Changes in perinatal health in two birth cohorts (1997/1998 and 2010) in São Luís, Maranhão State, Brazil

Mudanças na saúde perinatal em duas coortes de nascimento (1997/1998 e 2010) em São Luís, Maranhão, Brasil

Cambios en la salud perinatal en dos cohortes de nacimiento (1997-1998 y 2010) en São Luís, Maranhão, Brasil

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Abstract

The objective of this study was to analyze changes in perinatal health in two birth cohorts started in 1997/1998 and 2010, respectively, in São Luís, Maranhão State, Brazil. A total of 2,493 live born infants were included in 1997/1998 and 5,166 in 2010. Low birth weight (LBW) rate did not change (8.5% in 1997/1998 and 8.6% in 2010). Preterm birth (PTB) rate also remained stable (13.2% in 1997/1998 and 13% in 2010). Teenage deliveries and births to single mothers decreased. Maternal schooling and prenatal care coverage increased. Intrauterine growth restriction (IUGR) decreased from 13.3% to 10.6% (p < 0.001). The perinatal mortality rate decreased from 36.6 to 20.7 per 1,000 (p < 0.001) and the infant mortality rate (IMR) dropped from 28.5 to 12.8 per 1,000 (p < 0.001). The cesarean rate increased from 34.1% to 47.5% (p < 0.001). In conclusion, despite favorable changes in sociodemographic, behavioral, and health service factors and decreasing rates of IUGR and perinatal and infant mortality, LBW and PTB remained stable, while the cesarean rate increased.

Low Birth Weight Infant; Premature Birth; Fetal Growth Retardation; Cesarean Section; Cohort Studies

Resumo

O objetivo deste estudo foi analisar as mudanças na saúde perinatal em duas coortes de nascimento realizadas em 1997/1998 e 2010, em São Luís, Maranhão, Brasil. Um total de 2.493 nascidos vivos foi incluído em 1997/1998 e 5.166 em 2010. A taxa de baixo peso ao nascer (BPN) não se modificou (8,5% em 1997/1998 e 8,6% em 2010). A taxa de nascimento pré-termo (NPT) também permaneceu estável (13,2% em 1997/1998 e 13% em 2010). Nascimentos em adolescentes e em mulheres sem companheiro decresceram. A escolaridade materna e a cobertura do pré-natal aumentaram. A taxa de restrição de crescimento intrauterino (RCIU) diminuiu de 13,3% para 10,6% (p < 0,001). A taxa de mortalidade perinatal foi reduzida de 36,6 para 20,7 por mil (p < 0,001) e a taxa de mortalidade infantil diminuiu de 28,5 para 12,8 por mil (p < 0,001). A taxa de cesárea (TC) aumentou de 34,1% para 47,5% (p < 0,001). Apesar das mudanças favoráveis nas variáveis sociodemográficas, comportamentais e de serviços de saúde e da redução nas taxas de RCIU, mortalidade perinatal e infantil, as taxas de BPN e NPT permaneceram estáveis, enquanto a TC aumentou.

Recém-Nascido de Baixo Peso; Nascimento Prematuro; Retardo do Crescimento Fetal; Cesárea; Estudos de Coorte

Introduction

Temporal analysis of maternal and child health indicators allows evaluating socioeconomic changes and advances and setbacks in the availability and quality of health services [1]. Repeated population-based studies [2,3] are best suited to analyze changes in most perinatal health indicators when compared to information systems analysis. Coverage problems, underreporting, and lack of standardized information, especially for gestational age (GA), in the Brazilian Live Birth Information System (SINASC) limits the use of data for assessing changes in perinatal indicators over time [4]. Thus, serial cohort studies are one of the most important tools for the evaluation of temporal changes in social determinants and their effects on health conditions [5,6].

Population-based cohort studies have been conducted in two Brazilian cities, allowing temporal analysis of maternal and child health indicators. In Ribeirão Preto, São Paulo State, Southeast Brazil, the first cohort was started in 1978/1979, followed by a second in 1994. In Pelotas, Rio Grande do Sul State, in the South of Brazil, three cohort studies were started at 11-year intervals (1982, 1993, and 2004), allowing evaluation of temporal trends in maternal and child health indicators.

Preterm birth (PTB) rates have increased even in developed countries that have already achieved advances in the organization of health services for women and children [2,7,8,9,10,11]. The global PTB rate was estimated at 11.1% in 2010, with marked continental differences [12]. Cohort studies in the Southeast and South of Brazil have indicated an increasing PTB trend since the 1990s (9.10), reaching 13.6% in Ribeirão Preto-1994 [13] and 14.7% in Pelotas-2004 [14].

