early hospital discharge and mother's refusal was low (3.5% in the first survey and 4.2% in the second). The method was the same in both surveys and details are described elsewhere (Barbieri et al.,² 1989; Bettiol et al.,³ 1998).

The variables included in the analyses were: birth weight (less than 2,500 g; 2,500 g and over), newborn gender (male; female), maternal age in years (less than 20; 20 to 34; 35 and over), marital status (cohabiting; non-cohabiting), maternal schooling in years (less than 4; 4 to 11; 12 and over), parity including the current delivery (1; 2 to 4; 5 and over), maternal smoking (yes, if the mother had smoked at least one cigarette during pregnancy; no otherwise), family income in minimum wages (less than 4; 4 to 10; 10 and more), preterm birth (yes for less than 37 weeks of gestation; no otherwise), number of prenatal care visits (less than 4; 4 and more), type of insurance (public – those covered by social security or seen at public institutions; private – those who had a private prepaid health care plan or paid for services). A missing category was included for those variables with a large amount of unknown information. Gestational age was calculated according to the last menstrual period. Cases whose birth weight was above the 99th percentile for a given gestational age based on the British nomograms were excluded from the analysis because they were probably mistakenly considered as preterm births (Altman & Coles,¹ 1980). The occupation group of the head of household was drawn from an adaptation of the International Standard Classification of Occupations – ISCO-68 (Bettiol et al.,⁴ 1999) and it was considered as a proxy for socioeconomic status and grouped into three categories: non-manual workers, skilled/semi-skilled workers and unskilled workers. Parental occupation was used in the coding of occupational group in most cases. When parental occupation was not recorded, especially for non-cohabiting women, maternal occupation was used instead.

Student's t-test was used to make a comparison between the two surveys' mean birth weight according to occupational groups, and the chi-square test

was used when comparing characteristics of the two cohorts. Unadjusted and adjusted odds ratios were obtained by logistic regression using the Stata package. The group at lowest risk of LBW was used as a reference category. A complete model was fitted to include all determinants under analysis, the year of survey and a series of interaction terms between the year of survey and all potential risk factors. These interaction terms served to identify variations in the odds ratio between surveys. Backward elimination was used to fit the final reduced model. In addition, a crude model with the year of survey and a series of sequential models, including one by one all variables associated with LBW in the former model, were fitted. The aim was to identify variables influencing the odds ratio for the year of survey that may be responsible for the increasing trend in LBW among vaginal deliveries.

RESULTS

LBW rate and type of delivery

The LBW rate in 1978–79 was higher for live births by vaginal delivery (7.8%) compared to those infants whose mothers underwent cesarean section (5.9%). This pattern has changed in 1994: the LBW rate was higher for live births whose mothers underwent cesarean section (11.3%) than for those whose mothers had vaginal delivery (10.0%). The rate of increase in the LBW rate was higher for cesarean section (86.4%) than for vaginal delivery (32%).

The birth weights of infants born by cesarean section were much lower for the 1994 cohort compared to the 1978–79 one. The percentage of those born by cesarean section weighing less than 3,000 grams increased sharply. Although the birth weights of infants whose mothers had vaginal delivery were also reduced, this happened in a slower manner (Figure). The increasing trend in the LBW rate was restricted to the 36th and 37th weeks of gestational age.

The mean birth weight was reduced for all occupational groups (Table 1). The decrease was more marked among infants of better qualified families (–199 grams) than among infants of less qualified families (–97 grams). Social differences in LBW rate decreased due to the higher proportional drop rise among newborns of better qualified families.

Trends in childbearing population characteristics between 1978–79 and 1994

Some favorable trends were observed among this selected cohort of mothers who had vaginal delivery.

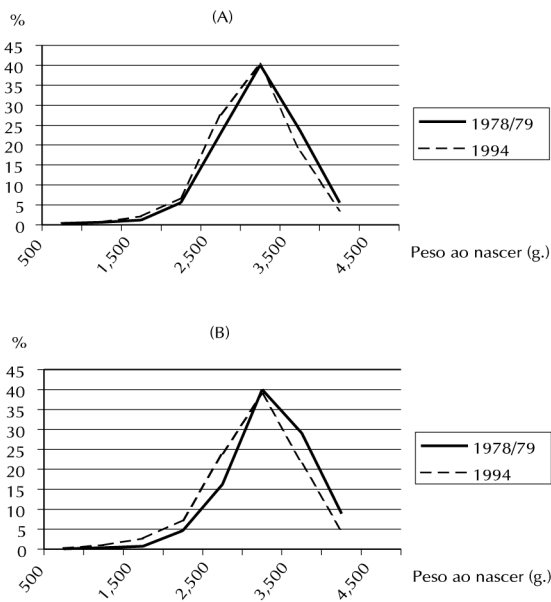


Figure - Distribution of birth weights among singleton live births from vaginal (A) and caesarean delivery (B) in Ribeirão Preto, 1978/79 and 1994.

