Infant mortality and low birth weight in cities of Northeastern and Southeastern Brazil

Mortalidade infantil e baixo peso ao nascer em cidades do Nordeste e Sudeste, Brasil

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Abstract

Objective

To compare estimates of low birth weight (LBW), preterm birth, small for gestational age (SGA), and infant mortality in two birth cohorts in Brazil.

Methods

The two cohorts were performed during the 1990s, in São Luís, located in a less developed area in Northeastern Brazil, and Ribeirão Preto, situated in a more developed region in Southeastern Brazil. Data from one-third of all live births in Ribeirão Preto in 1994 were collected (2,839 single deliveries). In São Luís, systematic sampling of deliveries stratified by maternity hospital was performed from 1997 to 1998 (2,439 single deliveries). The chi-squared (for categories and trends) and Student t tests were used in the statistical analyses.

Results

The LBW rate was lower in São Luís, thus presenting an epidemiological paradox. The preterm birth rates were similar, although expected to be higher in Ribeirão Preto because of the direct relationship between preterm birth and LBW. Dissociation between LBW and infant mortality was observed, since São Luís showed a lower LBW rate and higher infant mortality, while the opposite occurred in Ribeirão Preto.

Conclusions

Higher prevalence of maternal smoking and better access to and quality of perinatal care, thereby leading to earlier medical interventions (cesarean section and induced preterm births) that resulted in more low weight live births than stillbirths in Ribeirão Preto, may explain these paradoxes. The ecological dissociation observed between LBW and infant mortality indicates that the LBW rate should no longer be systematically considered as an indicator of social development.

Resumo

Objetivo

Comparar as estimativas das taxas de baixo peso ao nascer, prematuridade, pequeno para a idade gestacional e mortalidade infantil em duas coortes de nascimento no Brasil.

Métodos

As duas coortes foram realizadas na década de 90 em São Luís, localizada em uma

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região menos desenvolvida, no Nordeste, e em Ribeirão Preto, situada em uma região mais desenvolvida, no Sudeste. Foram coletados dados de um terço dos nascidos vivos de Ribeirão Preto, SP, em 1994 (2.839 partos únicos); em São Luís, MA, foi realizada amostragem sistemática de partos estratificada por maternidade, no período de 1997/98 (2.439 partos únicos). Os testes do qui-quadrado (categórico e para tendências) e t de Student foram usados na análise estatística.

Resultados

A taxa de baixo peso ao nascer foi menor em São Luís, constituindo um paradoxo epidemiológico. As taxas de prematuridade foram semelhantes, quando se esperava percentual mais elevado em Ribeirão Preto, por sua relação direta com o baixo peso ao nascer. Observou-se dissociação entre baixo peso ao nascer e mortalidade infantil, pois São Luís apresentou menor baixo peso ao nascer e maior mortalidade infantil, ocorrendo o inverso em Ribeirão Preto.

Conclusões

Maior prevalência de tabagismo materno e melhor acesso e qualidade da assistência perinatal promovendo intervenções médicas mais precoces (cesárea e prematuridade induzida) que resultam em maior número de nascidos vivos com baixo peso do que natimortos em Ribeirão Preto podem explicar estas discrepâncias. A dissociação ecológica observada entre baixo peso ao nascer e mortalidade infantil sugere que a taxa daquele não deve mais ser considerada sistematicamente como indicador de desenvolvimento social.

INTRODUCTION

The perinatal health situation in Brazil has been little investigated and, because of the limitations of the existing information systems, low birth weight (LBW), preterm birth rates and their respective risk factors are mostly unknown. The perinatal mortality rate is also practically unknown in many places, due to the lack of reliable records, especially with respect to fetal death. The "Sistema de Informação Sobre Nascidos Vivos (SISNASC)" (Live Birth Information System) has poor coverage in some towns, thus impairing the calculation of valid estimates. In addition, SINASC data do not provide the birth rate for children that were small for gestational age (SGA), because gestational age is defined in intervals and not in complete weeks, thus preventing the calculation of birth weight percentiles in relation to gestational age.

The existence of reliable statistics is of extreme importance for the general evaluation of population data. The lack of valid information impairs the planning and evaluation of health actions.

Few population-based cohort studies have been carried out in Brazil. Its perinatal health situation has been assessed in some epidemiological studies using representative samples of the birth population.[2,3,6,7,15-17] These studies employed systematic methodology and were representative of the towns where the studies were carried out.

Birth weight is the most important single determining factor for infant survival, since children with LBW (less than 2,500 g) are at much higher risk of death or illness during the first year of life.[14] Various factors can interfere with birth weight, such as the duration of pregnancy and intrauterine growth. Belizán & Villar[5] pointed out that delivery of SGA children is the main factor responsible for LBW in developing countries, while in developed countries this condition is mainly the result of preterm delivery.