Low birth-weight (LBW) rates have also increased around the world in the last 20 years [2,7,8,9,10,11]. The LBW rate increased from 8.5% in 1996 to 9.1% in Brazil's state capitals [15]. Temporal analysis in the Ribeirão Preto cohorts also showed an increase in the LBW rate from 7.2% in 1978/1979 to 10.6% in 1994 [16], but comparison of the 1982 and 2004 birth cohorts showed that LBW has not increased in Pelotas [14].

Intrauterine growth restriction (IUGR) rate, estimated as the percentage of small-for-gestational-age (SGA) newborns, was 27% in low and middle-income countries in 2010 [17]. In Brazilian cohorts, the rate increased in Ribeirão Preto from 1978/1979 to 1994 [18], but in Pelotas it decreased from 14.8% in 1982 to 12% in 2004 [14].

The cesarean rate, another important indicator of maternal and child health, increased from 38% in 2001 to 48.8% in 2008 in Brazil [19]. The same trend was seen in the cohorts in Ribeirão Preto, where cesareans accounted for half of all births in 1994 [20], a rate far higher than the levels considered acceptable by the World Health Organization (WHO) [21,22].

From 1930 to 1970, Brazil witnessed a reduction of approximately 1% per year in the infant mortality rate (IMR). However, the IMR did not decrease evenly between the neonatal and postnatal components. Neonatal deaths represented 68% of the IMR in 2008, and their reduction from 2000 to 2008 (3.2% per year) continued to be less than the drop in the postnatal mortality rate (PNMR) (8.1% per year) [19]. The two components of the IMR decreased by similar proportions in Ribeirão Preto from 1978-79 to 2004 [23]. In Pelotas, the neonatal and post-neonatal mortality rates declined from 1982 to 1993, but the neonatal component failed to show a clear decline from 1993 to 2004 [7].

The stillbirth rate (SBR) has also decreased in Brazil. Data for Brazil's state capitals show that the SBR fell from 14.1 per 1,000 in 1996 to 9.3 per 1,000 in 2010 [15]. In Pelotas, the late fetal mortality rate has also declined substantially in the last three decades [7].

São Luís, Maranhão State, started its first birth cohort in 1997-1998 [24], followed by a second in 2010. The two consecutive cohorts allowed a temporal analysis of maternal and child health in the city. The objectives of the current study were to analyze perinatal outcomes, socio-demographic and behavioral factors and use of health and perinatal services in a new birth cohort (BRISA – Brazilian Ribeirão Preto and São Luís birth cohort studies) started in 2010 and to compare these indicators to those from a cohort started 12 years earlier.

Methods

Study site

São Luís is the capital of Maranhão State in Northeast Brazil, one of the country's poorest regions. The city's Human Development Index was 0.658 in 2000, increasing to 0.768 in 2010, currently ranking 249th in the country [25]. The city's population was 1,014,837 in 2010 (Brazilian Institute of Geography and Statistics. http://www.censo2010.ibge.gov.br/sinopse/index.php?uf=21&dados=1, accessed on 12/Jul/2012).

The data in the two birth cohorts are population-based. The first cohort was assembled from March 1997 to February 1998 and included 2,831 hospital births. Details of the methods have been published elsewhere [24]. The second cohort,

called BRISA, was assembled from January to December 2010 and consisted of 5,236 hospital births involving a population-based sample of deliveries in the municipality.

In São Luís, hospital births comprised 96.3% of the 1997/1998 births [24] and 98% of the 2010 births. Maternity hospitals with fewer than 100 deliveries per year were excluded from the two studies (2.2% of deliveries in 1997/1998 and 3.3% in 2010). The target population thus consisted of 94.1% of all deliveries in 1997/1998 and 94.7% in 2010.

The sample was stratified according to hospital of birth. Probability of selection was proportional to the number of deliveries in each hospital. Systematic sampling was performed in each maternity hospital. All live births and stillbirths were listed by order of occurrence. A random number from 1 to 7 in 1997/1998 and from 1 to 3 in 2010 was generated to determine the random start in each hospital. Thus, one out of every seven deliveries in 1997/1998 and one out of three in 2010 were selected at random for interviewing the mothers. Losses due to refusal or early discharge totaled 5.8% in 1997/1998 and 4.6% in 2010.

The current study only included data for live births ≥ 20 weeks of GA or weighing ≥ 500g and born to mothers residing in the municipality. In 1997/1998, 290 live births to non-resident mothers and 48 stillbirths were excluded, so the final sample included 2,493 births.