In 1994 more women had private insurance and a higher family income; they also had a higher number of prenatal visits than 15 years ago and there was a decrease in the percentage of multiparous mothers. The percentage of smoking mothers decreased from 30.3% to 19.9%. (Table 2).

In contrast, the percentage of people in non-manual occupations and the percentage of mothers with 12 or more years of schooling decreased. Three known risk factors for LBW have arisen: the percentage of young mothers (from 16.1% to 23.0%), percentage of non-cohabiting mothers, which almost doubled from 7.6% to 14.8%; and the preterm birth rate among vaginal deliveries, which increased markedly from 8.6% to 13.9%, a 62% rise (Table 2).

Risk factors for LBW among women who had vaginal delivery

The adjusted risk of LBW was higher for female infants and live births of non-cohabiting mothers. It

was also higher for those infants whose mothers had less than four prenatal visits, first-births, those newborns whose mothers had less than 12 years of schooling and had smoking mothers (Table 3). There was an interaction between the year of survey and gestational age, indicating that the risk of LBW for those prematurely born fell from 17.75 (95% CI 12.98–24.88) in 1978–79 to 8.71 (95% CI 5.43–13.95) in 1994. Since mothers of prematurely born infants tend to have fewer prenatal visits, the number of visits was excluded from the model to verify whether this inherent bias may have affected the estimates. As there was no change in the associations described above, the model with the number of prenatal visits was used in the study.

Identification of factors probably associated with the increasing LBW rate

Table 4 shows the crude and sequentially adjusted year effect for LBW among vaginal deliveries. The crude odds ratio for LBW comparing 1994 with 1978–79 (1.32) indicated that the risk of LBW was 32% higher in 1994. When adjusted also for preterm birth, the risk of LBW for the 1994 cohort was smaller (1.14) and no longer statistically significant, showing that preterm birth was the main contributing factor to this increase. When non-cohabiting status was taken into account, the risk of LBW for 1994 was also reduced from 1.37 to 1.32, suggesting that non-cohabiting status might have also played a role in this increasing trend. The year effect for LBW in 1994 was higher or unchanged when adjusted for other factors. For example, when the risk of LBW was adjusted at the same time for the year effect, preterm birth and maternal smoking, it was 1.37, i.e., higher than 1.14, indicating that maternal smoking had contributed to lower the LBW rate.

DISCUSSION

It was shown in a previous study that the increase in the cesarean section delivery rate was the factor more closely associated with the increase in LBW rate in Ribeirão Preto along with gestational age and maternal smoking (Silva et al,¹⁵ 1998). In this study it

Table 1- Mean birth weight (grams) of infants from mothers who had vaginal delivery, according to occupational group. Ribeirão Preto, 1978/79 and 1994.

Occupational group	1978/79 Mean (sd)*	1994 Mean (sd)*	Difference	P-value**
Lower managers, executive and academic jobs	3,333 (506)	3,134 (453)	-199	<0.001
Skilled and semi-skilled	3,196 (535)	3,102 (563)	-94	<0.001
Unskilled/unemployed	3,159 (530)	3,062 (541)	-97	0.002
All groups	3,198 (545)	3,097 (542)	-101	<0.001

*Figures in parenthesis represent the standard deviation
**P-value for the difference between surveys (Student's t-test)

Table 2 - Trends in selected population characteristics among vaginal deliveries in singleton livebirths in Ribeirão Preto, Brazil, 1978/79 and 1994.