In the present study, LBW, preterm birth, SGA and infant mortality estimates were compared in two cohort studies.

METHODS

Study area

The city of Ribeirão Preto is located in the northwest of the State of São Paulo, with a population of 457,653 inhabitants in 1997. Ribeirão Preto is one of the most developed cities in the country, with 99% of homes receiving piped city water and having sanitary facilities. It has one of the highest *per capita* incomes in the country, of about US$ 5,600 per annum. Its main economic activity is the sugar cane agricultural industry, in addition to commerce and services. The city is also a regional university center of excellence. In 1994, Ribeirão Preto possessed 10 maternity hospitals.[6]

The city of São Luís, the capital of the State of Maranhão, is situated on an island on the northern

coast of the state, with a population of 801,895 inhabitants in 1997. São Luís is located in one of the poorest regions of the country, where only 50% of the homes are connected to a sewer network and only about 75% receive piped water. Its economic activity is associated with the aluminum steel industry and ore exportation from the Serra de Carajás, in addition to commerce and services. São Luís possessed 18 maternity hospitals in 1997.[16]

Population studies

The population studies were carried out in the 1990s in these two cities from different regions in Brazil. The cohort data from Ribeirão Preto were collected during a period of four consecutive months (May to August 1994), during which all live births were registered, giving a total of 3,663 observations. Considering only the live births from single deliveries from families living in the municipality of Ribeirão Preto, the sample consisted of 2,839 births. A period of four months was chosen because of a previous study in which no seasonality of birth distribution or LBW and preterm birth rates was observed.[2,6]

The cohort data from São Luís were obtained by means of systematic sampling of deliveries stratified by maternity hospital. One in every seven births was systematically selected from the birth lists at each hospital. A total of 2,831 women were interviewed and 2,439 live births from single deliveries from families living in the municipality of São Luís were considered. Hospital births represented about 96.3% (95% CI: 94.1-98.6%) of all births in 1996, thus assuring the representativeness of the hospital birth sample.[16] The study was carried out at 10 maternity units, including public and private ones, over a one-year period. Maternity units with less than 100 deliveries in 1996, corresponding to only 2.2% of deliveries in that year, were excluded from the sample. Therefore, the study included 94% of the hospital births that occurred during this period.

Standardized questionnaires were used in the two studies, with small differences between them. The methodology was basically the same and has been described in detail elsewhere.[6,16] Cases for which no information was available after the birth were excluded (3.2% in Ribeirão Preto and 5.8% in São Luís).

Anthropometric examination

The newborn was submitted to anthropometric examination soon after birth. Birth weight was determined using a baby-type balance, with 10-g graduations. The child was weighed without clothing and,

when he/she was crying, the weight was obtained after deep inspiration. The scales used in the hospitals were periodically monitored and replaced in the event of defects. The cohorts used the same technique. Birth weight was classified as low birth weight (<2,500 g) or non-low birth weight (≥2,500 g).

Preterm birth

For the Ribeirão Preto cohort, gestational age was calculated based on the date of the last normal menstrual period reported by the mother and, when not remembered, the date was classified as unknown. In São Luís, day 15 was adopted for those cases in which the last day of the normal menstrual period was unknown.

Because of errors in reported dates for the last normal menstrual period, which tend to overestimate the preterm birth rate,[13] birth weights incompatible with the dates of the last normal menstrual period that were above the 99th percentile of the English curve[1] were reclassified as unknown. The same procedure was employed in cases with an unlikely gestational age (less than 20 or more than 50 weeks). Finally, an imputation process was followed for all cases with unknown date or with the date reclassified as unknown, using a regression model that included birth weight, parity, family income and the sex of the newborn.[16] Newborns with a gestational age of less than 37 weeks were classified as preterm.

The classification of birth weight according to gestational age was based on the curve proposed by Williams et al.[18] Children weighing below the 10th percentile were classified as small for gestational age.

Statistical analysis

The chi-squared test (for categories or trends) was used to compare proportions and the Student t test to compare means between the two cities. The Stata 6.0 program was used for statistical analysis.

RESULTS

The incidence of LBW infants was higher in Ribeirão Preto (10.7%) than in São Luís (7.6%) (p<0.001). The very low birth weight rates were 1.3 and 1.1% in Ribeirão Preto and São Luís, respectively (p=0.497). No significant difference in the preterm birth rate (p=0.391) or percentage of SGA births (p=0.137) was observed between the two cities. However, infant mortality was higher in São Luís than in Ribeirão Preto (p=0.014) (Table 1). Among LBW children, 59.4% in Ribeirão Preto and 51.1% in São Luís were preterm.
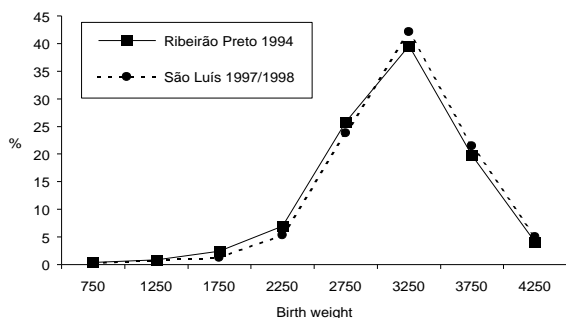
Figure 1 - Birth weight distribution in the cities of São Luís and Ribeirão Preto, Brazil.