In 2010, 21,401 births occurred at the selected units, one-third of which were picked by drawing lots (7,133). Of these, 5,475 births were to mothers residing in the municipality for at least three months and therefore eligible for the study. The sample consisted of 5,236 postpartum women, and after the exclusion of 70 stillbirths it consisted of 5,166 births (Figure 1).

The sample size for 2010 was calculated based on the number of hospital births that had occurred in São Luís in 2007. The minimum sample size was set at 5,000 births. This sample size allowed estimating prevalence rates around 50% (entering 50% as the estimated prevalence that results in the highest sample size) with 2% relative precision and 99% confidence level. It was also possible to compare two proportions considering a 5% probability of type I error and 80% study power, working with the maximum product of p x q (50% proportion of the event) and setting the minimum significant difference for detection at 4%. For prevalence rates of less than 50% it would be possible to detect smaller differences (it was possible to detect a 3% relative difference for a prevalence rate of 10% and a 2% relative difference for a prevalence rate of 5%) [26].

The following descriptions apply to both cohorts unless stated otherwise.

Properly trained undergraduate health students collected the data. A pilot study was conducted with simulation of all research steps at all hospital units for 24 hours. Supervision and quality control procedures were performed daily.

Data collection was performed in shifts, usually from 7:00 PM to 7:00 AM for the first shift and from 7:00 AM to 7:00 PM for the second. A form was elaborated for listing all births and recording the interviews, containing the ordered list of births, mother's name and address, whether she resided in the municipality (yes/no), date and time of delivery, number of newborns, whether the interview was held (yes/no), refusal, or discharge. Births were registered in order of occurrence with the time of birth.

The mothers were interviewed during the first 24 hours postpartum. Two standardized questionnaires with questions on the mother and newborn were used. The variables were monthly family income in minimum wages (≤ 1, 1.1 to 1.9, 2 to 2.9, 3 to 4.9, 5 to 9.9, and ≥ 10), head-of-family's occupation (non-manual, managerial and upper-level professionals, medium-level managerial, skilled manual, semi-skilled manual, unskilled manual, unemployed), number of household members (1 to 4, ≥ 5), economic class according to the Brazilian Economic Classification (CEB) – (A, B, C, D, and E, with class A being the wealthiest and best educated and class E the poorest and least educated), maternal work outside the home (yes/no), maternal schooling in years (none, 1-4, 5-8, 9-11, ≥ 12), maternal age in years (< 20, 20-34, ≥ 35), self-reported maternal skin color (white, black, brown, or other), marital status (married, common-law union, or single), religion (Catholic, Evangelical, Spiritist, or other), parity (1, 2, 3-4, ≥ 5), alcohol consumption during pregnancy (yes if at least one dose of alcoholic beverage per week or no otherwise), maternal smoking during pregnancy (yes if at least one cigarette per day during pregnancy or no otherwise), maternal consumption of coffee during pregnancy (yes if at least one cup a day or no otherwise), previous stillbirth (yes/no), previous miscarriage or induced abortion (yes/no), prenatal care during the index pregnancy (yes/no), number of prenatal visits (0, 1-3, 4-5, ≥ 6), time at first prenatal visit (first, second, or third trimester of pregnancy), category of prenatal care (Brazilian Unified National Health System – SUS, health plan/insurance, or out-of-pocket), type of delivery (vaginal or cesarean), tubal ligation following cesarean delivery (yes/no), professional that assisted the delivery (physician, nurse, or other), whether the same physician provided the