Variables	1978/79		1994		P-value*
	n	%	n	%	
Gender					
Male	2,404	51.2	705	50.4	0.816
Female	2,289	48.8	693	49.6	
Not known	5	(0.1)	1	(0.0)	
Maternal age (years)					<0.001
<20	749	16.1	320	23.0	<0.001
20 to 34	3,557	76.5	979	70.1	
35 and more	343	7.4	97	6.9	
Not known	49	(1.0)	3	(0.2)	
Marital status					<0.001
Non-cohabiting	355	7.6	200	14.8	<0.001
Cohabiting	4,287	92.4	1,151	85.2	
Not known	56	(1.2)	48	(3.4)	
Parity					<0.001
1	1,454	32.0	461	33.2	<0.001
2 to 4	2,360	51.9	760	54.7	
5 and more	733	16.1	168	12.1	
Not known	151	(3.2)	10	(0.7)	
Preterm birth					<0.001
No	3,150	91.4	932	86.1	<0.001
Yes	297	8.6	151	13.9	
Not known	1,251	(26.6)	316	(22.6)	
Prenatal visits					<0.001
<4	1,138	27.7	191	14.8	<0.001
4 and more	2,963	72.3	1,101	85.2	
Not known	597	(12.7)	107	(7.6)	
Type of insurance					<0.001
Private	340	7.3	240	17.8	<0.001
Public	4,329	92.7	1,106	82.2	
Not known	29	(0.6)	53	(3.8)	
Maternal smoking status					<0.001
No	3,135	69.7	1,037	80.1	<0.001
Yes	1,363	30.3	257	19.9	
Not known	200	(4.3)	105	(7.5)	
Maternal schooling (years)					<0.001
<4	1,251	27.6	279	21.7	<0.001
4 to 11	2,937	64.6	924	71.8	
12 and more	355	7.8	84	6.5	
Not known	155	(3.3)	112	(8.0)	
Family income					<0.001
<4 minimum wages	2,431	65.0	535	55.0	<0.001
4 to 10	971	26.0	313	32.2	
>10 minimum wages	338	9.0	125	12.8	
Not known	958	(20.4)	426	(30.5)	
Occupation groups					0.001
Non-manual	622	14.3	163	12.3	0.001
Skilled/semi-skilled	2,663	61.3	823	61.8	
Unskilled	1,059	24.4	344	25.9	
Not known	354	(7.5)	69	(4.9)	

*P-value for difference between surveys (chi-square test)

was demonstrated that the LBW rate increased over a period of 15 years also for those infants whose mothers had vaginal delivery, even though some risk factors for LBW decreased in the same period. Accentuated increases were detected in the percentage of young, non-cohabiting mothers and preterm births.

This increasing trend in LBW rate among vaginal deliveries seems to be largely attributable to a rise in the preterm birth rate and the percentage of non-cohabiting mothers. A further support to this evidence was that, when a separate model for 1994 was fitted, only these two risk factors remained associated with LBW. Despite the increase in the proportion of teen mothers, young maternal age did not contribute to this trend. These findings were also supported by others (Eriksson et al,⁷ 1997).

Although better qualified families had the lowest proportion of non-cohabiting mothers and preterm birth in both cohorts, they revealed the highest increase in the proportion of non-cohabiting women and preterm birth between 1978–79 and 1994 (data not shown). The higher increase in the proportion of preterm births and non-cohabiting mothers among better-off families partially explains the more accentuated reduction observed in their newborns' mean birth weight. Another possibility is that the increase in LBW and the drop in mean birth weight among vaginal deliveries is in part an artifact caused by a shift from vaginal to cesarean section delivery in the city. Better-off families mothers tended to undergo cesarean section more frequently in 1994 compared to 15 years ago (Gomes et al,⁸ 1999). Vaginal deliv-

Table 3 - Variables associated with low birth weight among women who had vaginal delivery* in Ribeirão Preto, Brazil, 1978/79 and 1994.

Variable	Total	n	%	OR (95% CI)	P-value
Gender					0.0011
Male	3,109	222	7.1	1.00	
Female	2,982	282	9.5	1.42 (1.15-1.75)	
Marital status					0.0357
Cohabiting	5,438	411	7.6	1.00	
Non-cohabiting	555	85	15.3	1.39 (1.02-1.90)	
Prenatal visits					<0.001
4 and more	4,064	271	6.7	1.00	
<4	1,329	177	13.3	1.60 (1.26-2.04)	
Not known	704	56	8.0	0.64 (0.39-1.06)	
Parity					0.0176
2 to 4	3,120	230	7.4	1.00	
1	1,915	179	9.3	1.37 (1.08-1.73)	
5 and more	901	76	8.4	0.93 (0.68-1.27)	
Maternal schooling (years)					0.0551
12 and more	439	16	3.6	1.00	
4 to 11	3,861	309	8.0	2.17 (1.18-4.00)	
<4	1,530	147	9.6	2.44 (1.28-4.63)	
Not known	267	32	12.0	1.82 (0.66-4.99)	
Maternal smoking					<0.001
No	4,172	258	6.2	1.00	
Yes	1,620	195	12.0	2.08 (1.68-2.59)	

*Model excluding values for those variables with few missing data. Reduced model obtained after backward elimination adjusted for all variables shown in this table.