Figure 1 shows the birth weight distribution per 500 g group in the two cities. The distribution of birth weight in Ribeirão Preto was shifted to the left compared to São Luís. The mean birth weight was 63 g lower in Ribeirão Preto than in São Luís (3,113 *vs* 3,176 g, p<0.05), whereas the standard deviation was higher (554 *vs* 530 g).

As shown in Figure 2, there were small differences in mean birth weight distribution according to gestational age between the two cities (from 37 to 45 weeks). However, among preterm newborns, the mean weight for gestational age was higher in São Luís than in Ribeirão Preto.
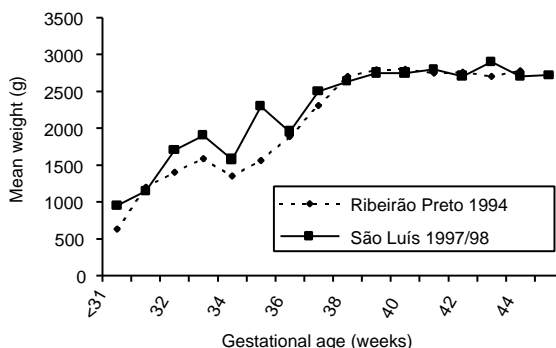

Figure 2 - Mean birth weight according to gestational age in the two cities in Brazil.

Table 2 shows the prevalence of LBW, preterm birth and SGA births according to family income (expressed as the number of minimum salaries) in the two cities. Only Ribeirão Preto showed a marked difference between family income and birth weight. There was no linear trend in the association between family income and preterm birth. The SGA rate was negatively associated with family income in both cities.

DISCUSSION

The LBW rate was higher in Ribeirão Preto, while infant mortality was higher in São Luís. Preterm and

Table 1 - Birth weight, gestational age, births that were small for gestational age and infant mortality in the cities of Ribeirão Preto and São Luís, Brazil, during the 1990s.

Variables	Ribeirão Preto 1994		São Luís 1997/98	
	f	%	f	%
Birth weight (g)				
<1,500	36	1.3	26	1.1
1,500–2,499	267	9.4	160	6.5
≥2,500	2,536	89.3	2,253	92.4
Gestational age (weeks)				
≥37	2,480	87.3	2,132	87.4
33–36	307	10.8	250	10.3
≤32	52	1.7	57	2.3
Small for gestational age				
Yes	364	12.8	347	14.2
No	2,475	87.2	2,092	85.8
Infant mortality*				
Yes	47	16.6	64	26.2
No	2,792	83.4	2,375	73.8
Total	2,839	100.00	2,439	100.00

*Calculated per 1,000 live births.

Table 2 - Prevalence of low birth weight, preterm birth and births that were small for gestational age, according to family income in the two cities of Brazil during the 1990s.

Family income	Low birth weight						Preterm birth						Small for gestational age					
	Ribeirão Preto			São Luís			Ribeirão Preto			São Luís			Ribeirão Preto			São Luís		
	N	f	%	N	f	%	N	f	%	N	f	%	N	f	%	N	f	%
≤1	237	31	13.1	786	67	8.5	237	32	13.5	786	108	13.9	237	42	17.7	786	132	16.8
1.1-3	593	75	12.6	718	43	6.0	593	84	14.2	718	66	9.2	593	86	14.5	718	99	13.8
3.1-6	485	38	7.8	412	34	8.3	485	50	10.3	412	63	15.3	485	71	14.6	412	47	11.4
6.1-10	299	22	7.4	157	11	7.0	299	29	9.7	157	18	11.5	299	29	9.7	157	23	14.7
>10	395	36	9.1	203	12	5.9	395	58	14.7	203	23	11.3	395	36	9.1	203	16	7.9
Unknown	830	101	12.2	163	19	11.7	830	106	12.8	163	28	17.2	830	100	12.1	163	30	18.4
		p=0.010			p=0.323			p=0.368			p=0.220			p<0.001			p=0.001	
Total	2,839	303	10.7	2,439	186	7.6	2,839	359	12.7	2,439	307	12.6	2,839	364	12.8	2,439	347	14.2

SGA birth rates were similar. The prevalence of SGA newborns increased as the family income decreased, while preterm birth did not show any variation and an increase in the LBW rate according to decreasing family income was only observed in Ribeirão Preto.