Figure 1

Flowchart of the BRISA cohort study. São Luís, Maranhão State, Brazil, 2010.
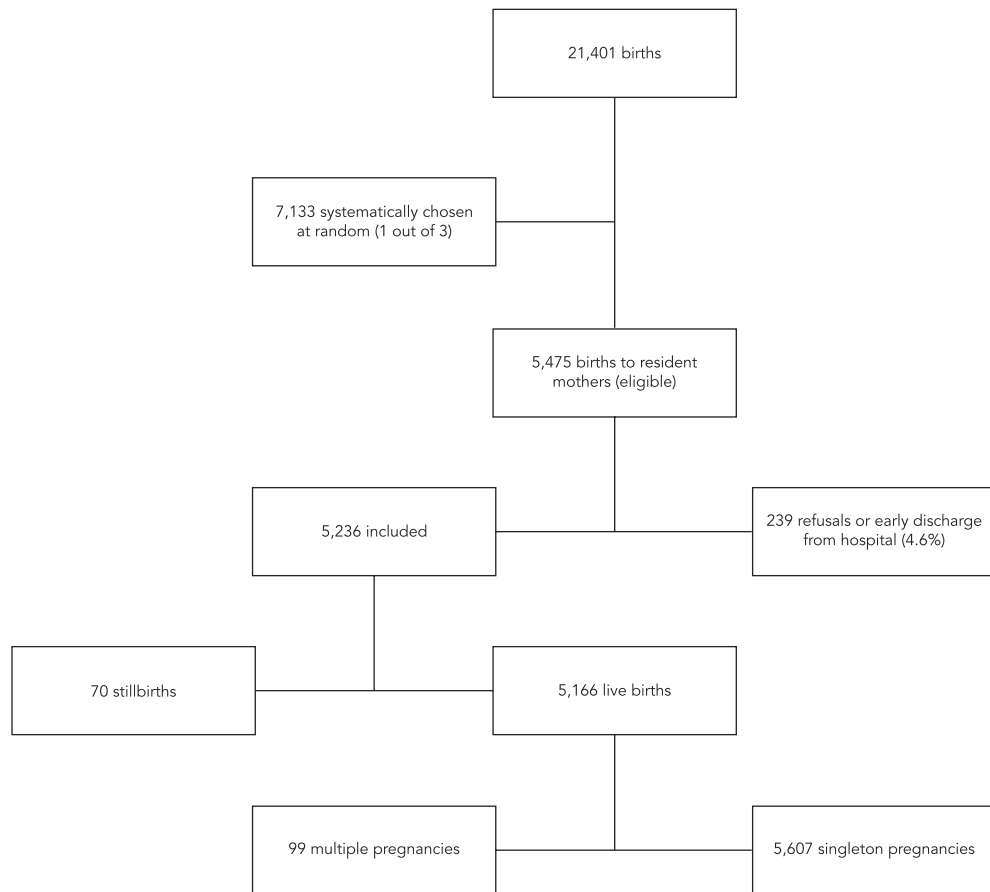
prenatal care and assisted the delivery (yes/no), category of admission for labor and childbirth (SUS, health plan/insurance, or out-of-pocket), newborn's sex (male, female), LBW defined as < 2,500g (yes/no), PTB defined as < 37 weeks GA (yes/no), newborn's weight-for-GA classification according to Williams et al. [27] (small, adequate, or large for GA), professional that assisted the newborn (pediatrician/neonatologist, obstetrician, anesthesiologist, nurse, nursing technician, or other), and determination of Apgar score in the delivery room (yes/no).

The monthly minimum wage was BRL 120.00 in 1997, corresponding to USD 110.80, and BRL 510.00 in 2010, corresponding to USD 291.54.

Newborns were weighed with no clothing using electronic scales accurate to 5g immediately after delivery. IUGR rate was estimated as the percentage of SGA < 10 percentile according to Williams et al. [27].

GA was based on the date of the last normal menstrual period (LNMP) reported by the mother. Day 15 was imputed for all cases for which the date of the LNMP was unknown. Birth weights above the 99th percentile of the British reference curve [28], considered inconsistent with GA, namely 69 cases in 1997 and 104 in 2010, were recoded as missing. Cases of implausible GA (less than 20 and more than 43 weeks) were also classified as missing. GA was imputed in a regression model containing birth weight, parity, monthly per capita family income, and newborn's sex. In 1997/1998, 204 cases were imputed (8.2%), 9 as preterm and 195 as term births whereas in 2010 a total of 452 cases were imputed (8.7%), 43 of which as preterm and 409 as term births.

Perinatal mortality rate (PMR) was estimated by dividing the number of stillbirths with 20 or more weeks GA plus early neonatal deaths (up to the 6th day of life) by the total number of live births and stillbirths multiplied by 1,000. SBR was calculated by dividing the number of stillbirths by the total number of live births and stillbirths multiplied by 1,000. Neonatal mortality rate (NMR) was calculated by dividing the number of deaths of infants less than 28 days of age by the total number of live births multiplied by 1,000. The IMR was calculated by dividing the number of deaths of infants less than one year of age by the total number of live births multiplied by 1,000. Neonatal and infant deaths for the BRISA cohort were identified through linkage of birth cohort data with mortality registry data. Probabilistic record linkage using the variables mother's name and newborn's date of birth and sex was performed using the RecLink statistical package [29]. Following three stages (standardization, blocking, and record pairing), pairs were classified based on threshold scores into true, false, and doubtful. Final doubts were checked and corrected manually.