Table 4 - Crude and sequentially adjusted year effect for low birth weight among vaginal deliveries. Ribeirão Preto, Brazil, 1978/79 and 1994.

Variables	OR (95% CI)
Adjusted only for survey factor	1.32 (1.08 - 1.62)
Survey factor plus preterm birth	1.14 (0.91 - 1.42)
Above factors plus maternal smoking	1.37 (1.08 - 1.73)
Above factors plus parity	1.37 (1.08 - 1.73)
Above factors plus non-cohabitation	1.32 (1.04 - 1.67)
Above factors plus gender	1.31 (1.03 - 1.66)
Above factors plus maternal schooling	1.33 (1.04 - 1.69)
Above factors plus prenatal visits	1.40 (1.09 - 1.79)

ery newborns in 1994 represented a selected cohort of poorer families with poor obstetric and neonatal outcomes. Results of the present study show that, in contrast to the childbearing population as a whole, the percentage of better qualified people and higher schooling decreased among mothers who had vaginal delivery.

The association between cesarean section and LBW tended to cover up socioeconomic differences in the likelihood of LBW. After a restricted analysis based on a selected sample including only vaginal deliveries, mothers with low levels of schooling had a greater risk of LBW. This indicates that socioeconomic differences came up again.

It has been shown that alcohol consumption and illicit drug use are closely related to increased risk of LBW (Brooke et al,⁵ 1989). In Ribeirão Preto, illicit drug use and alcohol consumption are high among teenagers (8.5% reported daily use of alcohol and 56.4% monthly consumption) (Muza et al,¹³ 1997). Alcohol consumption was the same among

social classes but illicit drug use was higher among better-off teenagers (Muza et al,¹⁴ 1997). The highest illicit drug use among better-off teenage mothers could play a role in the more marked decrease in mean birth weight among newborns of better-off mothers. Other potential causes that may explain this phenomenon, such as psychosocial stress, occupational hazards, deterioration of the health services quality in the city, genital infectious or iatrogenic practices associated with childbirth care, were not studied here.

There is some evidence regarding low quality of perinatal care in Brazil. The neonatal death rate, especially within the first 6 days of life, is decreasing very slowly. The reasons for this remain poorly understood. In the State of Rio de Janeiro, it has been shown that neonatal deaths due to respiratory ailments of the fetus and newborn are increasing and the causes of death said to be reducible by "adequate pregnancy monitoring and delivery care" and "early diagnosis and treatment" remain unchanged (Leal & Szwarcwald,¹² 1996).

The increasing use of ultrasound-based estimates of gestational age was one of the factors associated with an increase in the preterm birth rate in Canada (Kramer et al,¹¹ 1998). Despite the fact that there was an increase in ultrasound-based estimates of gestational age between these two decades, in this study the last menstrual period was used to assess gestational age. So, increasing frequency of ultrasound examination was not a factor in Ribeirão Preto. Changes in registration practices, resulting in a shift from stillbirths to live births at early gestational ages,

have not affected the estimates. To minimize this influence newborns weighing less than 500 grams were excluded from the analysis. Moreover, there was no clear increase in more premature births from the 35th week of gestation downwards.

It remains unclear whether this increasing trend in LBW rate is restricted to Ribeirão Preto. It is not known whether the same occurred in other Brazilian cities. The only information available is from the city of Pelotas, where an increase in LBW rate was also reported, although lower than the one seen in Ribeirão Preto (Horta et al,⁹ 1996).

It seems that factors associated with the increase in LBW rate in Ribeirão Preto are running in two ways. One trend is stronger and acts upon most affluent women, those who predominantly use the private health sector. Malpracticing cesarean section delivery seems to be the most important factor in this population (Gomes et al,⁸ 1999). The other one is weaker and affects socially deprived women assisted by the National Health Service and whose pregnancy is a burden. The present results also point out to the fact that the increase in the proportion of preterm birth and non-cohabiting women plays an important role in the increasing LBW rate among vaginal deliveries.

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