The present study showed a series of contradictions between perinatal indicators and the socioeconomic conditions of the two cities: why did Ribeirão Preto, although more developed than São Luís, show a higher LBW rate, if LBW is considered to be an indicator of social development? Why did Ribeirão Preto, with a higher LBW rate, present lower infant mortality than São Luís, if low birth weight is the factor most strongly associated with infant mortality? Despite the differences in LBW rates between the two cities, why did they show similar preterm and SGA birth rates? Why was a social difference in LBW only observed in Ribeirão Preto?

It can be seen that there is an epidemiological paradox between the two cities. Such situations have also been reported in studies from other countries that compared LBW rates between two ethnically different populations; for example, the epidemiological paradox between Latin women living in the United States and white American women. Latin women showed a lower LBW rate than for white American women, despite their socioeconomic disadvantage.[9] A similar paradox was reported by Baruffi et al[4] in Hawaii between Samoan and Caucasian women, with a higher LBW rate being observed for children born to Caucasian women of a better socioeconomic level.

Several hypotheses can be raised to explain the higher LBW rate observed in Ribeirão Preto. One explanation is the higher percentage of cesarean sections in Ribeirão Preto in comparison with São Luís (51.1 *vs* 33.2%). Previous studies[15,17] have shown an association between LBW and cesarean section rate in the two cities, with the population-attributable risk of cesarean section, in relation to LBW, being higher in Ribeirão Preto than in São Luís (20 *vs* 10.9%).

Another plausible hypothesis is the better perinatal care in Ribeirão Preto, which leads to the survival of fetuses that would otherwise be stillbirths. However, these survivors are live births with LBW. This may have contributed to the lower mean birth weight for each gestational age among preterm births observed in this city.

The higher prevalence of maternal smoking in Ribeirão Preto, in comparison with São Luís (21.4 *vs* 6.3%), is another possible explanation, since this habit represents a risk factor for LBW.[12]

It is also possible that, in São Luís, a large proportion of live births that die within the first hours of life are erroneously considered stillbirths, a fact that tends to underestimate LBW rates in these groups, especially among poorer classes. This fact has been observed in other studies, in relation to fetuses weighing less than 500 g, but may also be true for newborn infants with a higher birth weight.[11]

The preterm birth rate was expected to be higher in Ribeirão Preto than in São Luís due to the higher LBW rate observed in the former. However, similar preterm birth rates were observed for the two cities and preterm newborns showed a higher mean birth weight according to gestational age in São Luís. This finding might be due to bias in the determination of gestational age, which was calculated based on the date of the last normal menstrual period, because errors in reported date are more common in populations of low socioeconomic level.[8] Kramer et al[13] concluded that women of low sociocultural level mistake bleeding due to blastocyst implantation for menstrual bleeding. Therefore, the preterm birth rate in São Luís may have been overestimated and some of these erroneously classified preterm newborns contributed towards increasing the mean weight for gestational age among preterm births.

The similarity in SGA rates between the two cities may be explained by an equilibrium between two risk factors: socioeconomic factors were more prevalent in São Luís,[16] while the prevalence of maternal smoking was higher in Ribeirão Preto.[15]

Despite the higher LBW rate in Ribeirão Preto, in comparison with São Luís, infant mortality was lower in the former, probably due to better medical care and better socioeconomic conditions.

In contrast to São Luís, Ribeirão Preto showed differences in birth weight distribution according to family income. This fact may be explained by the hypothesis stated above, i.e., under-registration of live births among the poorer classes of São Luís. In addition, a higher rate of cesarean sections was observed for the wealthier classes in São Luís, probably leading to higher preterm birth and LBW rates. Differences in low birth weight according to family income were also reported for Pelotas in 1993.[10]

The present study shows some limitations. Estimation of gestational age based on the date of the last normal menstrual period is prone to error.[13] In addition, differences in methods used for dealing with unknown information regarding the date of the last normal menstrual period occurred. In São Luís, day

15 was adopted, while in Ribeirão Preto the date was classified as unknown. Differences in cultural perceptions of fetal viability was another limiting factor, which might have interfered with the birth records, with more live births being considered stillbirths in one city than in the other. The sample had an 80% power to detect differences of 2.5% or more among indicators from the two cities.

To reduce the differences due to errors in gestational age estimation, infants with weights incompatible with gestational age were excluded from the analysis. One aspect conferring reliability on the study was the standardization of the weight measurement performed under supervision in the two studies.

Regardless of the hypotheses for explaining the paradoxes identified, one conclusion can be derived from the present data. This is that the ecological dissociation observed between LBW and infant mortality indicates that the LBW rate should no longer be systematically considered as an indicator of social development. Differences in the access to and quality of perinatal medical care are possibly one of the factors responsible for this apparent epidemiological paradox.

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