Data processing and statistical analysis

Data were entered in duplicate in Microsoft Office Access 2007 (Microsoft Corp., USA), and the two entries were compared and errors corrected. Data were analyzed with Stata 12.0 (Stata Corp., College Station, USA). Absolute frequencies and percentages were calculated in descriptive analyses. The chi-square test was used to compare proportions between the two birth cohorts. The 95% confidence interval (95%CI) was calculated for PMR, SBR, IMR, and NMR based on the Poisson distribution.

Ethical aspects

The study complied with Resolution n. 196/96 of the Brazilian National Health Council and its complementary norms. Mothers who agreed to participate in the study gave written informed consent. Participants had the option to drop out of the study at any time during without any harm to themselves or their families. The project and the informed consent form were approved by the Ethics Research Committee of the UFMA University Hospital (protocol n. 4771/2008-30).

Results

In 2010, a total of 5,166 births were included in the study, considering only live births to moth-ers residing in São Luís. Most births (84.4%) occurred at the five main city hospitals (public or outsourced by the SUS).

Table 1 lists the families' socioeconomic, demographic, reproductive, and lifestyle characteristics. Table 2 shows the prenatal care and childbirth characteristics. Prenatal care coverage was 98%. The SUS was responsible for 79.9% of the prenatal care visits and 84.1% of the deliveries (Table 2).

Table 3 lists some newborn characteristics and perinatal and health care outcomes. The LBW rate was 8.6% and the PTB rate was 12.9%. Only 48.9% of the newborns were attended by a pediatrician or neonatologist in the delivery room. Apgar score was determined in 98.2% of the newborns.

Table 4 lists the changes in socioeconomic and perinatal health indicators between the 1997/1998 and 2010 cohorts. The LBW or PTB rates did not change during the study period, but important indicators improved. Maternal schooling increased. Prenatal care coverage and first prenatal visit in the first trimester increased, and there were decreases in the IUGR rate and percentage of single mothers and those younger than 20 years. The IMR, NMR, and PMR also dropped sharply. On the negative side, there was an increase in the cesarean rate (Table 4).

Discussion

Temporal analysis of maternal and child health indicators in São Luís comparing the 1997/1998 cohort with the 2010 BRISA cohort shows that LBW and PTB rates remained stable while the IUGR rate and IMR decreased. There was also a favorable evolution of various socioeconomic and demographic factors associated with these conditions, such as a decline in teenage deliveries, increased maternal schooling, lower percentage of births to single mothers, and increased overall prenatal coverage and first prenatal visit in the first trimester. Despite these favorable indicators, the cesarean rate increased.

The LBW rate remained stable between the two study periods in the São Luís cohorts. A similar result was observed in the 1982, 1993, and 2004 cohorts in Pelotas, where this rate also stabilized around 9-10% [14]. However, these findings differed from Ribeirão Preto, where the LBW rate increased from 7.2% in 1978/1979 to 10.6% in 1994 [30]. Based on birth registry data, an increase in LBW rate was also observed in Brazil's state capitals as a whole [15], but not in the country as a whole [31].

Table 1

Socioeconomic, demographic, reproductive and life-style characteristics of women. BRISA cohort study, São Luís, Maranhão State, Brazil, 2010.

Variables	n	%
Monthly family income (minimum wages)		
≤ 1.0	764	14.8
1.1-1.9	1,244	24.1
2.0-2.9	820	15.9
3.0-4.9	656	12.7
5.0-9.9	486	9.4
≥ 10.0	267	5.2
Missing	929	18.0
Occupation of the family head		
Managers and higher levels professionals	571	11.0
Medium level administrators	487	9.4
Skilled manual workers	248	4.8
Semiskilled manual workers	1,853	35.9
Unskilled manual workers	1,388	26.9
Unemployed	447	8.6
Missing	172	3.3
Number of household members		
1-4	3,544	68.6
≥ 5	1,622	31.4
Economic class		
A	145	2.8
B	788	15.2
C	2,603	50.4
D	1,125	21.8
E	195	3.8
Missing	310	6.0
Self-reported skin color		
White	958	18.5
Black	661	12.8
Mulatto	3,469	67.2
Other	78	1.5
Religion *		
Catholic	2,720	52.7
Evangelical	1,418	27.5
Spiritist	27	0.5
Other	16	0.3
None	981	19.0
Maternal job outside the home		
Yes	1,737	33.6
No	3,429	66.4
Parity		
1	2,443	47.3
2	1,592	30.8
3-4	948	18.4
≥ 5	183	3.5

(continues)

Table 1 (continued)

Variables	n	%
Previous stillbirth		
Yes	151	2.9
No	5,015	97.1
Previous abortion		
Yes	1,115	21.6
No	4,051	78.4
Alcohol consumption during pregnancy		
Yes	746	14.4
No	4,420	85.6
Maternal smoking during pregnancy		
Yes	208	4.0
No	4,958	96.0
Maternal coffee consumption during pregnancy *		
Yes	4,576	88.6
No	589	11.4

* Missing values were excluded.

PTB rates were also stable in the two periods in the São Luís cohorts, at around 13%. These data differ from the findings in Ribeirão Preto, where the PTB rate increased between 1978/1979 and 1994, reaching 13.6% in the latter [13] and in Pelotas, increasing between 1982 and 2004, reaching 14.7% [14]. A review study based on birth registry data also demonstrated that the PTB rate is increasing in Brazil [32]. Another review of population-based studies reached the same conclusion [33].

A 23.7% reduction in the IUGR rate was observed between the two periods in the São Luís cohorts (1997/1998 and 2010). These data differ from the trend in Ribeirão Preto, where the rate increased from 1978/1979 to 1994, reaching 18% in the latter [18]. Comparative data from the Pelotas cohorts showed a reduction in the IUGR rate from 1982 to 1993, but the rate later increased, reaching 12% in 2004 [14].

The reason for a drop in the IUGR rate while LBW and PTB remained stable in the São Luís cohorts between 1997/1998 and 2010 are not fully understood and need further elucidation. The IUGR rates in Brazil may have increased during the 1990s up to 2000, and may have decreased more recently. Since the São Luís data presented here were collected more recently than the Pelotas and Ribeirão Preto data, the current study may have detected the more recent downward national trend in IUGR.

Various studies have identified and discussed the paradoxical trend of increasing LBW rate in parallel with favorable evolution in various socioeconomic and demographic factors and improvement of health services in the last two decades, especially in more developed regions of Brazil [31,34,35]. The increase in LBW and PTB rates has been attributed to the increasing multiple pregnancy rate [36], increased use of assisted reproduction techniques, and improved medical care leading to a reduction in stillbirths, although simultaneously leading to an increase in LBW and/or PTB rates [31] and iatrogenic complications from the excessive number of cesarean deliveries [2,7,13]. Recent stabilization of the LBW and PTB rates in São Luís suggests that the increases observed in PTB and LBW rates in previous decades in Brazil may be leveling out. Consistent with the present data, a downward IUGR rate and stabilization of the LBW rate were detected recently in Porto Alegre, a city in the South of Brazil [37].

The São Luís cohorts showed a downward trend in IMR, dropping to less than half the rate observed in 1997/1998, reaching 12.8 per 1,000 live births in 2010. The Ribeirão Preto and Pelotas cohorts also showed a reduction in the infant mortality rate. The IMR in Ribeirão Preto was 17 per 1,000 live births in 1994 [38] and in Pelotas it was 19.4 per 1,000 in 2004 [39]. A decrease in IMR was also found in Porto Alegre from 1995 to 1999, reaching 12.2 per 1,000 in the latter [40]. These findings are consistent with the reduction in IMR observed in Brazil as a whole in recent decades [19].

Neonatal and perinatal mortality also decreased significantly, while the decrease in the stillbirth rate was not statistically significant, pos-

Table 2

Characteristics of prenatal and childbirth care in the BRISA cohort study, São Luís, Maranhão State, Brazil, 2010.

Variables	n	%
Attended prenatal care		
Yes	5,063	98.0
No	103	2.0
Number of prenatal visits		
None	103	2.0
1-3	537	10.5
4-5	1,149	22.2
≥ 6	3,117	60.3
Missing	260	5.0
Trimester of beginning of prenatal care		
No prenatal care	103	2.0
First	3,418	66.2
Second	1,426	27.6
Third	117	2.3
Missing	102	2.0
Category of prenatal care *		
No prenatal care	103	2.0
SUS	4,123	79.9
Health plan/Health insurance	702	13.6
Private	230	4.5
Type of delivery *		
Vaginal	2,710	52.5
Cesarean	2,456	47.5
Tubal ligation during cesarean delivery *		
Yes	502	9.8
No	4,644	90.2
Professional attending delivery *		
Doctor	4,883	94.9
Nurse	200	3.9
Other	61	1.2
The same doctor provided prenatal care and attended delivery *		
Yes	892	17.3
No	4,270	82.7
Category of admission *		
SUS	4,345	84.1
Health insurance	656	12.7
Private	164	3.2
Total	5,166	100.0

SUS: Brazilian Unified National Health System.

* Missing values were excluded.

sibly due to low numbers in the earlier cohort to assess differences in very rare outcomes. This is consistent with the findings in the Pelotas cohorts, where all these rates fell from 1982 to 2004 [7].

Childbirth among women younger than 20 years (teenage pregnancy) decreased by 36.9% in São Luís from 1997/1998 to 2010, but still repre-

sented a large proportion of all births. In contrast, there was an increase in the teenage pregnancy rate in the Ribeirão Preto cohorts from 1978/1979 to 1994, reaching 17.5 in the latter [41]. However, more recent birth registry data agree with the findings in São Luís and indicate that the teenage pregnancy rate is falling in Brazil, from 23.5% in

Table 3

Sex of the newborn, intrauterine growth restriction and characteristics of health care provided to the newborns. BRISA cohort study, São Luís, Maranhão State, Brazil, 2010.

Variables	n	%
Sex		
Male	2,631	50.9
Female	2,535	49.1
Professional who attended the newborn		
Pediatrician/Neonatologist	2,527	48.9
Obstetrician	1,001	19.4
Anesthesiologist	77	1.5
Nurse	917	17.8
Nurse technician	295	5.7
Other	12	0.2
Missing	337	6.5
Determination of Apgar score		
Yes	5,073	98.2
No	93	1.8
Total	5,166	100.0

1997 to 19.3% in 2011 (Health Informatics Department. Nascidos vivos – Brasil, 2013. http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinasc/cnv/nvuf.def, accessed on 12/Dec/2013), probably reflecting younger women's greater access to contraceptive methods and better knowledge of reproductive issues.

Meanwhile, there was an 83.7% increase from 1997/1998 to 2010 in the number of pregnant women aged 35 years or older. Despite this increase, the percentage of childbirths among women aged 35 years or more is lower than in other Brazilian cities such as Rio de Janeiro [42], Pelotas [43], and Aracaju [1].

In São Luís, from 1997/1998 to 2010, social determinants associated with perinatal health improved, with emphasis on the reduction of low maternal schooling (less than 4 years of study). Similar results were shown in the Ribeirão Preto cohorts from 1978/1979 to 1994 [38] and in the Pelotas cohorts from 1982 to 2004 [44].

Another positive change was a 21.7% reduction from 1997/1998 to 2010 in births to single mothers in the two São Luís cohorts. This result differs from the findings in the Ribeirão Preto [38] and Pelotas [44] cohorts, showing an increase in the percentage of births to single mothers. Even so, this indicator in the two municipalities of the Southeast and South regions is still lower than that of São Luís in 2010.

Prenatal care coverage increased by 6.8% in São Luís from 1997/1998 to 2010, although access was still not universal, with about 2% of all pregnant women still receiving no care. Similar results were also shown in Ribeirão Preto, where prenatal care coverage increased from 1997/1998 to 1994 [45] and in Pelotas from 1982 to 2004 [46], values similar to that of São Luís in 2010. Another favorable indicator in São Luís was early beginning of prenatal care, with an 11% absolute increase in the first prenatal visit in the first trimester, covering up to 67.5% of pregnant women in 2010. In Ribeirão Preto, in 1994, 64% of pregnant women had started prenatal care in the first trimester [47], a rate close to that observed in São Luís in 2010. The studies consistently show a marked increase in prenatal care coverage, in the appropriate number of prenatal visits, and in prenatal care starting in the first trimester. This favorable trend in prenatal care contributed to the declining PMR and IUGR rate.

On the negative side, the cesarean rate increased by 39.3% from 1997/1998 to 2010 in São Luís, reaching 47.5% in 2010. The cesarean rate also increased in Ribeirão Preto from 1997/1998 to 1994 [20] and in Pelotas from 1982 to 2004 [46]. The cesarean rates in all three municipalities were far higher than the 15% limit considered acceptable by the WHO [21,22].

A limitation of the present study was the existence of only two observations over time, which did not allow the study of temporal trends, although it did permit the identification of temporal changes, providing information for the implementation of public policies with a potentially positive impact. In addition, the limited number

Table 4

Comparison of perinatal health indicators in two birth cohorts. São Luís, Maranhão State, Brazil, 1997/1998 and 2010.

Variables	1997/1998		2010		p-value *
	n	%	n	%	
Low birth weight					0.867
No	2,275	91.5	4,706	91.4	
Yes	212	8.5	445	8.6	
Preterm birth					0.764
No	2,164	86.8	4,497	87.1	
Yes	329	13.2	669	12.9	
Classification of weight for gestational age **					< 0.001
Small for gestational age	345	13.9	547	10.6	
Adequate for gestational age	1,943	78.1	4,187	81.0	
Large for gestational age	199	8.0	432	8.4	
Type of delivery					< 0.001
Vaginal	1,643	65.9	2,710	52.5	
Cesarean	850	34.1	2,456	47.5	
Maternal age (years)					< 0.001
< 20	728	29.3	954	18.5	
20-34	1,657	66.5	3,805	73.6	
35 or more	106	4.3	407	7.9	
Maternal schooling (years)					< 0.001
12 or more	120	4.8	779	15.1	
9-11	880	35.4	2,983	57.9	
5-8	1,059	42.6	1,156	22.4	
1-4	273	11.0	208	4.0	
0	155	6.2	26	0.5	
Marital status					< 0.001
Married	717	28.8	1,126	21.8	
Consensual union	1,167	46.8	3,053	59.1	
Single	608	24.4	987	19.1	
Prenatal care					< 0.001
No	203	8.2	103	2.0	
Yes	2,262	91.8	5,063	98.0	
Beginning of prenatal care					< 0.001
No prenatal care	203	8.2	103	2.0	
First trimester	1,401	56.5	3,418	67.5	
Second trimester	799	32.2	1,426	28.2	
Third trimester	79	3.2	117	2.3	
Infant mortality rate					
No	2,422		5,100		
Yes	71	35.8 ***	66	16.2 ***	< 0.001
Neonatal mortality rate					
No	2,443		5,120		
Yes	50	26.4 ***	46	11.9 ***	< 0.001
Perinatal mortality rate					
No	2,448		5,128		
Yes	93	44.7 ***	108	25.0 ***	< 0.001
Stillbirth rate					
No	2,493		5,166		
Yes	48	25.0 ***	70	16.9 ***	0.062

Note: the totals for some variables may differ because of missing values. Percentages may not reach 100% because of rounding.

* p-value calculated excluding missing data;

** Classification of weight for gestational age according to the curve of Williams et al. [27];

*** Per 1,000.

of birth cohorts in Brazil hinders the comparison of perinatal indicators and visualization of regional disparities. However, São Luís is the capital of one Brazil's poorest states, while the cities of Ribeirão Preto and Pelotas belong to states with better socioeconomic indicators, thus allowing comparison of dissimilar social situations. Another limitation was the high percentage of missing data for income.

On the positive side, this was the first study to compare two population-based birth cohorts in Northeast Brazil. Although data collection involved a large number of interviewers, these professionals were properly trained and monitored by supervisors who checked the lists of hospital births daily and worked to reduce losses. Probabilistic sampling also reduced the likelihood of selection bias, and the large sample size allowed highly precise estimates of the target indicators. Since the data were collected in the first hours postpartum and were also obtained from patients' medical records, the probability of recall bias was low.

In conclusion, we observed favorable evolution in various perinatal indicators, which may have contributed to reducing the IUGR rate and IMR in São Luís. However, while some sociodemographic and behavioral factors and health services utilization improved, the PTB and LBW rates remained stable and the cesarean rate increased.

Resumen

El objetivo de este estudio fue analizar los cambios de la salud perinatal en dos cohortes de nacimiento realizadas en 1997/1998 y 2010 en São Luís, Maranhão, Brasil. Un total de 2.493 niños nacidos vivos fueron incluidos en 1997/1998 y 5.166 en 2010. La tasa de bajo peso al nacer (BPN) no cambió (8,5% y 8,6%). La tasa del nacimiento prematuro (TNP) también se mantuvo estable (13,2% y 13%). Los nacimientos entre adolescentes y madres solteras disminuyeron. La escolaridad de la madre y la cobertura de atención prenatal aumentaron. La tasa de restricción del crecimiento intrauterino (RCIU) se redujo de un 13,3% a un 10,6% (p < 0,001). La tasa de mortalidad perinatal disminuyó de 36,6 a 20,7 por mil (p < 0,001), y la tasa de mortalidad infantil (TMI) se redujo de 28,5 a 12,8 por mil (p < 0,001). La tasa de cesárea (TC) aumentó de 34,1% a 47,5% (p < 0,001). A pesar de los cambios favorables en factores sociodemográficos, de conducta y de servicios de salud, y de la reducción de RCIU, mortalidad perinatal e infantil, las tasas de BPN y el PTB se mantuvieron estables, mientras que la TC aumentó.

Recién Nacido de Bajo Peso; Nacimiento Prematuro; Retardo del Crecimiento Fetal; Cesárea; Estudios de Cohorte

Contributors

Acknowledgments

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